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### A National Model for Urban Stream Restoration

by Dr. John Field, PG, and Peter Carney

Restoration of urban-impaired streams in the United States presents unique challenges from both a watershed management and scientific perspective. How can channel processes be returned to a natural state in a setting where many landowners are typically involved, numerous regulatory requirements must be satisfied, and the watershed stressors causing degradation of the streams remain in place? These and other issues had to be addressed as part of a recently completed stream restoration project on a portion of Long Creek in the heavily developed area near the Maine Mall in South Portland, Maine. The process Figure 1. Google Earth image of a portion of the Long Creek Watershed showing the location of the restoration reach and upstream reference reach.

of getting to the finished result on Long Creek is considered by the United States Environmental Protection agency (US EPA) as a potential model for urban stream restoration throughout the United States. As described below, the restoration of Long Creek first required an understanding of what the problems were before devising and implementing solutions to resolve the identified issues both from the management and scientific perspectives.

#### (Restoration, from page 1) **Identifying the Problems**

#### Management perspective

Long Creek is a coastal, freshwater, low-gradient, urban stream with a drainage area of 3.5 square miles in the heart of greater-Portland, Maine's shopping and commercial center. Although development of the watershed began in the 1940s, water quality impairments began to be formally documented in Long Creek in the 1980s. The federal Clean Water Act (CWA), first passed in 1972, required states to adopt water quality classifications. The Maine Department of Environmental Protection (Maine DEP) subsequently devised a four-tier classification system for fresh surface waters in the state including classes AA, A, B, and C where AA waters are of the highest quality. Long Creek is primarily comprised of Class C waters requiring suitable habitat for fish and other aquatic life (e.g., macroinvertebrates). Some pollutant discharges are allowed to cause some changes to aquatic life as long as the receiving waters are only minimally affected.

Under Section 303(b) of the CWA, states are required to regularly list streams that do not meet their state water quality classification. In 1998, Maine DEP first listed Long Creek as an impaired water body, a regulatory status that remains in place to this day. Subsequent studies

by Maine DEP (DEP, 2002) and the US EPA (EPA, 2007) documented the causes of impairment to be low dissolved oxygen levels, decreased large woody debris, high water temperatures, high suspended solids, and high levels of metals with many of these linked to impervious surface areas that currently encompass 28 percent of the watershed. To ensure action was taken to address the identified

impairments, the Conservation Law Foundation (CLF) filed a petition with US EPA in 2008 (CLF, 2008) requesting that stormwater discharges from impervious surfaces within the watershed be required to obtain National Pollution Discharge Elimination System permits under the requirements of the CWA. Subsequently, US EPA determined that stormwater discharges from the dozens of properties with one acre or more of impervious area required a permit for the discharge of stormwater, presenting a problem to the numerous individual landowners in the watershed with limited experience in dealing with regulatory matters.

Ultimately, conditions in the stream channel largely determine whether the streams are listed as impaired. Maine DEP has developed a biomonitoring methodology for correlating benthic macroinvertebrate populations with the attainment of the four water quality classes. Attaining Class C (and Class B in small portions of the upper watershed) conditions will be necessary before Long Creek will be removed from Maine DEP's list

of impaired streams and will require coordination between numerous landowners, towns, and regulators to implement stream restoration projects that improve conditions for those macroinvertebrate species indicative of suitable water quality and overall stream health.

#### Science perspective

A geomorphic assessment was completed of Long Creek to understand the existing conditions on Long Creek and how human activities in the channel (e.g., undersized stream crossings), on the floodplain (e.g., addition of artificial fill), and over the larger watershed (*e.g.*, impervious surfaces) have altered natural channel processes and morphology (*i.e.*, shape and dimensions). The assessment ultimately identified that undersized crossings, artificial fill on the floodplain, and increased runoff from impervious surfaces have all played a role in altering the natural conditions of the creek, contributing to channel incision, bank erosion, the exposure of a clay hardpan on the channel bottom, and the loss of wood and flow complexity in the channel. The result is poor habitat for those macroinvertebrate species that serve as the State's primary indicator of a stream in good health. Due to the absence of such indicator species, the State has listed Long Creek as an urban-impaired stream.



Figure 2. Cross section in the restoration reach showing how artificial fill and an earthen berm severely constrict the natural floodplain.

The 2,000-foot recently restored section of Long Creek that is the focus of this article (Figure 1) exemplified these various human impacts and resulting problems. Artificial fill added to the side slopes between the floodplain and the higher surface on which the commercial developments are found has narrowed the floodplain from an undisturbed width of more than 200 ft in the reference reach to less than 85 ft in large portions of the restoration reach where the channel's bankfull width is 15 ft. (The reference reach conditions remain relatively natural and forested despite being just upstream of the restoration reach because the area is within the flyway of Portland's Jetport where development is forbidden.) The floodplain was further constrained to less than 10 ft wide in one section of the restoration reach area where a stormwater retention basin was built on the floodplain with an enclosing berm built near the edge of the channel (Figure 2). The constrained floodplain, along with excess runoff from the impervious surfaces, has increased flow velocities in the channel. This resulted in the simplification of the channel (*i.e.*,

limited wood retention in channel) and the removal of fine organic matter and sand on the channel bottom, exposing the clay hardpan underneath. While hardpan is exposed on only 10 percent of the channel bottom in the reference reach, that value exceeded 35 percent in the restoration reach. The prevalent clay hardpan and the absence of wood in the channel did not provide suitable habitat for macroinvertebrates in the restoration reach. Consequently, restoration was deemed necessary to provide the channel complexity and floodplain access necessary to create and sustain the conditions required for macroinvertebrate colonization.

#### **Solving the Problems**

#### Management perspective

projects can be built on out-of-the-way land

individual stormwater retrofits on already

impacts.

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that serve multiple parcels, rather than having

developed parcels. Creating the mechanism to

implement these collective projects has resulted

in a lower cost per acre for treating stormwater

Funding for projects identified in the Watershed

Management Plan is acquired through a

individual property owners constructing multiple

While CLF's petition was pending before US EPA, the City of South Portland received a grant under Section 319 of the CWA to study the possibility of implementing a watershedbased restoration plan for the Long Creek Watershed to better understand and identify potential solutions to the problems Maine DEP, and the City of South Portland. In addition, associated with urban impairments in the Long Creek Watershed. LCWMD had to secure easements from nine landowners to Under the resulting Watershed Management Plan (FBE, 2009), a construct the project over 2,000 feet of stream and adjacent series of coordinated restoration efforts would be undertaken on behalf of those landowners, towns, and other entities requiring discharge permits and willing to cooperatively implement the framework created to address the urban impairments in the plan. These cooperating entities would sign on to a "general heavily developed watershed. permit" that would provide permit coverage for the entire category of similar stormwater discharges in the watershed Science perspective and obviate the need for individual landowners to obtain an "individual permit". The general permit would reduce duplicative efforts and ease coordination with regulatory agencies.

In 2009, Maine DEP issued the *General Permit* — Post Construction Discharge of Stormwater in the Long Creek Fall 2019. First, log jams were constructed completely across Watershed that incorporated cooperative implementation of the the channel (simulating features in the reference reach) to restore activities identified in the Watershed Management Plan as a flow complexity and a channel substrate of fine sediment and permit condition. Those choosing not to engage cooperatively in organic matter (leaves, fine detritus) (Figure 3). In less than five implementing the Watershed Management Plan *Figure 3. Constructed full-spanning log jam in restored reach of Long Creek* were required to obtain an individual permit showing flow complexity created as flow passes over and through the structure for their discharge, although 96 percent of the five months after construction. Two other constructed log jams are visible in background. regulated impervious surface area ultimately fell under the general permit and the Watershed Management Plan. The plan is unique in that it offers the key incentive of collectively undertaking projects. Under the plan, large instream restoration projects that span multiple properties can be designed and constructed as a single project. Similarly, stormwater treatment



\$3,000 per-acre-of-impervious-surface annual fee levied on each permittee. To manage the funds, technical development, and permitting that must be completed for each project, the four municipal entities within the watershed formed, by way of cooperative agreement, a quasi-municipal special district known as the Long Creek Watershed Management District (LCWMD). All permittees falling under the general permit are required to enter into a "Participating Landowner Agreement" that allows the District to construct projects identified in the Watershed Management Plan on their property and to carry out good housekeeping, pollution prevention, inspection, maintenance, and monitoring activities.

The in-stream restoration project highlighted in this article was identified in the Watershed Management Plan. The completion of the restoration project was the culmination of a series of meetings of an "expert review panel" convened by LCWMD that prioritized the restored reach among other sections of Long Creek and its tributaries that were considered. Permits to construct the project were required from the U.S. Army Corps of Engineers,

floodplain. Clearly, the large restoration project, and associated benefits, would not have been possible without the management

The project design focused on techniques that would restore natural channel processes to Long Creek and enhance habitat for the macroinvertebrate species indicative of a healthy and naturally functioning stream. Construction was completed in



months after the completion of construction as leaves, branches, and other materials have accumulated on the upstream face of the log jams, water is cascading through the structures, oxygenating the water, and creating numerous microhabitats in close proximity (*i.e.*, fast and slow currents, deep and shallow water). To reduce flow velocities in the channel and ensure the benefits of the log jams are sustained, a berm constricting the floodplain (Figure 2 and Figure 4a) was removed in order to restore a portion of the floodplain (Figure 4b). Although a more complete restoration of the original floodplain width was not possible due to commercial developments on the artificial fill, high flows less than two months after project completion were



Figure 5. Reconnected floodplain inundated for the first time in more than 40 years following a rainstorm less than two months after project construction.

able to spread out on the floodplain in the restored area for the first time in more than 40 years (Figure 5). Future monitoring will establish whether macroinvertebrate populations are responding to the restoration and if the water quality impairments are being reduced.

#### Conclusion

The successful restoration of a critical section of Long Creek in South Portland, Maine required the development of a sound management structure in consort with a site-specific restoration plan. The Long Creek Watershed Management District was established to navigate and build the sensitive relationships between multiple landowners, regulators, towns, and other interests in order to



Figure 4. Long Creek restoration included a) removal of a stormwater retention berm to b) reconnect a portion of the floodplain.

reach consensus on mutually acceptable solutions to problems resulting from urbanization of the Long Creek Watershed. With LCWMD established, the participating landowners are now able to undertake larger more impactful projects that would otherwise be impossible to complete individually on

> their own properties – an arrangement also preferred by the regulatory agencies and more beneficial for the creek itself. By identifying the factors impacting channel form and function in the restoration reach and comparing that with conditions in the less disturbed reference reach a technical scientifically-sound plan was designed and implemented that reduced the impacts

of human development (*e.g.*, removal of floodplain encroachments) and returned natural features to the channel (*e.g.*, log jams) to restore the natural processes necessary for improving and sustaining high-quality macroinvertebrate habitat (*e.g.*, flow complexity, deposition of fine nutrient-rich sediment) and overall stream health.

Stream restoration has become a billion dollar industry in the United States with many failures and limited documented success (Miller and Kochel, 2010; Cockerill and Anderson, 2014). The currently widely used form-based restoration approaches impose idealized natural channel conditions on the landscape that are often not in equilibrium with their urbanized settings and, as a result, often quickly unravel as the streams readjust and respond to the unaddressed human-influenced conditions present in the watershed. While some of the specific restoration techniques used on Long Creek may not be applicable elsewhere (such as channel-spanning log jams on larger streams), the management structure established and more scientifically sound process-based restoration approach used could serve as a national model for implementing more effective and sustainable restoration projects on urbanimpaired streams across the country.◆

Dr. John Field, PG, is President of Field Geology Services. Mr. Peter Carney serves as Executive Director for the Long Creek Watershed Management District.

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## Generous Attitudes Generate Gratitude



#### by Gary G. Marsh

At the start of the pandemic, as I was pulling into the entrance of a local store, I recognized a buddy in his pickup truck talkin to someone in the parking lot. I stopped and rolled down my window to say hello while maintaining the appropriate 'social distance.' The person standing said, "Watch out, Mike has the 'macaroni' virus!" alluding to Mike's recent eating habits and waistline. Thank goodness self-quarantine hasn't defeated our sense of humor, though it appears may change our world forew

Although this virus has postponed some, if not most, of our enjoyable activities, events, family outings, and plans, we hope it will end soon. As you may know, the River Management Society (RMS) Training Symposium, Mountain Creeks to Met Canals, in Richmond, VA, has been rescheduled for May 18-22 2021. On the upside, this provides planners and organizers an additional year to garner sponsors, speakers, and resources for another exciting networking opportunity. On the flip side, RMS greatly depends on this signature event every two years to help fund talented staff (our Executive Director, Journal Editor, Riv Training Center Coordinator, Communications Coordinator, G and Project Assistant, and interns) as well as critical operating expenses. Since this financial support will be delayed a year in the budget cycle, I am encouraging those members who are at to help sustain the momentum and progress RMS has achieved date.

With some 400 active members, RMS is an efficient, creative, and fiscally responsible steward of a small annual operating budget. Our members have played a key role in the success of RMS in the past, and I imagine we all would like to see an increase in services and programs built up by our Chapters and the Board's leadership. The national RMS Board of Directors will be preparing a 2021 calendar year budget in October at its annual meeting. This exercise will no doubt involve hard choices based on this year's (2020) funding shortfall due to Covid-19 restrictions. Ideally, membership dues and symposiu workshop registration fees will remain the same, and we will be able to maintain our quarterly RMS Journal. The stability of RMS depends on steady momentum from consistent funding, networking, and training. The wealth of RMS emphasizes the richness of its membership. The more we know about RMS (and its members), the more we appreciate what our small nonprofit can do. Giving back is one way to express gratitude for what RMS has done for each of us.

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ng l ver. e tro 1,	RMS is largely a volunteer organization. We rely on members lending leadership skills as Chapter or National officers and Board members — there are vacancies in the Pacific, Midwest, Southeast and Canadian Chapters. We encourage members to submit nominations for the annual RMS awards, serve on a committee, or enlist new members (by also considering the gift of membership!). We appreciate those who organize and host Chapter river trips and workshops. We often invite members to write Journal articles, and speak on behalf of RMS within your community. We enjoy publishing your book reviews, poems, float or 'flipping the boat' stories. Some of you have grant-writing skills that we'd love to tap. Some of you have already started stockpiling articles for our live and/or silent auctions that will take place in Richmond, VA, next year. Everyone has a role to play.
S ver IS ble I to	Financial donations are necessary and important to any organization. Giving is a private and confidential matter — freely motivated without coercion, imposition, or gimmick. Those who are not able to give financially should not feel obligated to do so. RMS also relies on those who give their time, energy, passion, and expertise. We should not give to compete — for prestige or recognition — nor desire for anything in return. While it may not be the right time, and you may not have the resources to give, be assured that your generosity of attitude always generates gratitude from RMS. When it rains, it pours, and river momentum increases. Thanks to you all, water still flows downhill, even in a drought.◆
1	Please review ways to give. As you may know the IRS has delayed filing 2019 taxes until July 15, 2020. For those who can, please consider a donation, in-kind donation, or monthly donor program. In addition, check out the many other tax-deductible options at this link: <u>https://rms.memberclicks.net/donate</u>
ım/ f	You may also want to glance at the RMS Strategic Plan (2017-2022) to see where the organization is headed: https://rms.memberclicks.net/plans-and-policies
nd t	Mentoring is yet another opportunity: https://rms.memberclicks.net/mentoring You may also want to get involved with our River Training

Center: https://rms.memberclicks.net/training