UNITED STATES ENVIRONMENTAL PROTECTION AGENCY PRELIMINARY RESIDUAL DESIGNATION PURSUANT TO CLEAN WATER ACT REGION I

I. INTRODUCTION

Under Clean Water Act ("CWA") section 402(p), 33 U.S.C. § 1342(p), the United States Environmental Protection Agency ("EPA") has established permitting requirements for certain storm water discharges. EPA established such requirements in two phases: Phase I, 55 Fed. Reg. 47990 (Nov. 16, 1990); and Phase II, 64 Fed. Reg. 68,722 (Dec. 8, 1999). In addition, under section 402(p)(2)(E) and (6) and 40 C.F.R. § 122.26 (a)(9)(i)(D), the EPA Regional Administrator may designate additional storm water discharges as requiring National Pollutant Discharge Elimination System (NPDES) permits where he determines that the discharge, or category of discharges within a geographic area, contributes to a violation of a water quality standard.

On March 6, 2008, EPA Region I received a petition from the Conservation Law Foundation requesting that the Agency designate certain storm water discharges into Long Creek as requiring NPDES permits. Upon reviewing the petition and other relevant facts and law, and in consultation with the State of Maine, EPA Region I determined that a designation pursuant to its authority under the CWA is appropriate. This determination is made without deciding whether it is necessary for EPA to respond to a petition under 40 C.F.R. §122.26(f)(2) in a state such as Maine that has been approved to administer the NPDES program pursuant to CWA §405(a) and 40 C.F.R. Part 123.

EPA is encouraging public comment on the nature and scope of this preliminary residual designation for forty-five days following public notice of it, after which EPA will review this preliminary residual designation. The question of whether this preliminary residual designation was proper will remain open for consideration until the close of the public comment period on any NPDES general or individual permit related to this preliminary residual designation. It is EPA's intention to make a final residual designation at the close of the comment period.

A. GENERAL

This Record of Decision documents a preliminary determination pursuant to the CWA, 33 U.S.C. §§ 1251 et seq., and 40 C.F.R. §122.26 (a) (9)(i)(D) by the Regional Administrator of EPA Region I that storm water controls and NPDES permits are needed for discharges to waters of the United States from the following category of storm water discharges ("designated discharges"):

> **Designated Discharges:** Storm water discharges from properties on which there are impervious surfaces or areas equal to or greater than one acre in the Long Creek watershed.

For purposes of this preliminary residual designation, the Long Creek watershed includes all areas that discharge directly to Long Creek or its tributaries or that discharge indirectly to Long Creek or its tributaries through Municipal Separate Storm Sewer Systems (MS4s) or other private or public conveyance systems. The watershed boundary is approximately delineated in Attachment A. This boundary was established using drainage divide coverage developed by the Maine Office of GIS and surface elevation data from USGS topographic maps, as well as on-ground survey work conducted by DEP in developed areas as of 2005.[1.]

For purposes of this preliminary residual designation, impervious surface or impervious area means: the total area of a parcel or right-of-way that consists of buildings 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 surfaces and 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.

This is a determination that properties from which there is a designated discharge are required to obtain a NPDES permit because this category of discharges contributes to a violation of a water quality standard. This preliminary residual designation shall not apply to any discharge already subject to the NPDES permitting program.

This determination is made consistent with § 402(p) of the CWA, 33 U.S.C. § 1342(p), and related regulations found at 40 C.F.R. § 122.26.

This document is structured generally as follows: Subsections B and C of this section provide a general introduction to the Long Creek watershed. Section II discusses scientific research, including studies specific to Long Creek, documenting that land development and the creation of impervious surfaces generate storm water that contributes to the degradation of receiving waters. Section III describes the CWA storm water residual designation authorities. Section IV documents how storm water discharges are currently contributing to violations of Maine water quality standards. Section V then provides the basis for EPA's selection of the designated discharges as those needing control in this preliminary residual designation. Finally, Section VI presents EPA's determinations under 40 C.F.R. § 122.26 (a) (9) (i) (D).

B. LONG CREEK GENERALLY

Long Creek, formerly known as Jackson Brook, is a low-gradient freshwater stream in southern Maine that flows into Clark's Pond, the Fore River and eventually Casco Bay. The entire Long Creek above Clark's Pond drains a watershed area of 3.45 square miles. There are seven subwatersheds of Long Creek, located primarily in the City of South Portland and the Town of Westbrook, with portions of five of those seven subwatersheds located in the Town of Scarborough and in the City of Portland (see map in Attachment B for subwatershed delineations).

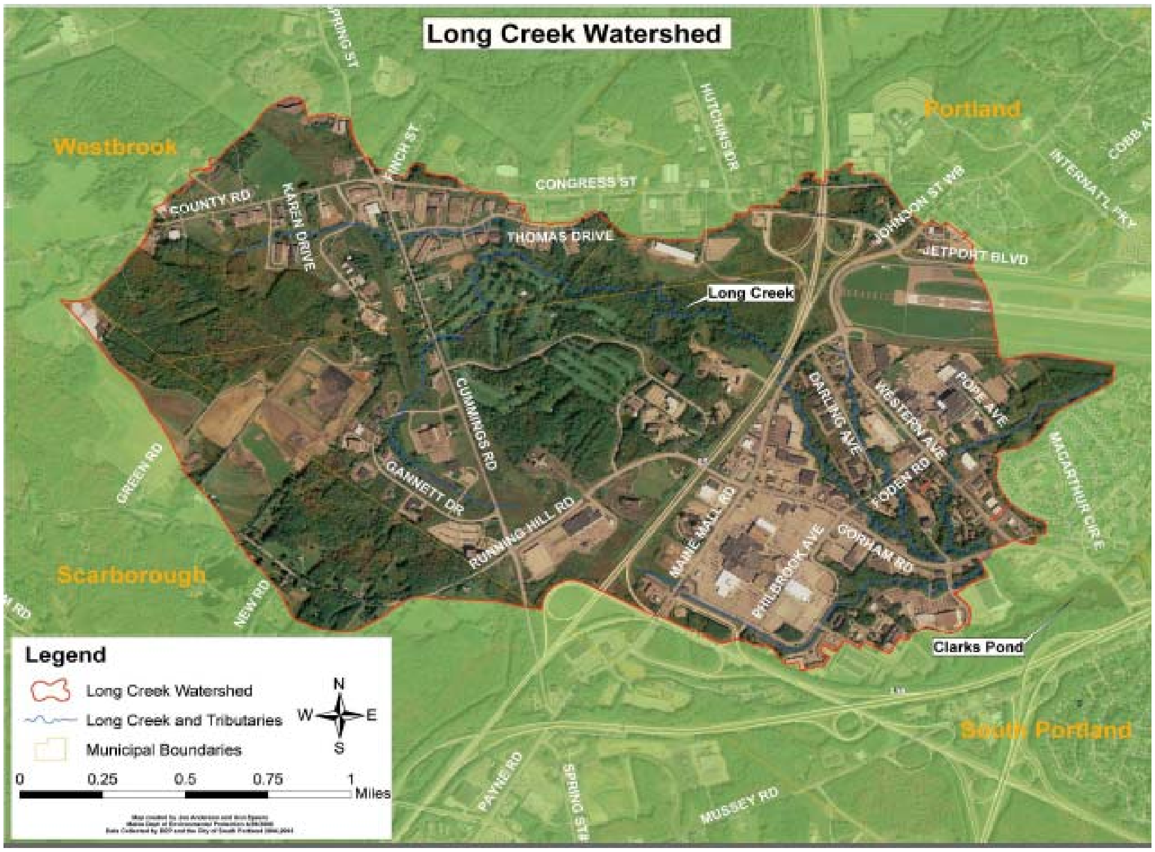


Figure 1. Long Creek Watershed Source: Long Creek Restoration Project, 2008

In 1997, the Maine Legislature ordered the establishment of a comprehensive watershed protection program and directed the Maine Land and Water Resources Council (MLWRC) to list "nonpoint source (NPS) priority watersheds" for restoration funding.[33.] The MLWRC listed Long Creek as one of Maine's "highest priorities" despite its very small size due to its potential high value in an urban setting.[34.] ("Priority waters are selected based on NPS impairment or threat status, value of the waters, and feasibility for success of restoration or protection efforts.") (Note that while often described as "nonpoint" source discharges, urban storm water runoff and the pollutants it contains can also reach waters through a CWA "point source" discharge. Thus, although 303(d) listings sometimes refer to a nonpoint source as the cause of an impairment, in some cases it would be more accurate for this to refer to a point source discharge not designated for NPDES coverage.)

DEP, acting pursuant to § 303(d) of the CWA, included a 4.12 mile segment of Long Creek in its 1998, 2002, 2004, 2006 and 2008 lists of impaired Maine waters. In 1998, DEP listed Long Creek as impaired for not meeting applicable state water quality criteria for dissolved oxygen levels. In 2002, 2004, 2006 and 2008, DEP listed that segment of Long Creek as impaired for non-attainment of applicable aquatic life uses.

In 1999, EPA Region I chose for grant funding DEP's Long Creek proposal for study of an impaired urban watershed. That grant resulted in a document that compares Long Creek watershed and Long Creek to the adjacent Red Brook watershed and Red Brook.[4.] That study identified urban runoff from rain events as the suspected cause of water quality impairments in Long Creek.

Between the years 1998-2006, DEP conducted an extensive scientific study of Long Creek's chemical, physical, and biological water quality, as well as its hydrology and fluvial geomorphology. DEP's sampling and analysis indicated that Long Creek's water quality exhibited low dissolved oxygen, high temperatures, high suspended solids, and high levels of heavy metals, specifically zinc, lead, and copper. All of these pollutants are commonly associated with storm water runoff from impervious surfaces such as streets, parking lots, and roofs of large buildings.

Mounting public attention supports the goal of reviving the aquatic ecosystems in Long Creek. The City of South Portland and the South Portland Land Trust are developing creek-side trails and greenbelt easements.[35.] A stakeholder group has formed to develop a watershed remediation plan.[36.] Finally, developers are building residential and mixed use neighborhoods adjacent to these waters.[37.]

With the exception of municipal separate storm sewer systems (MS4s), there are no known natural or currently permitted point source discharges of lead, zinc or copper into Long Creek. The only known other point source discharges into Long Creek are two 2007 sanitary sewer overflows from South Portland's Long Creek pump station (formerly Combined Sewer Overflow outfall #004, which was closed in 2004). This historical discharge was located downstream of Clark's Pond and does not appear to affect stream reaches covered by this designation.

C. LONG CREEK and IMPERVIOUS COVER

Significant land development in the Long Creek watershed, including development for commercial, industrial, and transportation-related land uses, has occurred over the last few decades. Specific examples of development include: an enclosed regional shopping mall with 140 stores, 18 restaurants, and over 5,500 parking spaces; part of the Portland airport (Portland International Jetport); a golf course; two office parks; residential complexes; portions of the Maine Turnpike; an interstate highway; and a waste incinerator and associated landfill.[4.] By 2006, impervious acreage had expanded to cover an estimated 35% of the watershed and has undoubtedly expanded further since, given the rapid pace of development in the area.[26.] As shown in Attachment B, conditions on a subwatershed basis range from a low of 11% impervious area in the southwestern portion of the upper watershed, to a high of 60% impervious cover in the downstream portion of the Long Creek watershed.

Annual rainfall in the Long Creek watershed averages 42.27 inches per year as measured at the nearby Portland Airport. Rainfall sufficient to generate storm water runoff in the Long Creek watershed is transported from impervious surfaces and other point sources such as catch basins, drains, culverts, pipes, and catchment outfalls to Long Creek and its tributaries.[2.]

Prior to the 1960s, the Long Creek and Red Brook watersheds were primarily forest and farmland, and both sustained populations of brook and brown trout.[38.] Clark's Pond, at the base of the two watersheds, was a popular swimming, fishing, boating and picnicking spot. Its waters were "clear and open," supporting brook trout, among many other species, and up until the late 1950s produced some of the "clearest" and "finest" ice in the Portland region.[38.]

II. GENERAL FACTUAL BACKGROUND

A. IMPERVIOUS COVER, STORM WATER and WATER QUALITY

The clearing of natural land cover and construction of impervious surfaces convert precipitation (normally infiltrated into the ground and taken up by vegetation) to surface runoff. The land's capacity to attenuate flows and break down pollutants is reduced as other features of the terrain are ditched, drained, piped and armored to efficiently shed runoff. This combination of reduced retention and enhanced conveyance causes increased flooding, degraded stream channels, reduced ground water recharge, lower stream baseflows, and polluted surface waters.

Numerous scientific studies document that impervious cover both increases the volume of rainfall that becomes runoff and amplifies the loads of pollutants flowing to surface waters. There are several reasons for this: 1) rain falling on impervious cover runs off without infiltrating into the ground, thus creating a higher volume of runoff per unit area; 2) unlike pervious areas that trap and filter pollutants through soils and surface retention, impervious surfaces allow greater amounts of pollutants to be carried away by runoff; and 3) pollutants such as metals on impervious surfaces are particularly susceptible to transport by runoff because of their tendency to adhere to very small (i.e., fine) particles, which are easily washed off hard surfaces by rainfall. These factors, operating simultaneously, dramatically increase pollutant loadings from impervious surfaces.

Local and national monitoring of the nature and impacts of storm water pollution shows that the typical sample of urban storm water is characterized by high levels of pollutants such as sediment, nutrients, metals, organic carbon, hydrocarbons, pesticides, and bacteria.[6.] The impervious surfaces in the developed portions of the Long Creek watershed are similar to those in urban watersheds in terms of the pollutant loadings they create, and DEP classifies Long Creek as one of Maine's urban watersheds. As presented in section IV.B.2, below, analyses of Long Creek water samples indicate high levels of suspended solids, and high levels of heavy metals, such as zinc, lead and copper.

Storm water research links specific metals to specific associated sources and source areas in highly developed watersheds, with examples shown in Table 1. Zinc in urban environments results from the wear of automobile tires (60%), fuel combustion, weathering of paints, galvanized gutters and downspouts, roofs, and road salts. Source areas for zinc include streets, parking lots, and rooftops. Sources of lead include diesel fuel emissions, and weathering of paints and stains. Source areas for lead include streets, parking lots, and residential and commercial rooftops. Sources of copper include auto brake pad wear (50%), weathering of pipes and fittings, algaecides, and electroplating. Source areas for copper include streets, parking lots, and residential and commercial roofs. Table 1 indicates the direct correlation between impervious cover and metals contamination.

Table 1. Example Metal Source Area Concentrations in the Urban Landscape (ug/l)

Source Area	Total Zinc	Total Lead	Total Copper
High Traffic Street	508	50	46
Medium Traffic Street	339	55	56
Low Traffic Street	229	33	24
Commercial Rooftop	330	9	9
Basin Outlet	203	32	16
Commercial Parking Lot	178	22	15
Residential Rooftop	149	21	15
Residential Driveway	107	17	17
Residential Lawn	59	N/R	13

Note: N/R = Not reported
(Adapted from CWP 2003; data source: Bannerman et al, 1993)[6.]

In 2001, Maine DEP issued new guidelines under its Chapter 500 Storm Water Management Rules establishing more stringent standards for developments in watersheds of urban impaired streams, including Long Creek, due to the effects of storm water runoff.

Percent Impervious Cover ("IC") is used by DEP as a surrogate measure of the health of urban impaired streams because "[r]ecent studies have shown that the percentage of IC in a watershed strongly affects the health of aquatic systems."[39.] IC "relates the primary causal factors [stressors] to specific impairments.[39., 4.]

DEP has adopted guidelines specifying the percentage range of IC that can coexist with a biological community that meets aquatic life criteria. The guidelines for watersheds as a whole are 7%-10% IC for Class B streams (usual attainment at 8%) and 10%-15% IC for Class C streams (usual attainment at 15%).[39.] A survey of urban impaired streams in Maine found that "[s]tream response to imperviousness exhibits a threshold at 6%-10%, beyond which damage to the biotic community is significant."[40.] EPA Region I approved Maine's use of Percent IC as a surrogate measure of stream health for the same reasons, noting that using IC relates directly to both the source of the impairment and to restoration methods.[41.]

B. RELATIONSHIP BETWEEN IMPERVIOUS COVER and WATER QUALITY in LONG CREEK

Extensive scientific research documents that contaminated storm water generated from impervious cover contributes to the degradation of water quality. Studies specific to Long Creek establish that as the watershed underwent development and impervious surfaces generating contaminated storm water expanded, water quality declined and now violates Maine's water quality standards. Comparative studies between the more developed portions of Long Creek and the less developed portions of Red Brook, two comparable watersheds in their undeveloped states, further substantiate that impervious surfaces and the storm water running off it cause or contribute to water quality standards violations in Long Creek.

Data analyzed in 2005 indicate that, with respect to Long Creek, the impervious area in the watershed as a whole was 35%. Information available at the sub-watershed level indicates that impervious cover ranges from 11%-60% (see Attachment B). As described below, studies of the Long Creek watershed document the expansion of impervious cover and the subsequent decline in water quality, including numerous violations of water quality standards.[2., 4.]

The map of the Long Creek watershed in Attachment A uses shaded and colored areas to indicate the location of some of these various types of impervious surfaces. This map shows Long Creek and tributaries (in blue), the Long Creek watershed boundary (in red), main stem and tributary subwatersheds (in yellow), and municipal boundaries (for South Portland, Scarborough, Westbrook, and Portland).

Both EPA and DEP have examined the relationship between impervious cover and water quality in the Long Creek watershed. DEP conducted an extensive watershed assessment to which EPA then applied an analytical construct to find links between imperviousness and stream degradation. These efforts yielded reports that compare the water quality in the more heavily developed portions of Long Creek to the water quality in the less developed portions of Red Brook, a nearby stream: ["Two Urban Streams" noted above; C. Zeigler et al., *Causal Analysis of Biological Impairment in Long Creek: A Sandy-Bottomed Stream in Coastal Southern Maine,* EPA National Center for Environmental Assessment, Office of Research and Development, EPA/600/R-06/065F (Dec. 2007) ("EPA Stressor Report".)] Long Creek and Red Brook share similar morphology. Both are low-gradient (gently sloped) and, in most locations, have streambeds dominated by fine sediment size classes, i.e., sands, silts, and clays. Because the upper Red Brook watershed is identical to the Long Creek watershed in almost all respects except land use, it is used as an unimpaired reference stream in DEP and EPA's watershed assessment analyses of Long Creek.[2., 4.]

As noted above, Long Creek is located in the towns of South Portland, Portland, Westbrook, and Scarborough, Maine and is a tributary to Clark's Pond and the Fore River Estuary with a contributing watershed of 3.45 square miles and three separate branches, including the north branch (LC-N), the south branch (LC-S), and the main stem (LC-M). Red Brook is located in the towns of South Portland and Scarborough, Maine and is also a tributary to Clark's Pond and the Fore River Estuary The Red Brook watershed covers 3.3 square miles.

Between 1952 and 1995, urban land cover of the Long Creek watershed increased by 36 percent, while urban cover in Red Brook increased by only 10 percent.[2., 4.] The Long Creek watershed contains intensive urbanization and commercial development, including the Maine Mall and many other associated commercial and retail developments, I-95 and I-295 and associated interchanges, industrial facilities, office parks, hotels and a golf course, and some forest and wetlands. While the lower Red Brook watershed also includes portions of I-95 and I-295 and has some residential and retail development, that portion of Red Brook upstream of I-95 (Upper Red Brook) is primarily characterized by less development, and greater forest and wetland land use types.

As noted below, DEP included Long Creek on its list of impaired waters in 1998, 2002, 2004, 2006, and 2008. Portions of Red Brook also exceed water quality criteria, but the Upper Red Brook reference segment upstream of I-295 meets Maine Class A water quality standards (the second highest possible classification for fresh waters) and has a healthy population of brook trout.[2., 48.]

All of the Long Creek branches that were sampled downstream of areas with significant amounts of impervious surfaces and other urban/suburban land use activities had higher concentrations of metals, nutrients, chloride, suspended solids, and polycyclic aromatic hydrocarbons compared to Red Brook, which was sampled below a region having a relatively low percent total impervious area (PTIA) value.[2.]

Brook trout and brown trout had been documented in Long Creek as recently as the late 1960s.[2.] Today, brook trout are non-existent in Long Creek, but "fairly abundant" at sampling locations in Red Brook with PTIA values between 2%-8%.[2.]

In addition to the comparative studies noted above that document the direct relationship between impervious cover and water quality degradation, the deleterious effects of impervious cover on water quality are also evident in comparing water quality data from samples collected from Long Creek during wet weather (when storm water would be flushing pollutants from extensive impervious surfaces into the Creek) to water quality data from samples collected during wet weather from Upper Red Brook (where the influence of impervious cover and its pollutant loading would be less). That comparison shows that wet weather metals levels in Long Creek violated standards for lead, zinc, copper and nickel; in contrast, wet weather metals levels in Upper Red Brook had the lowest detected levels of maximum concentrations of lead, zinc, copper and nickel during storm flows, and all samples were below state criteria for chronic and acute exposure.[4.]

Scientists comparing the extent of impervious cover (and water quality) in Long Creek and Red Brook concluded that impervious cover was in large part responsible for water quality impairments (and resultant water quality standards violations as documented below) in Long Creek.[2.]

Additional studies also connect water quality impairments in Long Creek to the expansion of impervious cover.[38.] These studies document that significant degradation of the Long Creek and Clark's Pond watershed began in the late 1960s with construction of I-295 and the Maine Mall, and associated land use changes. As described by the City of South Portland's Planning Department, as a result of the I-295 construction, "[t]he channel of Jackson Brook [now refereed to as Long Creek] became choked with sediment, much of which entered Clark's Pond. The construction and the sedimentation, lasted several years. At about the same time, construction of the Maine Mall began and land use of the watershed changed dramatically. The development of several sites in the Jackson Brook [now Long Creek] watershed brought severe erosion and sedimentation to Clark's Pond …. In addition, urban runoff …began to affect the Pond."[38.]

By 1983, South Portland, working in cooperation with DEP, found that sedimentation from ongoing development and storm water discharges from impervious surfaces, such as parking lots and highways, were the causes of ongoing and severe water quality problems in the watershed.[38.] They further found that parking lot runoff into LC-N, LC-M, and LC-S "was a major concern," and recommended that the city require sediment controls on new construction. For existing and new infrastructure, the study recommended a series of storm water Best Management Practices (BMPs), including buffer strips, oil and water separators, vegetative treatment of storm water, and storm water detention facilities.[38.]

A follow-up study of Clark's Pond by South Portland in 1994 noted that despite the comparative size of the Long Creek and Red Brook watersheds, "75% of the total flow entering Clark's Pond during precipitation events is from [Long Creek]," and attributed that fact to the greater commercial development of Long Creek, including the Maine Mall area.[52.] This follow-up study mapped "significant" and "major" storm water inputs within the Long Creek watershed and identified these sites as being "moderate" or "severe" problems and further identified pollutant hotspots from "automobiles and associated activities, including gas stations, car maintenance lots, and drive-thru restaurants and banks." The greatest concentration of hotspots was found in LC-M and the study determined that "although they tended to be apparently away from the edge of the stream channel, they likely still contributed pollutants to the stream during storms because storm water 'washed' the pavement and then headed directly towards storm water collection systems, only to be contributed directly to the stream."[52.]

The effect of storm water on Long Creek's water quality is also apparent in comparing metals levels among subwatersheds with varying levels of impervious cover. LC-S, which has the highest percent total impervious area, also had the highest levels of toxic pollutants--including levels of lead, zinc, and copper--in storm flows that violated state standards “sometimes by a factor of 9.”[52.] Of the three subwatersheds in which DEP conducted sampling and analysis for metals contamination, two have impervious cover exceeding 40% and one has impervious cover exceeding 25%. If DEP data from the three storms are averaged for each metal of concern--zinc, lead and copper--concentrations are higher on average in the two >40% impervious cover subwatersheds than in the 25%-40% impervious cover subwatershed. Averaging of results for this wet weather sampling is appropriate due to the variability in time of sampling, rainfall volume, antecedent dry period, and other factors relevant to variability in storm water sampling generally.

Table 2. Metal Concentrations Averaged for each Storm and Averaged Across Three Storms

Watershed/Site	%IC	Zinc (ug/l)	Lead (ug/l)	Copper (ug/l)
LC-S-0.186 Maine Mall	>40	98	21	12
LC-M-0.595 Mall Plaza	>40	100	15	10
LC-N-0.585 Jetport	25-40	90	12	9

Using data developed by DEP in its “Two Urban Streams Study,” the “EPA Stressor Report” analyzes the leading causes of ecosystem stress in Long Creek, focusing particularly on the stressors that cause biological impairments. The “EPA Stressor Report” establishes probable causes of water quality standards violations in Long Creek by applying DEP's monitoring data to EPA's Stressor Identification process, a methodology that assesses causes and effects in surface water pollution.

The Report identifies for each probable cause/stressor, the anthropogenic activities related to that stressor, and the specific steps, or “causal pathways,” between the source and the biological response. It identifies impervious surfaces and the storm water it generates as an anthropogenic source that contributes to each of the probable causes of the biological impairments in Long Creek. The Report concludes that multiple probable causes or environmental stressors are responsible for the biological impairment of Long Creek, including decreased dissolved oxygen, altered flow regime, decreased woody debris, increased water temperatures and increased toxicity.[2.] The Report further concludes that each of these individual proximate stressors may also be acting jointly to cause Long Creek’s biological impairments and particularly notes the complex interactions of dissolved oxygen, altered flow regime and temperature.[2.]

III. GENERAL LEGAL BACKGROUND

A. CLEAN WATER ACT

In 1987, Congress amended the CWA to require implementation, in two phases, of a comprehensive national program for addressing storm water discharges. In 1990, EPA promulgated the Phase I Rule that regulates storm water discharges from major storm water pollution sources, including discharges associated with industrial activities, discharges from construction sites greater than five acres and discharges from large and medium municipal MS4s. 55 Fed. Reg. 47,990 (Nov. 16, 1990). In 1999, EPA expanded the universe of storm water discharges subject to control under the NPDES program by adding discharges from smaller MS4s in urbanized areas (small MS4s) and discharges from construction sites disturbing between one and five acres of land. 64 Fed. Reg. 68,781 (Dec. 8, 1999). EPA promulgated these rules based on data collected through extensive, nationwide storm water studies.

Section 402(p) of the CWA and related regulations recognize that in order to protect water quality, additional storm water sources may need to be regulated on a case-by-case or category-by-category basis relying on additional information or localized conditions. CWA section 402(p)(2)(E) and (6) and 40 C.F.R. § 122.26 (a) (9) i) C) and (D). This authority to regulate other sources based on storm water's localized adverse impact on water quality through NPDES permits is commonly referred to as the "Residual Designation" authority.

B. RELEVANT REGULATORY PROVISIONS

EPA's regulations addressing the control of storm water discharges are found, generally, at 40 C.F.R. Part 122. EPA's authority to designate for NPDES permitting purposes storm water discharges is found at 40 C.F.R. §122.26(a), which provides, in relevant extract, as follows:

(9)(i) On and after October 1, 1994, for discharges composed entirely of storm water … operators shall be required to obtain a NPDES permit … if:

(D) The Director, or in States with approved NPDES programs, either the Director or the EPA Regional Administrator, determines that the discharge, or category of discharges within a geographic area, contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

This preliminary residual designation is based on 40 C.F.R. §122.26(a)(9)(i)(D).

IV. FACTUAL BASIS FOR DETERMINATIONS

A. MAINE WATER QUALITY STANDARDS

1. Criteria and Uses

The goal of the CWA is to restore and maintain the chemical, physical and biological integrity of the Nation's waters, including, where attainable, the protection and propagation of fish, shellfish and wildlife and the provision of recreation in and on the water. CWA section 101(a), 33 U.S.C. § 1251(a). To advance these goals, states are required to promulgate water quality standards that include both (1) beneficial uses of their waters; and (2) criteria to protect those uses. CWA section 303, 33 U.S.C. § 1313. 40 CFR § 131.2. Water quality criteria can be expressed in narrative or numeric terms. Id.

Maine has adopted and EPA has approved water quality standards under the CWA in order to enhance water quality and to serve the purposes of the CWA. Maine's water quality standards are organized so that different sets of standards apply to each of several classes. These classes represent a hierarchy of uses.

The relevant standards for Long Creek are those for Class B and Class C, as described in Table 3 below. Both Class B and C waters are designated to support, among other uses, fishing, and habitat for fish and other aquatic life. Those portions of Long Creek located in Westbrook are designated Class B waters and those portions of Long Creek located in South

Portland, Scarborough and Portland are designated Class C waters. Class B and Class C waters are protected by criteria relating to aquatic life, including criteria for dissolved oxygen and toxic pollutants that are presented in Table 3 below. Figure 1, above, displays which stretch of Long Creek flows through each of these municipalities and, hence, which class applies to each segment.

The Class B and Class C water quality criteria applicable to Long Creek include numeric criteria for dissolved oxygen and toxic metal pollutants and narrative criteria protecting aquatic life use. Maine has also developed biocriteria that provide a quantitative method for interpreting the narrative aquatic use standard. The relevant use standard and associated biocriteria are discussed further in Part B (4), below.

The numeric metals criteria concentrations established to protect aquatic life are expressed as "chronic" levels (which address lethal and sub-lethal effects from long-term exposures) and as "acute" levels (which address effects usually expressed as lethality from short-term exposures).

To account for fluctuating exposures and related adverse effects, Maine's water quality criteria for metals include limits on the duration of aquatic life's exposure to pollutant concentrations above the criteria to an averaging period of 1 hour for acute criteria, and an averaging period of 4 days for chronic criteria. To protect ecological communities against environmental stresses, the criteria provide that, on average, excursions of the chronic criteria can occur for no more than one hour every three years and that excursions of the acute criteria can occur for no more than four days every three years. In other words, the acute criterion concentration for a particular metal should not be exceeded instream for more than one hour every three years on average; the chronic criterion should not be exceeded for more than four days every three years on average. These averaging periods and frequency of exceedence values are part of the water quality standards and are used in assessing violations of the metals standards.

Table 3. Applicable Maine Water Quality Standards

	Designated Uses/Criteria	Source
Standards for classification of fresh surface waters	Class B waters 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.	38 MRSA §465 (3)(A)
	Discharges to Class B waters may not cause adverse impact to aquatic life in that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.	38 MRSA §465 (3)(C)
	Class C waters 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.	38 MRSA §465 (4)(A)
	Discharges to Class C waters may cause some changes to aquatic life, except that the receiving waters must be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.	38 MRSA §465 (4)(C)
Dissolved oxygen levels: numeric criteria	The dissolved oxygen content of Class B waters shall be not less than 7 parts per million or 75% of saturation, whichever is higher, except that for the period from October 1st to May 14th, in order to ensure spawning and egg incubation of indigenous fish species, the 7-day mean dissolved oxygen concentration shall not be less than 9.5 parts per million and the 1-day minimum dissolved oxygen concentration shall not be less than 8.0 parts per million in identified fish spawning areas.	38 MRSA §465: (3)(B)
	The dissolved oxygen content of Class C water may be not less than 5 parts per million or 60% of saturation, whichever is higher, except that in identified salmonid spawning areas where water quality is sufficient to ensure spawning, egg incubation and survival or early life stages, that water quality sufficient for these purposes must be maintained. In order to provide additional protection for the growth of indigenous fish, the 30-day average dissolved oxygen criterion of a Class C water is 6.5 parts per million using a temperature of up to 24 degrees centigrade or the ambient temperature of the water body, whichever is less.	38 MRSA §465: (4)(B)
Toxic metal pollutant levels: numeric criteria	Zinc: chronic 30.6 ug/l ; acute 30.6 ug/l Lead: chronic 0.41 ug/l; acute 10.52 ug/l Copper: chronic 2.36 ug/l; acute 3.07 ug/l Notes: Hardness level used in calculations: 20 mg/l. Criteria numbers represent total metals. Duration and frequency for excursion from criteria concentrations: Acute: Not to exceed 1 hour every 3 years on average; Chronic: Not to exceed 4 days every 3 years on average.	Chapter 584

On a periodic basis, Maine and other states issue a list under Section 303(d) of the CWA, 33 U.S.C. § 1313(d), that identifies all surface waters that do not meet state water quality standards. Since 1998, DEP has designated Long Creek as a water quality limited stream under § 303(d) of the CWA due to non-attainment of Maine's Class C and Class B water quality standards as follows:

a. In 1998, DEP listed Long Creek as impaired for dissolved oxygen due to nonpoint sources.[46.]

b. In 2002, DEP listed Long Creek as impaired for "fishing/aquatic life" due to urban nonpoint sources.[47.]

c. In 2004, DEP listed Long Creek as impaired for "aquatic life" due to "Urban NPS and Habitat."[48.]

d. In 2006, DEP listed Long Creek as impaired based on "Benthic-Macroinvertebrate bioassessments (streams)" and "Habitat Assessment (streams)."

e. In 2008, DEP listed Long Creek as impaired based on "Benthic-Macroinvertebrate Bioassessments (Streams)" and "Habitat Assessment (Streams)."[49.]

As noted earlier, while often described as "nonpoint" source discharges, urban storm water runoff and the pollutants it contains can also reach waters through a CWA "point source" discharge. Thus, although 303(d) listings such as those above sometimes refer to a nonpoint source as the cause of an impairment, in some cases it would be more accurate for this to refer to a point source discharge not designated for NPDES coverage. A list of DEP's monitoring results and their relationship to regulatory standards is presented in Attachment D.

B. VIOLATIONS OF WATER QUALITY STANDARDS IN LONG CREEK

The following five sub-sections present and explain documented violations of Maine's water quality standards in Long Creek. A map of sampling locations referred to is provided in Attachment C.

1. Dissolved Oxygen

a. Dissolved Oxygen Standards

Dissolved oxygen (DO) is a critical element for sustaining aquatic life such as macroinvertebrates and fish. The amount of oxygen dissolved in water varies depending on water temperature, the partial pressure of oxygen in the atmosphere, and the purity of the water.[53.] As water temperature increases, or as levels of chlorides and suspended solids increase, the ability of water to hold oxygen in the dissolved state decreases. This results in a stream less able to support aquatic life. DO in water is measured in terms of concentration in parts per million or milligrams per liter (mg/l) and in terms of percent saturation. The Maine water quality standards for Class B waters require that dissolved oxygen be not less than 7 parts per million or 75% of saturation, whichever is higher, except that for the period from October 1 to May 14, in order to ensure spawning and egg incubation of indigenous fish species, the 7-day mean dissolved oxygen concentration shall not be less than 9.5 parts per million and the 1-day minimum dissolved oxygen concentration shall not be less than 8.0 parts per million in identified fish spawning areas.

The relevant applicable Maine water quality standards for Class C waters require that dissolved oxygen shall be not less than 5 parts per million or 60% of saturation, whichever is higher, except that in identified salmonid spawning areas where water quality is sufficient to ensure spawning, egg incubation and survival or early life stages, that water quality sufficient for these purposes must be maintained. In order to provide additional protection for the growth of indigenous fish, the 30-day average dissolved oxygen criterion of a Class C water is 6.5 parts per million using a temperature of up to 24 degrees centigrade or the ambient temperature of the water body, whichever is less.

b. Violations of Water Quality Standards for Dissolved Oxygen

Storm water from impervious surfaces contributes to DO water quality violations in Long Creek by increasing both stream temperature and the levels of impurity. With respect to increased temperature, impervious surfaces absorb and retain solar energy as heat and release it slowly through mechanisms including storm water runoff. Research has established a direct correlation between the extent of imperviousness in a watershed and summer daily mean surface water temperatures. This correlation is particularly evident in small headwater streams such as Long Creek. Increased stream temperatures limit a stream's capacity to hold oxygen in the dissolved state.

With respect to surface water impurities, storm water from impervious surfaces transports pollutants that originate from nearby soil erosion and as atmospheric and vehicular deposition of pollutants. Storm water also transports sediment and chlorides from impervious surfaces that have been treated with sand and de-icers during winter. Higher volumes and velocities of storm water runoff from impervious surfaces also increase the levels of instream suspended solids from stream bed erosion during storms.[6.] All these impurities limit surface water's capacity to hold oxygen in the dissolved state.[53.]

As noted above, dissolved oxygen is a measure of the amount of dissolved oxygen in water, expressed in terms of mass per volume or expressed as a percent of the saturation value of DO in water (i.e., the maximum amount of DO that water of a certain temperature and purity can hold in solution). Maine's water quality standards include both expressions and both criteria must be met to attain standards. Monitoring results from Long Creek sampling sites show violations of water quality criteria related to dissolved oxygen at several locations during three sampling events in 2000. Table 4 indicates that in Class B segments of Long Creek, dissolved oxygen levels were well below the 7.0 mg/l standard and the 75% saturation standard. In Class C segments of Long Creek, dissolved oxygen was less than the 5.0 mg/l criteria in two out of five sites. The 60% saturation level for Class C waters was not attained at any of the Class C sites identified in Table 4 below.

Table 4. Long Creek Data Showing Non-attainment of Maine's Class C Water Quality Criteria for Dissolved Oxygen with Water Temperature Readings

				Class B DO		Class C DO	
Maine Dissolved Oxygen Criteria = not less than:				7.0 mg/l	75% sat.	5.0 mg/l	60% sat.
Date	Site #	Site	Time (AM)	mg/l	% sat.	mg/lL	% sat.
6/15/00	LC-M-2.270	Sable	6:11	4.50	48.0	-	-
	LC-Mn-2.274	Goodyear	6:08	5.98	60.2		
	LC-N-0.585	Jetport trib above Foden Rd	5:28	-	-	5.63	56.1
9/1/00	LC-S-0.186	Hoyts/MVP-Q site	4:58	-	-	4.96	54.0
	LC-M-1.653	Public Works	5:43	-	-	5.61	59.5
	LC-M-2.270	Sable	5:59	4.07	43.4	-	-
	LC-M-2.754	Maine trib - below RWS & impoundment	6:13	-	-	4.61	47.0
	LC-Mn-2.274	Goodyear	6:02	4.44	45.9	-	-
	LC-N-0.585	Jetport trib above Foden Rd	5:18	-	-	5.32	58.0
9/30/00	LC-Mn-2.274	Goodyear	6:09	6.17	54.8	-	-

(Data source: ME DEP 2002, Appendices C-3a and b)[4.]

Table 4 indicates that DEP sampling conducted in Long Creek during June and September of 2000 documented violations of water quality standards relating to DO in the three major stream segments assessed, including both those designated Class B and Class C. Storm water discharges from impervious surfaces contribute to such DO violations.

2. Toxic Metals

a. Metals Standards

Maine water quality standards require that the concentration of zinc, lead and copper fall below the following concentrations:

Table 5: Criteria Concentrations for Metals

	Choronic (ug/l)	Acute (ug/l)
Zinc (ug/l)	30.6	30.6
Lead (ug/l)	0.41	10.52
Copper (ug/l)	2.36	3.07

Hardness level used in calculations: 20 mg/l.
Criteria numbers represent total metals.
Duration and frequency for excursion from criteria concentrations:
Acute: Not to exceed 1 hour once every 3 years on average;
Chronic: Not to exceed 4 days once every 3 years on average

b. Violations of Metals Water Quality Standards

Metals are routinely found in storm water runoff from impervious surfaces and can have both acute and chronic effects on aquatic life, depending on the concentration, duration, and frequency of exposure. General scientific data compiled from several sources on event mean concentrations (EMCs) and detection frequency for metals in storm water show that certain metals, such as zinc, lead, and copper, are typically present at concentrations that are potentially harmful.[6.]

Since there are no known discharges to Long Creek other than storm water, metals present must be attributable to storm water discharging to Long Creek.

Metals data collected during dry and wet weather in the Long Creek watershed provide documentation that storm water discharging to Long Creek from impervious surfaces contains metals at levels that violate water quality standards. The table below is important for two purposes: it shows that water quality sampling at various locations documents violations of the applicable acute water quality standards for metals; and it shows that these high levels are attributable to storm water.

The table compares levels of metals detected at sampling sites during dry weather and wet weather conditions. The dry weather sampling column indicates the levels of metals detected at that sampling location when storm water was not discharging to the stream; the wet weather column indicates the levels of metals detected at the same sampling location during storm water discharge events.

Table 6: Range of Long Creek Metals Concentrations during Base flow and Storm Water Conditions

		Dry Weather	**Wet Weather**
Site	Site #	Zinc (ug/l)	Zinc (ug/l)
Hoyts/Maine Mall	LC-S-0.186	6-7	35-270
Mall Plaza	LC-M-0.595	Nd	42-200
Jetport	LC-N-0.585	13-15	41-140
		Lead (ug/l)	Lead (ug/l)
Hoyts/Maine Mall	LC-S-0.186	Nd	3-90*
Mall Plaza	LC-M-0.595	Nd	3-52*
Jetport	LC-N-0.585	nd	3-31*
		Copper (ug/l)	Copper (ug/l)
Hoyts/Maine Mall	LC-S-0.186	nd-2	3-44**
Mall Plaza	LC-M-0.595	nd	5-21
Jetport	LC-N-0.585	nd	5-18

(Data source: ME DEP 2002, Appendix C-2c)[4.]

Notes: "nd" = non-detect.

* In the ranges presented for lead, results > 10.52 represent violations of both acute (10.52 ug/l) and chronic (0.41 ug/l) criteria; results from 3-10.52 represent violations of the chronic criterion (0.41 ug/l) alone.

** In the range presented for copper, results > 3.07 represent violations of both acute (3.07 ug/l) and chronic (2.36 ug/l) criteria; results from 3-3.07 represent violations of the chronic criterion (2.36 ug/l) alone.

At each of the locations sampled, the wet weather data, collected while storm water was discharging to Long Creek, show metals concentrations significantly higher than the levels detected at the same location when storm water was not discharging. These data indicate that storm water discharging to Long Creek from impervious surfaces cause or contribute to water quality standards violations.

c. Metals Modeling

To further assess the relationship between storm water discharges and violations of water quality standards for metals in Long Creek, EPA conducted modeling studies designed to predict such violations. These studies included continuous simulations using a pollutant runoff model. EPA used the model (P8 Urban Catchment model) to estimate hourly metals concentrations in discharges to a watershed area with characteristics similar to one of the more impervious subwatersheds discharging to Long Creek.[14.] The model estimated hourly metals concentrations, which were then used to assess the likelihood that, and durations and frequencies at which, the applicable metals criteria would be violated.

EPA applied the model to simulate hourly runoff flow and pollutant concentrations from a hypothetical 361-acre drainage area that includes 163.9 acres of impervious cover (45.4% impervious), based on the characteristics of a typical, highly impervious subwatershed tributary to Long Creek. The model was used to simulate a 10-year period (1993-2002) using hourly rainfall and temperature data from a representative area in New England. Water quality aspects of the model were first adjusted to match typical urban runoff event mean concentrations (EMCs) for the three primary metal pollutants of concern--zinc, lead, and copper. The model simulated the buildup of pollutants on impervious surfaces during dry-weather and the subsequent wash-off from storm water. Obtaining representative samples of storm water is challenging because the quality of storm water varies, depending on numerous factors such as the length of the dry period preceding the sampling event, the intensity and length of the storm sampled, and when during the storm samples are taken. Consequently the application of mathematical models in predicting the probability of water quality standards violations from storm water discharges provides a useful analytical method.

Modeling results indicate that storm water runoff from impervious surfaces carried excessive amounts of pollutants, resulting in frequent violations of both the acute and chronic criteria for all three metals in every modeled event for the 361-acre subwatershed. Hourly modeling results indicate that the acute zinc and copper criteria concentrations were exceeded for every hour of simulated runoff discharge during the 10-year period, and the acute lead criterion concentration was exceeded for 78% of the simulated runoff discharge hours. All simulated discharges were found to exceed the chronic criteria concentrations for zinc, lead, and copper for every hour of discharge.

EPA also performed calculations in its modeling exercise to account for base-flow fluctuations in Long Creek and their relationship to water quality standards violations. Concentrations of pollutants in a stream's water vary with different levels of its base flow. Long Creek is a relatively small stream, with typically low base flows, ranging from 0.1 to 0.4 cubic feet per second (cfs).[4.] EPA's base flow calculations indicated that the acute criteria for metals were violated under different assumed base flows ranging from 0.4 to 10 cfs at a frequency far exceeding the allowable frequency of 0.004%, or 1 hour every three years.[14.] The model runs that assumed baseflows of .4 to 10 cfs, which are significantly higher than typical baseflows in Long Creek, indicate that even when high baseflows would dilute the effects of storm water discharges, violations would still be expected.

In summary, Long Creek has no known pollutant sources other than storm water discharges, and thus EPA concludes that storm water alone is responsible for the excess metals detected. Sampling data indicate that at each location, discharges of storm water to Long Creek are causing or contributing to violations of the applicable water quality criteria for zinc, lead and copper. These results are validated by water quality modeling studies specific to Long Creek.

3. Sediment

a. Sediment as it Relates to Aquatic Life Use Standards

Maine's water quality standards do not contain numeric criteria for sediments. However, as noted above, the standards do require that Class B waters support habitat for fish and other aquatic life and that the habitat must be characterized as unimpaired. Further, the criteria require that discharges to Class B waters not cause adverse impact to aquatic life in that the receiving waters must be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community. In addition, with respect to Class C waters, Maine's water quality standards require that waters be suitable as habitat for fish and other aquatic life.

The presence of sediment in storm water discharges contributes to a violation of designated uses relating to aquatic life and habitat in Long Creek and, hence, it contributes to a violation of a water quality standard.

Sediment is a common and significant component of storm water runoff and the degradation of surface water quality.[6.] Sediment in storm water discharges to surface waters such as Long Creek reduces light penetration in the water column, thereby limiting adequate levels of light for healthy aquatic vegetation; scours macroinvertebrates and periphyton (plants attached to rocks) from streams; abrades and damages fish gills (increasing risk of infection and disease); decreases sight distance for trout (reducing feeding efficiency); and smothers and destroys the habitat of aquatic insect larvae and other macroinvertebrates that are important forms of aquatic life at the base of the food chain. Sediment can also slightly increase stream temperature in the summer and can be a major carrier of nutrients and metals.[6.]

During storm events, total suspended solids in Long Creek range as high as 273 mg/l. General research as reflected below indicates that such levels of sediment can create significant risks to fish habitat.

Table 7. Suspended Sediment Risk to Fish Habitat

Canadian Research Results	European Research Results
100-200 mg/l – moderate risk	80-400 mg/l – unlikely to support good freshwater fisheries
200-400 mg/l – high risk	
>400 mg/l – unacceptable risk	>400 mg/l – only poor fisheries likely to be found

(Source: from data presented in APEM 2007) [8.]

b. Violations of Sediment-related Water Quality Standards

Results from general studies, such as those appearing in Table 7, assess sediment conditions that are less variable than the typical conditions caused by storm water discharges to Long Creek. However, they indicate that total suspended solids (TSS) levels caused by storm water discharges to Long Creek, which range as high as 273 mg/l during storm events, contribute to the impairment of fish habitat for aquatic life uses.

DEP measured and compared levels of suspended solids in Long Creek during wet and dry weather in 2000 and 2001.[4.] During dry weather, suspended solids in Long Creek ranged from below detection limits to <10 mg/l. Following rain events when storm water discharges carried pollutants from impervious surfaces in the watershed into receiving waters, DEP measured levels of suspended solids in Long Creek ranging from a low of <10 mg/l to a high of 273 mg/l. Although Maine water quality standards have no criterion for TSS, DEP concluded that levels of TSS in Long Creek due to storm water discharges contribute to violations of narrative standards for fish habitat.

4. Aquatic Life Use

a. Biocriteria

Maine has developed biocriteria through the use of benthic macroinvertebrate sampling and associated community structure modeling. Maine uses these criteria to measure attainment of aquatic life use that is part of its water quality standards for surface waters. Macroinvertebrates include various species of insect larvae, aquatic insects, crustaceans, mollusks, mites, leeches and worms that attach to substrate on the bottom of streams and provide an important link in the aquatic food chain. As stationary instream residents, benthic organisms integrate the effects of changes in water quality and other stressors related to physical habitat and food web disturbances over time, allowing a direct effects-based assessment of environmental quality. Benthic macroinvertebrates provide one measure of the biological health of streams and reflect biological degradation in streams subject to excess storm water discharges.

Maine's biocriteria provide a quantitative methodology for interpreting Maine's narrative biological criteria and aquatic life uses for rivers and streams, and for evaluating standards attainment. The biocriteria are part of the legally applicable Maine water quality standards. DEP determines whether a river segment is in attainment of water quality standards related to aquatic life use by conducting in-stream sampling and comparing the results to the biocriteria using modeling and assessment protocols.

b. Violations of Biocriteria in Maine's Water Quality Standards

Maine's biocriteria were used to support the listing of Long Creek in the 2002 Section 303(d) list required under the CWA, and in subsequent listings in 2004, 2006, and 2008. To support these listings, DEP collected and evaluated macroinvertebrate data from Long Creek. Table 8 presents results from 1999 that show that Long Creek in Westbrook failed to meet Maine's aquatic life criteria for Class B streams. Table 8 also presents results from 1999 and 2004 that show that Long Creek in South Portland failed to meet the aquatic life criteria of Maine's water quality standards for Class C streams based on macroinvertebrate sampling.

Table 8. Long Creek Macroinvertebrate Data Showing Non-attainment of Maine's Macroinvertebrate-Based Biocriteria to Support Aquatic Life Use

Date	Site	Station	Statutory Class	Final Determintation (Model)	Attains WQS for Statutory Class?
1999	Westbrook; Goodyear Branch – 40m upstream of Sable Oaks Golfcourse trib; (aka Blanchette Brook)	409	B	NA	No
1999	Westbrook; Sable Oaks Branch – 40m upstream of Goodyear trib; (Upper Long Creek)	411	B	C	No
1999	S. Portland; (rt branch facing upstream) 40m upstream of confluence with VTec left branch (North Branch)	414	C	NA	No
2004	S. Portland; - 30m upstream of Foden Rd by "Atlantic Place;" (Lower Long Creek)	752	C	NA	No
2004	S. Portland; Gorham Rd, Shops at Clark's Pond, back of Home Depot; (South Branch)	753	C	NA	No

Note: "NA" means non-attainment of Maine's aquatic life criteria at any classification level.
(Source: ME DEP 2008b, 2008c and 2008d)[12., 13, 25.]

Maine's narrative aquatic life criteria require that indigenous fish species be supported in all stream classes. Brook trout are considered indigenous to all flowing Maine streams, and Long Creek is known to have been a fishery for brook trout prior to the accelerated development of the area.

As part of its biomonitoring effort, in June 2000, DEP conducted fish studies at locations in Long Creek noted in Table 9 to identify what species were being supported. These monitoring efforts found that none of the sites sampled in Long Creek were supporting trout fisheries. Consequently DEP concluded that the relevant segments of Long Creek were not attaining criteria relating to the support of indigenous fish species.

Table 9. Long Creek Fish Sampling Locations relating to Non-attainment of Maine's Narrative Biocriteria to Support Aquatic Life Use.

Date	Site	Site Location
May/June 2000	Lower Long Creek	Main stem near confluence with North Branch
May/June 2000		Behind old Service Merchandise Building
May/June 2000	Middle Long Creek	Main stem midway between confluence with Blanchette Brook and Turnpike
May/June 2000	Upper Long Creek	Upper main stem roughtly ¼ mi. upstream of Spring St.

The absence of brook trout in Long Creek is a violation of aquatic life use criteria for all the stream classes in Maine. This impairment of aquatic uses is particularly concerning in Long Creek in light of its recent history as a brook trout fishery. It is worth noting that the less developed portions of adjacent Red Brook support a very healthy brook trout population.

Although these biomonitoring data show non-attainment of Maine's water quality standards in Long Creek, they do not alone indicate the specific pollutant or other environmental stressor causing the impairment. Maine uses measurements of other ambient water quality parameters such as physical and chemical data together with biomonitoring to identify stressors. The discussions above on DO, toxic metals and sediment, together with the biomonitoring data, establish that storm water discharges from impervious surfaces contribute to the violation of various criteria established to protect aquatic life uses. The EPA Stressor Report also draws a direct relationship between storm water, the stressors associated with it, and impairments to aquatic life uses in Long Creek.

In summary, sampling conducted by DEP shows that storm water discharges from impervious surfaces in the Long Creek watershed cause or contribute to frequent violations of numerous water quality standards--including those for or related to criteria for dissolved oxygen and metals, for sediment as it relates to the aquatic life use, and for aquatic life uses as assessed through Maine's biocriteria--at multiple locations in Long Creek. In addition, modeling exercises conducted by EPA in which Long Creek conditions were simulated also establish that storm water from impervious surfaces cause or contribute to numerous water quality standards violations for metals at numerous locations in Long Creek under various wet weather conditions.

V. SELECTION OF DESIGNATED DISCHARGES

As noted above, regulations promulgated under the CWA provide EPA with the authority to designate a wide range of storm water discharges or categories of discharges once specific standards in 40 C.F.R. § 122.26 relating to localized conditions are met. The regulations also provide EPA with broad discretion in designating discharges based on localized considerations.

In enacting CWA Section 402(p), Congress allowed for the immediate regulation of specified sources known to present the most significant threats to surface water quality. In promulgating the Phase II storm water rule (64 Fed. Reg. 68722, Dec. 8, 1999) implementing section 402(p), EPA sought to control sources presenting the greatest potential harm to water quality on a nationwide basis. This preliminary residual designation follows a similar principle in controlling localized discharges that are known to be contributing to water quality standards violations in Long Creek that are currently unregulated.

This preliminary residual designation covers storm water discharges from properties on which there are impervious surfaces equal to or greater than one acre in the Long Creek watershed. Below is a discussion of the rationale used by EPA to identify this category of discharges for this preliminary residual designation.

A. Impervious Cover

The category of discharges here being designated for control under the NPDES program includes storm water discharges from impervious surfaces. Imperviousness relates directly to the quality and quantity of storm water discharged into Long Creek and has a direct and well understood relationship to water quality degradation generally. In fact, imperviousness is often used as a surrogate measure of water quality degradation caused by storm water.

Land development over the last several decades in the Long Creek watershed has had a direct, verifiable and yet reversible impact on Long Creek water quality. Sections I.C (Long Creek and Impervious Cover), II.A (Impervious Cover, Storm water and Water Quality), and II.B (Relationship between Impervious Cover and Water Quality in Long Creek), above, substantiate that impervious cover impairs aquatic habitat by increasing the volume and velocity of storm water runoff and the loads of pollutants carried by it. With respect to Long Creek specifically, scientific observations confirm that as land development and the attendant storm water discharges from impervious cover increased in the watershed, water quality and aquatic habitat in the stream declined. These observations include macroinvertebrate and fish sampling, sampling and analysis of metals contamination, dissolved oxygen concentrations and sediment loads as well as research identifying impervious cover as a common factor in a number of causal pathways leading to aquatic habitat degradation. In summary, uncontrolled storm water discharges from impervious surfaces are a major source of water quality degradation in Long Creek. This designation covers storm water discharges from impervious surfaces that are causing or contributing to violations of applicable water quality standards in Long Creek.

B. Impervious surfaces equal to or exceeding one acre

Impervious cover analyses based on 2005 Long Creek conditions indicate that a one-acre impervious area threshold for this preliminary residual designation will result in discharges from 90% of the impervious area in the watershed coming under NPDES jurisdiction. Currently, a number of Long Creek storm water discharges, including those from MS4s, are authorized under NPDES permits. This preliminary residual designation will not apply to any discharge already subject to the NPDES permitting program. However, this designation will require all designated discharges to apply for and obtain coverage under a NPDES permit. The State of Maine is approved to administer the NPDES permit program. Once the State issues NPDES permits covering the designated discharges, this residual designation will result in a level of storm water control that will significantly improve water quality in Long Creek.

The total watershed impervious acreage is roughly 630 acres. A one-acre impervious area threshold results in storm water discharges from roughly 90% of the impervious area in the watershed being subject to NPDES permitting. Storm water discharges from some roadways in the watershed are already covered under NPDES general permits issued by the State of Maine to MS4s, the Maine Turnpike Authority and the Maine Department of Transportation. This designation will cover storm water discharges from the remaining roadways that meet the definition of designated discharges. This will result in storm water discharges from a total of 116 acres of road and turnpike rights-of-way in the watershed (representing roughly 18% of the impervious cover in the watershed) becoming subject to NPDES permitting.

A one-acre impervious area threshold will also designate for NPDES permitting storm water discharges from an additional 455 acres of impervious area located on property parcels, representing roughly 72% of the impervious cover in the watershed. This leaves storm water discharges from roughly 59 acres of impervious cover, representing roughly 10% of the impervious cover in the watershed, that will not be subject to NPDES permitting requirements.

For purposes of projecting an appropriate impervious acreage threshold, EPA assumes that permits will be able to control storm water discharges at 67% efficiency.[54.] A residual designation of storm water discharges from properties with impervious surfaces equal to or greater than one acre, in combination with a permitting scheme that applies best management practices (BMPs) achieving a 67% efficiency, will result in an effective impervious cover in the Long Creek watershed of 13.7%, a level that will contribute in a significant way to water quality improvements in Long Creek.

Table 10 below shows the correlation between the application of NPDES permitting to various acreage thresholds in the Long Creek watershed and the resulting percent of impervious cover captured by that threshold.

Table 10. Calculations for % Effective Impervious Cover resulting from different Permitting Acreage Thresholds:

Acreage Threshold	% IC Area	% Effective IC
0	100	11.6
0.5	97.56	12.1
1	90.85	13.7
2	79.96	16.2
3	70.83	18.4
4	64.84	19.8
5	64.21	19.9

Assumptions:
35% IC within Long Creek watershed as a whole;
BMPs are retrofitted on all significant contributing sources;
BPMs address 67% of the impervious area effect (BMP efficiency rate).

While storm water research has not identified any precise level of effective impervious cover that correlates to acceptable water quality, there is general agreement on a range of acceptable values. "Effective" impervious area or cover reflects runoff conditions following installation of best management practices (BMPs) that infiltrate, result in plant uptake of, or store storm water for reuse, thereby reducing the volume of storm water discharge. Research identifies a watershed imperviousness level of between 5% and 20% as causing degradation of aquatic habitat and other water quality impairments. For purposes of this preliminary residual designation, EPA is establishing a goal of 10%-15% effective imperviousness, a benchmark in the mid-range of the relevant literature values.

As noted in the Preamble to EPA's Phase I Storm Water Final Rule, 55 Fed. Reg. 47990 (Nov. 16, 1990) storm water research in numerous geographical areas, concentrating on numerous variables and employing widely different methods, has reached a common conclusion: stream degradation occurs at relatively low levels of imperviousness, such as 10 to 20 percent (even as low as 5 to 10 percent).[6.] Furthermore, research has indicated that few, if any, urban streams can support diverse benthic communities at impervious levels of 25 percent or more. Macroinvertebrate diversity becomes poor when impervious land exceeds 10 to 15 percent (Klein, 1979). Since this study, extensive research from around the country has found this threshold to be consistent with other studies.[50.]

In addition to this extensive and geographically diverse research, DEP has adopted guidelines specifying the range of impervious cover that can coexist with a biological community that meets aquatic life criteria in Maine. Those guidelines indicate acceptable levels of impervious cover representing 7%-10% of watershed surface for Class B streams (usual attainment at 8%) and 10%-15% IC for Class C (usual attainment at 15%).[39] As noted above, assuming that storm water discharges from 90% of the impervious area in the Long Creek watershed are covered by NPDES permits--which will be the result of this preliminary residual designation--and those discharges are controlled with 67% efficiency, an effective impervious cover of 13.7% should result. Additional measures, such as streambank restoration, should provide further water quality benefits that would bring Long Creek within Maine's impervious cover guidelines.

Based on these analyses, this preliminary residual designation will cover discharges from properties with impervious surfaces equal to or exceeding one acre. This preliminary residual designation is intended to help restore Long Creek and is **not** a determination that smaller impervious surfaces are not contributing to water quality standards violations. Additional storm water management measures, including control of smaller impervious surfaces, may be necessary in the future. Use of this one-acre threshold is based on localized conditions and is a reasonable approach to address adverse impacts of storm water and to protect and maintain water quality in Long Creek as required by the CWA.

VI. DETERMINATION THAT THE DISCHARGE OR CATEGORY OF DISCHARGES WITHIN A GEOGRAPHIC AREA CONTRIBUTES TO A VIOLATION OF A WATER QUALITY STANDARD PURSUANT TO 40 C.F.R. § 122.26(a) (9)(i)(D)

1. As noted above, the applicable Maine Water Quality Standards identify Long Creek as a Class C water in South Portland, Scarborough, and Portland, Maine and as a Class B water in Westbrook, Maine. Both classes are designated to support Long Creek as a habitat for fish and other aquatic life. Maine's applicable water quality standards contain designated aquatic life uses and criteria to protect those uses.[51.]

2. Based on extensive sampling, Maine determined in its 1998 Section 303(d) list that Long Creek was not meeting water quality standards for dissolved oxygen, and in its 2002, 2004, 2006, and 2008 Section 303(d) lists that Long Creek was not meeting the water quality standards relating to aquatic life use. Extensive water quality sampling has also shown that both biological and chemical water quality criteria are being violated. For purposes of this designation, the relevant water quality standards that are being violated are those related to: aquatic life criteria (based on benthic macroinvertebrate and habitat assessments and on sediment), dissolved oxygen, and toxic metals--specifically zinc, lead, and copper.

3. The discharges of storm water to Long Creek from impervious surfaces equal to or greater than one acre are directly or indirectly causing or contributing to violations of the applicable Maine water quality standards.

4. In order to ensure effective and enforceable reductions from these designated discharges, that category of discharges must be controlled through the issuance of permits under the NPDES program.

VII. AUTHORIZING SIGNATURE

U.S. Environmental Protection Agency

By: ________________________ Date: ____________________

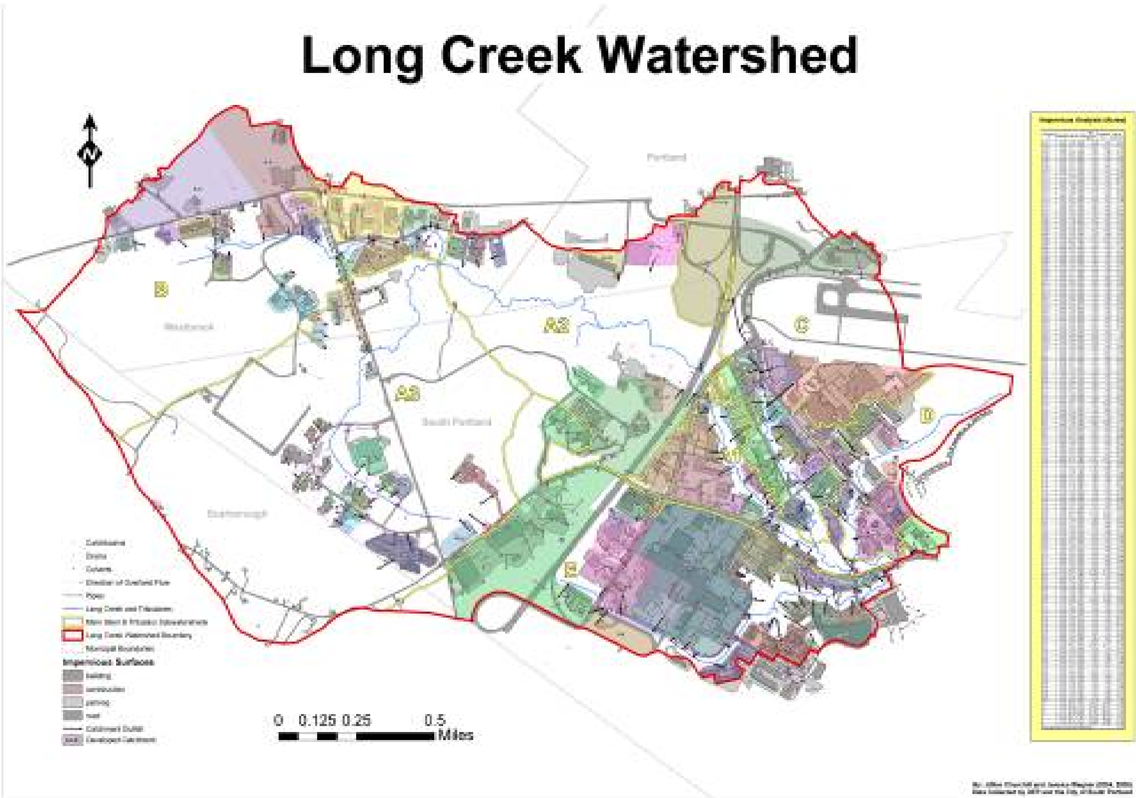
Robert W. Varney
Regional Administrator
EPA Region 1

Attachments

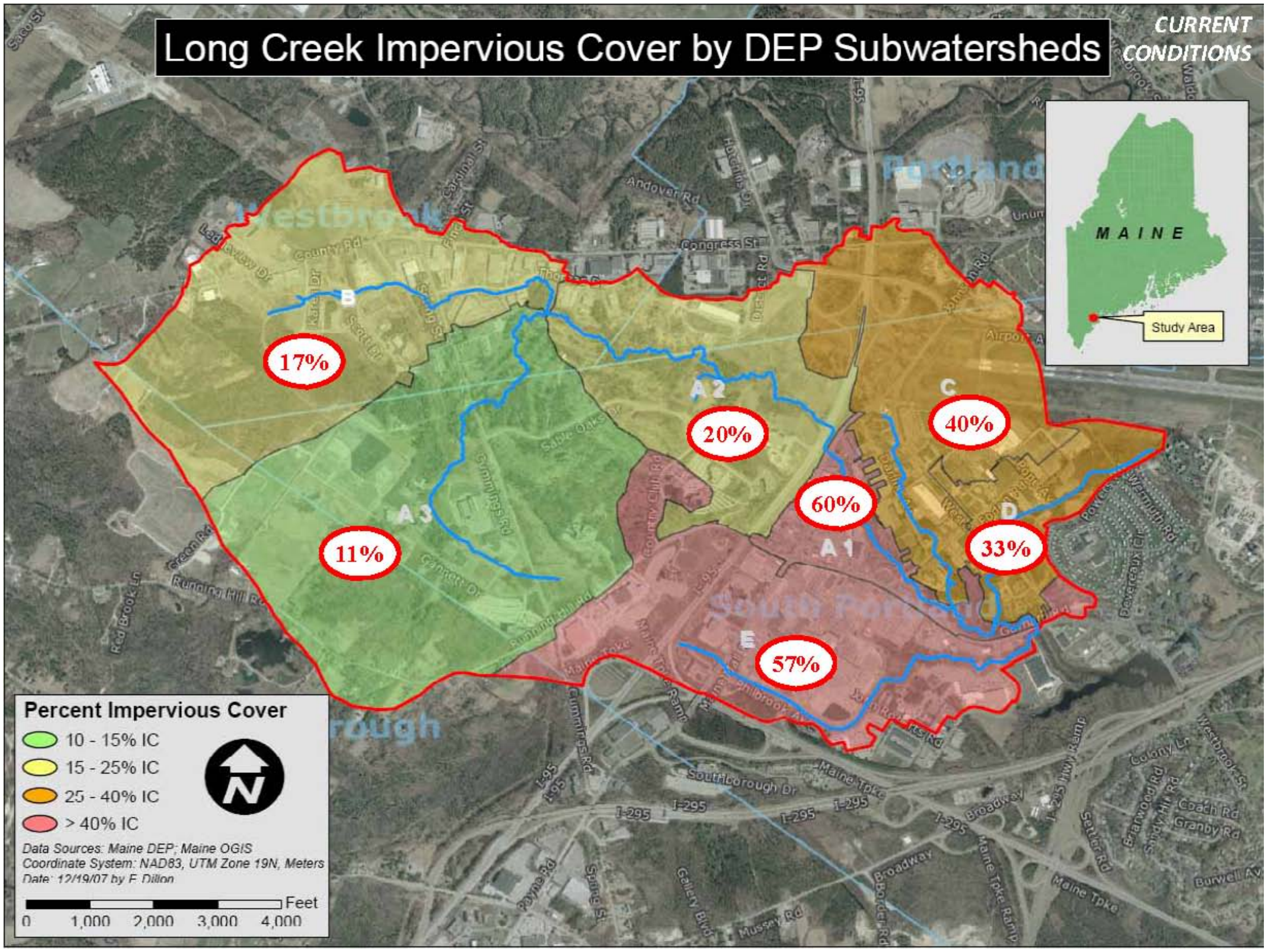
A. Long Creek Watershed
B. Long Creek Impervious Cover by Subwatershed
C. Long Creek Sampling Sites with Non-attainment of WQS
D. ME Summary of Water Quality Standards violations
E. References

____

ATTACHMENT A

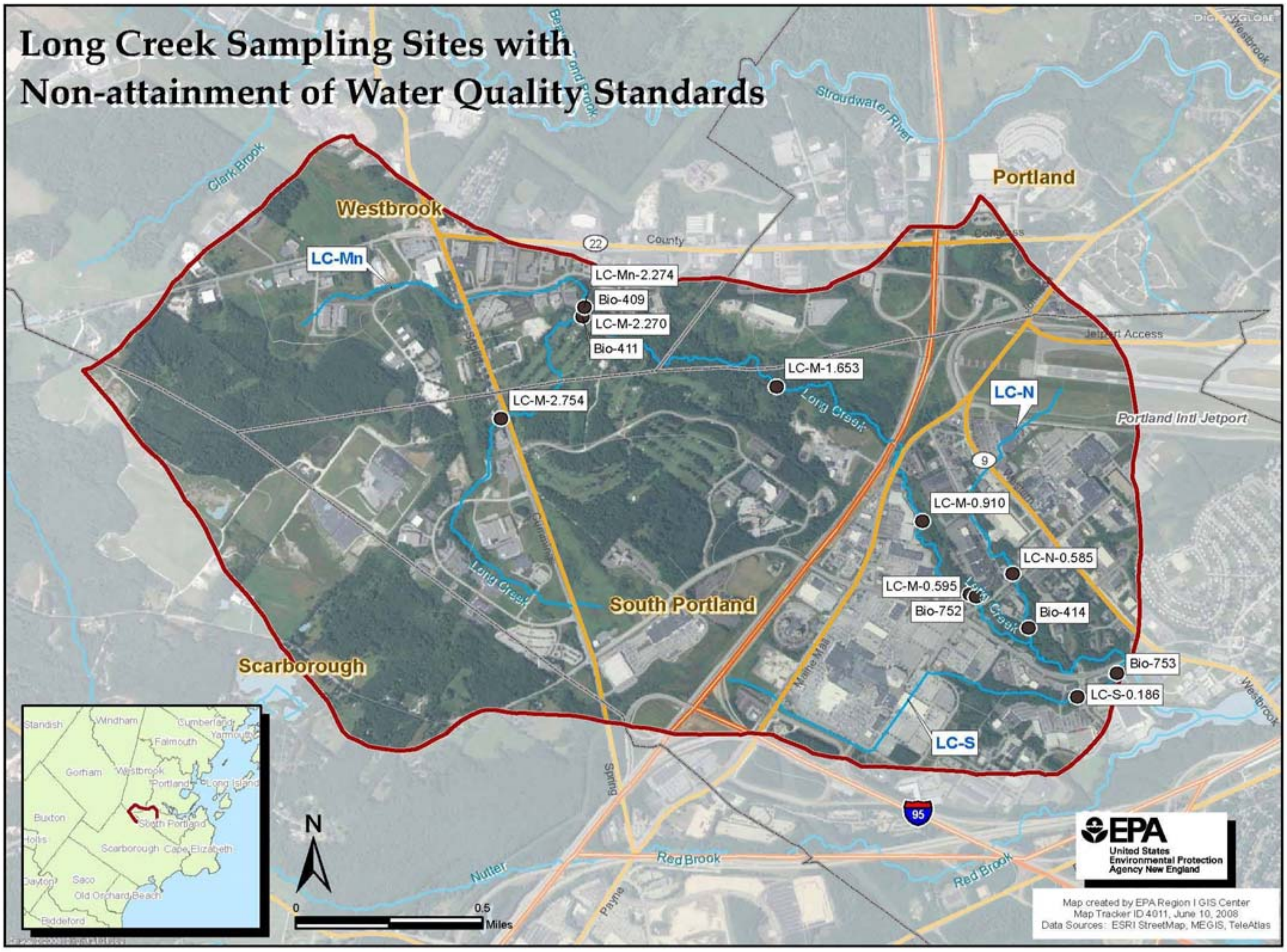


ATTACHMENT B



Source: F.B. Environmental Consulting, May 2008

ATTACHMENT C



ATTACHMENT D

Summary of Violations of Water Classification Standards in the Freshwater Portion of Long Creek and Its Tributaries

(Source: Maine DEP, September 30, 2008)

The following lists the documented incidents of violation of stream classification standards in the freshwater portion of Long Creek and its tributaries. The impairments are organized by the segment or tributary in which they occur. Prior to the list of actual violations is a discussion of the different types of violations reported. This summary does not include violations of the bacteria standards. It only includes violations of the standards that would contribute to impairment of the aquatic community.

Discussion of types of violations:

- **Aquatic life criteria violations**
  - Macroinvertebrate community – The macroinvertebrate community is sampled by deploying rock bags on the stream bottom and collecting the organisms that colonize the bags. The collected organism are identified and quantified and the data used to calculate 25 variables that are applied to linear discriminant models which predict the probability that the community will meet the aquatic life criteria for a given stream classification (A, B, or C). The criteria are defined in Chapter 579 "Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams."
  - Brook Trout – The aquatic life criteria defined in 38MRSA Section 465 require for all stream classes that indigenous fish species be supported. Brook trout are considered indigenous to all flowing Maine streams and Long Creek is known to have been a fishery for brook trout prior to the accelerated development of the area. The less developed portions of adjacent Red Brook support a very healthy brook trout population. Absence of brook trout is therefore deemed a violation of aquatic life use criteria for all the stream classes, and in particular in Long Creek because of its history as a brook trout fishery. The stream was evaluated (electrofished) at a number of sites and failed to yield brook trout at any of the sites sampled.
- **Toxic criteria violations**
  - Metals – The concentrations of several heavy metals (lead, copper, cadmium, nickel, and zinc) were monitored during 3 storm events (3 samples per storm) at 3 sites and 3 times during base flow conditions at 6 sites. Duplicate samples were collected at one of the sites during each sampling event. No violations of the EPA's criterion continuous concentration (CCC)

were measured during the base flow conditions, but the EPA's criterion maximum concentration (CMC) for lead, copper and zinc were exceeded a number of times during the storm event monitoring. These exceedences are a violation of Chapter 584 "Surface Water Quality Criteria for Toxic Pollutants." The monitored storms were:

- Storm 1 (3/28/2000) – approximately 1.8 inch rainfall
- Storm 2 (10/18/2000) – approximately 1.4 inch rainfall
- Storm 3 (9/25/2001) – approximately 1.5 inch rainfall

The CMCs (Chapter 584) for lead, copper and zinc at a hardness of 20 mg/l (hardness was not monitored) are:

- Lead – 0.0105 mg/l
- Copper – 0.0031 mg/l
- Zinc – 0.0306 mg/l

- Chloride was also sampled under storm event and low flow conditions at the same time that metal samples were collected (as described above). Under storm event conditions, maximum chloride concentrations at the three Long Creek monitoring stations were usually much higher than those at a middle-reach site on Red Brook, although CMC (Chapter 584) criteria were not exceeded. (All sites mentioned here were downstream of I-95, Maine Mall Road, and the associated commercial development.)

  A similar pattern was observed among the two streams during low flow conditions; however, on the south branch of Long Creek, a violation of CCC (Chapter 584) criteria (> 230 mg/l) was detected on two separate dates (8/6/00 & 8/23/00).

  With only one exception, the maximum (per event) chloride concentrations were always greater at the three Long Creek stations compared with the Red Brook station. During low flow conditions (8/6/2000, 8/23/2000, 9/19/2000), the Long Creek stations had chloride maximum concentrations ranging from 1.5 – 5.2 times greater than the Red Brook station. During storm events (3/28/2000, 10/18/2000, 9/25/2001), the Long Creek stations had maximum concentrations ranging from 1.2 – 11.4 times greater than the Red Brook station. (The one exception was on 9/25/2001 where the north branch of Long Creek had a value that was 0.9 times that of the Red Brook station.)

- **Dissolved oxygen criteria violations**

  Dissolved oxygen measurements were taken at a number of stations on 9/23/1999 in the middle of the day and 6/15/2000, 9/1/2000 and 9/30/2000 in the early morning. The dissolved oxygen criteria are defined in 38MRSA Section 465. Violations were recorded of both of the following statutory dissolved oxygen standards.

- o Concentration – The dissolved oxygen concentration must be not less than 7 ppm in Class B waters and not less than 5 ppm in Class C waters.

- o % saturation – The % saturation of dissolved oxygen must be not less than 75% in Class B waters and not less than 60% in Class C waters.

Violations of Stream Water Quality Classification Standards in Long Creek

[“Station” will be used to refer to MDEP Biomonitoring stations. “Sites” will refer to site-codes used in the MDEP (2002) report[1].]

Lower Long Creek (the main stem from the Turnpike to the confluence with Clark’s Pond) **Class C**.

- Biological criteria violations
  - o Macroinvertebrates (August 2004). The macroinvertebrate community failed to meet Class C criteria. Rock bag sampling just upstream of Foden Road [Station 752 (~30m upstream of Foden Rd by "Atlantic Place")].

  - o Fish (May/June 2000). Electrofishing at two sites failed to yield any brook trout. The sites were (a) in the main stem near the point of confluence with the North Branch [Station 409; Site LC-M-0.380] and (b) behind the old Service Merchandise building [Site LC-M-0.910; Station 410].

- Toxic criteria violations in the main stem just upstream of Foden Road [Site LC-M-0.595].

  - o Lead
    - ▪ Storm 1 – 0.052 mg/l, 0.021 mg/l and 0.014 mg/l (exceeded CMC in 3 out of 3 samples)
    - ▪ Storm 3 – 0.025 mg/l (dup. 0.020 mg/l) (exceeded CMC in 1 out of 3 samples)

  - o Copper
    - ▪ Storm 1 – 0.021 mg/l, 0.011 mg/l and 0.012 mg/l (exceeded CMC in 3 out of 3 samples)
    - ▪ Storm 2 – 0.007 mg/l, 0.007 mg/l and 0.006 mg/l (exceeded CMC in 3out of 3 samples)
    - ▪ Storm 3 – 0.006 mg/l (dup. 0.006 mg/l), 0.015 mg/l (dup. 0.013 mg/l) and 0.005 mg/l (dup. 0.005 mg/l) (exceeded CMC in 3 out of 3 samples)

  - o Zinc
    - ▪ Storm 1 – 0.200 mg/l, 0.082 mg/l and 0.075 mg/l (exceeded CMC in 3 out of 3 samples)
    - ▪ Storm 2 – 0.093 mg/l, 0.120 mg/l and 0.093 mg/l (exceeded CMC in 3 out of 3 samples)
    - ▪ Storm 3 – 0.084 mg/l (dup. 0.083 mg/l), 0.110 mg/l (dup. 0.100 mg/l) and 0.047 mg/l (dup. 0.042 mg/l) (exceeded CMC in 3 out of 3 samples)

[1] Maine Department of Environmental Protection. (2002) A biological, physical and chemical assessment of two urban streams in southern Maine: Long Creek & Red Brook. Prepared by J. T. Varricchione. Maine Department of Environmental Protection, Augusta, ME; DEPLW0572.

Middle Long Creek (the main stem from the confluence with Blanchette Brook to the Turnpike) **Class C**.

- Biological criteria violations
  - Fish (May/June 2000). Electrofishing in the main stem at a point approximately midway between the confluence with Blanchette Brook and the Turnpike failed to yield any brook trout [near Site LC-M-1.653].

Upper Long Creek (the main stem above its confluence with Blanchette Brook) **Class B and C**.

- Biological criteria violations

  - Macroinvertebrates (August 1999). The macroinvertebrate community failed to meet Class B criteria. Rock bag sampling in the main stem just upstream of the confluence with Blanchette Brook [Station 411 (Sable Oaks branch - 40m upstream of Goodyear trib); Site LC-M-2.270].
  - Fish (May/June 2000). Electrofishing in the upper region of the main stem, on an unmapped portion of the stream ~ ¼ mile upstream of Spring Street, failed to yield any brook trout [Site LC-Mw-2.896].

- Dissolved oxygen Class B criteria violations in the main stem just upstream of the confluence with Blanchette Brook [Station 411 (Sable Oaks branch - 40m upstream of Goodyear trib); Site LC-M-2.270].

  - Concentration
    - On 6/15/00 D.O. concentration was 4.50 mg/l.
    - On 9/1/00 D.O. concentration was 4.07 mg/l.
  - % Saturation
    - On 6/15/00 D.O. % saturation was 48%.
    - On 9/1/00 D.O. % saturation was 43.4%.

- Dissolved oxygen Class C criteria violations in the main stem below RWS and its impoundment (just upstream of the Spring Street crossing) [Site LC-M-2.754].

  - Concentration
    - On 9/1/00 D.O. concentration was 4.61 mg/l.
  - % Saturation
    - On 9/1/00 D.O. % saturation was 47%.

Goodyear Branch (aka Blanchette Brook) (the tributary that drains most of the Westbrook portion of the watershed, including the Colonel Westbrook Business Park and the Spring Street/County Road intersection) **Class B**.

- Biological criteria violations

  - Macroinvertebrates (August 1999). The macroinvertebrate community failed to meet Class B criteria. Rock bag sampling in Blanchette Brook just upstream of the confluence with the main

stem [Station 409: Goodyear Branch - 40 m upstream of Sable Oaks Golf Course trib; Site LC-Mn-2.274].
  - Fish (May/June 2000). Electrofishing in Blanchette Brook just upstream of the confluence with the main stem failed to yield any brook trout [near Station 409 and Site LC-Mn-2.274].

- Dissolved oxygen criteria violations in Blanchette Brook just upstream of the confluence with the main stem [Station 409; Site LC-Mn-2.274].

  - Concentration
    - On 6/15/00 D.O. concentration was 5.98 mg/l.
    - On 9/1/00 D.O. concentration was 4.44 mg/l.
    - On 9/30/00 D.O. concentration was 6.17 mg/l.
  - % Saturation
    - On 6/15/00 D.O. % saturation was 60.2%.
    - On 9/1/00 D.O. % saturation was 45.9%.
    - On 9/30/00 D.O. % saturation was 54.8%.

North Branch (the tributary that drains the Jetport Plaza area and the Fairchild Semiconductor plant and runs along the north side of Darling Avenue, joining the main stem after passing under Foden Road) **Class C**.

- Biological criteria violations

  - Macroinvertebrates (August 1999). The macroinvertebrate community failed to meet Class C criteria. Rock bag sampling in S. Portland; [Station 414 (right branch facing upstream) 40 m upstream of confluence with VTec left branch].
  - Fish (May/June 2000). Electrofishing in the north branch just upstream of the confluence with the main stem failed to yield any brook trout [Station 414 ({right branch facing upstream} 40 m upstream of conf); Site LC-N-0.415].

- Toxic criteria violations in the north branch just upstream of Foden Road [Site LC-N-0.585].

  - Lead
    - Storm 1 – 0.026 mg/l, 0.031 mg/l and 0.012 mg/l (exceeded CMC in 3 out of 3 samples)
    - Storm 3 – 0.015 mg/l (exceeded CMC in 1 out of 3 samples)

  - Copper
    - Storm 1 – 0.010 mg/l, 0.018 mg/l and 0.007 mg/l (exceeded CMC in 3 out of 3 samples)
    - Storm 2 – 0.006 mg/l (dup. 0.006 mg/l) and 0.006 mg/l (dup. 0.005 mg/l) (exceeded CMC in 2 out of 3 samples)
    - Storm 3 – 0.006 mg/l, 0.013 mg/l and 0.005 mg/l (exceeded CMC in 3 out of 3 samples)

  - Zinc
    - Storm 1 – 0.110 mg/l, 0.140 mg/l and 0.083 mg/l (exceeded CMC in 3 out of 3 samples)

    - Storm 2 – 0.041 mg/l (dup. 0.044 mg/l), 0.110 mg/l (dup. 0.078 mg/l) and 0.110 mg/l (dup. 0.110 mg/l) (exceeded CMC in 3 out of 3 samples)
    - Storm 3 – 0.064 mg/l, 0.120 mg/l and 0.047 mg/l (exceeded CMC in 3 out of 3 samples)

- Dissolved oxygen criteria violations in the north branch just upstream of Foden Road [Site LC-N-0.585].

  - % Saturation
    - On 6/15/00 D.O. % saturation was 56.1%.
    - On 9/1/00 D.O. % saturation was 58.0%.

South Branch (the largest and southernmost tributary which drains the Running Hill Shopping Plaza, the Maine Mall area and the Clark's Ponds Pond Shopping Center and joins the main stem immediately above its discharge to Clark's Pond) **Class C**.

- Biological criteria violations
  - Macroinvertebrates (August 2004). The macroinvertebrate community failed to meet Class C criteria. Rock bag sampling in south branch just upstream confluence with main stem/Clark's Pond [Station 753 (Gorham Rd, Shops at Clark's Pond, back of Home Depot)].
  - Fish (May/June 2000). Electrofishing at a site upstream of the entrance to the Clark's Pond Shopping Center failed to yield any brook trout [Station 408 ({formerly} Hoyt's theater - 75 m upstream of trail crossing); Site LC-S-0.369].

- Toxic criteria violations in the south branch upstream of the entrance to the Clark's Pond Shopping Center [Site LC-S-0.186].

  - Lead
    - Storm 1 – 0.090 mg/l (dup. 0.078 mg/l) and 0.018 mg/l (dup. 0.020 mg/l)(exceeded CMC in 2 out of 3 samples)
  - Copper
    - Storm 1 – 0.044 mg/l (dup. 0.036 mg/l) and 0.010 mg/l (dup. 0.011 mg/l) (exceeded CMC in 2 out of 3 samples)
    - Storm 2 – 0.006 mg/l and 0.005 mg/l (exceeded CMC in 2 out of 3 samples)
    - Storm 3 – 0.007 mg/l and 0.005 mg/l (exceeded CMC in 2 out of 3 samples)
  - Zinc
    - Storm 1 – 0.270 mg/l (dup. 0.220 mg/l) and 0.085 mg/l (dup. 0.088 mg/l) (exceeded CMC in 2 out of 3 samples)
    - Storm 2 – 0.064 mg/l and 0.095 mg/l (exceeded CMC in 2 out of 3 samples)
    - Storm 3 – 0.062 mg/l and 0.035 mg/l (exceeded CMC in 2 out of 3 samples)
  - Chloride – low flow conditions
    - On 8/6/2000 chloride concentration was 245 mg/l (exceeded CCC in 1 out of 1 sample). Note: the last pre-sampling precipitation at Jetport was a small amount: 0.08 inches at ~4.5 days prior to sampling; before that was 0.02 at ~6 days and 0.01 at ~7 days.

        - On 8/23/2000 chloride concentration was 243 mg/l (exceeded CCC in 1 out of 1 sample). Note: the last pre-sampling precipitation event at Jetport was a small amount: 0.06 inches at ~4.3 days prior to sampling; before that was 0.01 inches at ~6.8 days.

- Dissolved oxygen criteria violations in south branch upstream of the entrance to the Clark's Pond Shopping Center [Station 408 ({formerly} Hoyt's theater - 75 m upstream of trail crossing); Site LC-S-0.369].

    - Concentration
        - On 9/1/00 D.O. concentration was 4.96 mg/l.
    - % Saturation
        - On 9/1/00 D.O. % saturation was 54.0%.

REFERENCES

1. ME DEP, 2008a. Personal communication via telephone from Jeff Dennis, ME DEP to Jennie Bridge, EPA, June 4 and August 11, 2008.

2. EPA, 2007. *Causal analysis of Biological Impairment in Long Creek: A Sandy-Bottomed Stream in Coastal southern Maine*, NCEA/ORD, EPA/600/R-06/065F, December 2007.

3. Glasoe, S. & A. Christy, 2004. *Literature Review and Analysis of Coastal Urbanization and Microbial contamination of Shellfish Growing Areas*, EPA-supported study by Puget Sound Action Team, June 2004.

4. Varricchione, J.T., 2002. *A Biological, Physical, and Chemical Assessment of Two Urban Streams in Southern Maine: Long Creek & Red Brook.* ME DEP LW0572, December 31, 2002.

5. Saravanapavan, T., 2008. *Stormwater Best management practices (BMP) Performance analysis – Interim Report.* Tetra Tech, Inc. progress report to EPA, March 3, 2008.

6. Center for Watershed Protection, 2003. Watershed Protection Research Monograph No.1, *Impacts of Impervious Cover on Aquatic Systems*, March 2003.

7. Shaver, E. *et al*, 2007. *Fundamentals of Urban runoff Management*, NALMS, 2nd Edition, 2007.

8. APEM, 2007. *Review of UKTAG Proposed Standard for Suspended Solids – Final Report*, APEM Ref: 410242 WWF-UK, August, 2007.

9. EPA, 1994. *Water Quality Standards Handbook*, EPA-823-B-94-005a, August 1994.

10. ME DEP, 2003. *Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams*. Rule Chapter 579, May 2003.

11. Davies, S., and L. Tsomides, 2002. *Methods for Biological Sampling and Analysis of Maine's Rivers and Streams*, ME DEP LW 0387-B2002, August 2002.

12. ME DEP, 2008b. *Stream Macroinvertebrate Samples*, pdf attachment to e-mail from Susan Davies, ME DEP, to Jennie Bridge, EPA, May 22, 2008.

13. ME DEP, 2008c. *Aquatic Life Classification Attainment Report for Station Number* S-752, pdf attachment to e-mail from Leon Tsomides, ME DEP, copied to Jennie Bridge, EPA May 6, 2008.

14. Voorhees, M., 2008a. *Metals Runoff Modeling Analysis for Long Creek, ME*, EPA technical memo dated July 10, 2008.

15. ENSR, 2006. *Stormwater TMDL Implementation Support Manual*, ENSR Corporation March 2006. http://www.epa.gov/region1/eco/tmdl/assets/pdfs/Stormwater-TMDL-Implementation-Support-Manual.pdf

16. Arnold, C.L. and C.J. Gibbons, 1966. *Impervious Surface Coverage: The Emergence of a Key Environmental Indicator, Journal of the American Planning Association*, vol. 62, no. 2, Spring 1996, pages 243-258.

17. Roy, A.H. et al, 2005. *Investigating hydrologic alteration as a mechanism of fish assemblage shifts in urbanizing streams*. J.N. Am. Benthol. Soc., 2005, 24(3):656-678.

18. Deacon, J.R., S.A. Soule, and T.E. Smith, 2005. *Effects of Urbanization on Stream Quality at Selected Sites in the Seacoast Region in New Hampshire*, 2001-03, U.S. Geological Survey Scientific Investigations Report 2005-5103, November 15, 2005, Abstract online at http://pubs.usgs.gov/sir/2005/5103/

19. CT DEP, 2006. *Percent Impervious Cover as a Surrogate Target for TMDL Analyses in Connecticut*, December 14, 2006 draft.

20. Center for Watershed Protection, 1998. *Basic Concepts in Watershed Planning*, Chapter 1 from *The Rapid Watershed Planning Handbook*, October 1998, Table 1, page 135.

21. Maine DEP, 2005. *Draft Percent Impervious Cover TMDL Guidance for Attainment of Tiered Aquatic Life Uses*, Draft 7, 2005.

22. Field, J., 2006. *Fluvial Geomorphic Assessment of Two Long Creek Tributaries, South Portland, Maine*, report submitted to ME DEP, June 2006.

23. Field, J., 2005. *Fluvial Geomorphic Assessment of Long Creek and Red Brook, South Portland, Maine*, report submitted to EPA, May 2005.

24. ME DEP, 2006a. *Maine Stormwater Best Management Practices Manual*, Maine Department of Environmental Protection, No. DEPLW0738, January 2006. http://www.maine.gov/dep/blwq/docstand/stormwater/stormwaterbmps/index.htm

25. ME DEP, 2008d. *Summary of Violations of Water Classification Standards in the Freshwater Portion of Long Creek and Its Tributaries*, September 30, 2008.

26. ME DEP, 2006b. Long Creek – *Defining Significant Contributing Sources*, notes based on Long Creek South Portland Parcel Impervious Analysis, June 6, 2006.

27. University of New Hampshire Stormwater Center, 2007. *2007 Annual Report*, 2007.

28. Roseen, R. 2007. Permeable paving preferences, e-mail on NPS Information Exchange from the Director of the UNH Stormwater Center, Environmental Research Group, June 1, 2007, 3:19 PM.

29. Voorhees, M., 2008b. *Percent Reduction in Effective Impervious Cover Based on Storage Size of Offline Infiltration*, from EPA technical memo on P8 model runs dated May 2008.

30. ME DEP, 2008e. *Long Creek Parcel Impervious Area Analysis*, spreadsheet received from ME DEP June 25, 2008.

31. Bridge, J., 2008a. *Long Creek Total Impervious Area Analysis*, graph generated using spreadsheet from ME DEP 2008e plus IC from road and turnpike right-of-ways, August 21, 2008, based on data in reference 26; revised October 28, 2008, based on data in reference 30.

32. F.B. Environmental Consulting, 2008. *Considerations for Implementation of Long Creek Watershed Management Plan*, presentation to the Long Creek Models & Outreach Committee Meeting, May 2, 2008.

33. See P.L. 1997, Chapter 519.

34. Nonpoint Source Priority Watersheds List (1998) ("1998 NPS Priority List"). See also 2002 IWQ Report.

35. See South Portland Land Trust Quarterly, March 2007 (available at http://www.splandtrust.org/SPLTq107.pdf).

36. See http://www.cumberlandswcd.org/long_creek/index.htm. See also City of South Portland, Long Creek Watershed Management homepage at http://www.southportland.org/index.asp?Type=B_BASIC&SEC=%7B84E5EC60-471A-45BA-B370-17771DD81DAF%7D&DE=%7B108C6DEE-B20A-4590-A988-78440BD0A3BE%7D

37. See M. McGowan & B. Smith, *A Case Study of the Brill Hill Development in South Portland, Maine*, Muskie School of Public Service University of Southern Maine (May 2005) (available at http://efc.muskie.usm.maine.edu/NCI%20Files/NCIWorkbook/Session%20Two/7%20Brick%20Hill%20Case%202.pdf

38. S. Seeley & B. Valle, South Portland Planning Department, *Clark's Pond Study*,(1983).

39. Maine DEP, *Birch Stream Total Maximum Daily Load (TMDL) Report*, 14 (2007) ("Birch Stream Report").

40. C. Morse, *Measuring the Impact of Development on Maine Surface Waters*, at 7 University of Maine (2003).

41. See, e.g., J. Bridge, *EPA New England's Birch Stream TMDL Review*, 8-10 (Sept. 12, 2007).

42. Schueler, T.R. 1994. "The Importance of Imperviousness." *Watershed Protection Techniques* 1(3); May, 1994.

43. C., R.R. Horner, J.R. Karr, B.W. Mar, and E.B. Welch. 1997. "Effects Of Urbanization On Small Streams In The Puget Sound Lowland Ecoregion." *Watershed Protection Techniques* 2(4).

44. Yoder, C.O., R.J. Miltner, and D. White. 1999. "Assessing the Status of Aquatic Life Designated Uses in Urban and Suburban Watersheds." In *Proceedings: National Conference on Retrofits Opportunities in Urban Environments*. EPA 625-R-99-002, Washington, DC.

45. Yoder, C.O and R.J. Miltner. 1999. "Assessing Biological Quality and Limitations to Biological Potential in Urban and Suburban Watersheds in Ohio." In *Comprehensive Storm water & Aquatic Ecosystem Management Conference Papers*, Auckland, New Zealand).

46. See Maine DEP, "Maine Section 303(d) Waters -1998", Table 1, p. 5 (1998) (*1998 303(d) report*).

47. See Maine DEP, *2002 Integrated Water Quality Report*, App D-46 (2002).

48. See *Maine DEP, 2004 Integrated Water Quality Monitoring and Assessment Report*, App. II 56 (2004) ("2004 IWQ Report")

49. See Maine DEP, *2006 Integrated Water Quality Report*.

50. (Schueler, T. 1995. *Environmental Land Planning Series: Site Planning for Urban Stream Protection*. Prepared for Metropolitan Washington Council of Governments.)

51. Maine's water quality standards can be found at Maine Revised Statutes Annotated Title 38, Article 4-A Water Classification Program. Maine's s toxics criteria were established by Rule: 06-096 CMR 584 Surface Water Quality Criteria for Toxic Pollutants.

52. S. Portland City Engineering Dep't, *Clark's Pond Storm Water Study*, 2 (1994).

53. Metcalf & Eddy, 1972. *Wastewater Engineering: Collection, Treatment, and Disposal*, McGraw-Hill, 1972.

54. Bridge.J., 2008b. *Assumed BMP Efficiency Rate*, memo to the Long Creek file, October 14, 2008.