



STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

PAUL R. LEPAGE
GOVERNOR

DARRYL N. BROWN
COMMISSIONER

April 21, 2011

Tamara Lee Pinard
Executive Director
Long Creek Watershed Management District
Cumberland County Soil & Water Conservation District
35 Main Street, Suite 3
Windham, Maine 04062

Dear Tamara,

The purpose of this letter is to confirm the Department's approval of the final revision of the Long Creek Monitoring Plan, dated March 30, 2011. We appreciate the hard work that you and Kate have put into this plan, as well as the current and ongoing efforts to further assess the condition of Long Creek and its tributaries. Thank you.

Sincerely,

Donald T Witherill
Director, Division of Watershed Management

AUGUSTA
17 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0017
(207) 287-7688 FAX: (207) 287-7826
RAY BLDG., HOSPITAL ST.

BANGOR
106 HOGAN ROAD, SUITE 6
BANGOR, MAINE 04401
(207) 941-4570 FAX: (207) 941-4584

PORTLAND
312 CANCO ROAD
PORTLAND, MAINE 04103
(207) 822-6300 FAX: (207) 822-6303

PRESQUE ISLE
1235 CENTRAL DRIVE, SKYWAY PARK
PRESQUE ISLE, MAINE 04769-2094
(207) 764-0477 FAX: (207)760-3143

web site: www.maine.gov/dep

LONG CREEK MONITORING PLAN

REVISED MARCH 30, 2011

PURPOSES OF MONITORING

Monitoring of conditions in Long Creek as funded by landowners in the watershed reflect specific regulatory and management needs. These are:

- (1) To determine whether or not Long Creek meets applicable water quality standards;
- (2) To gather information to improve management of Long Creek; and,
- (3) To document effectiveness of restoration programs and progress towards meeting standards.

The committee working on the design of the monitoring plan did not support a fourth potential goal – documenting the effectiveness of individual BMPs. The committee considered that the probable costs to gather data of practical, scientific or engineering significance was likely to be too high. In addition, meeting participants were of the opinion that excellent research on effectiveness of BMPs is already being carried out at the UNH Stormwater Center, and little new would be learned by carrying out similar work in Long Creek.

This monitoring plan is not an open-ended research effort, but is focused on gathering the information needed to manage Long Creek. We believe that the restoration of Long Creek provides a unique opportunity to study changes in an urban watershed in the face of a watershed-wide restoration effort. The work being undertaken here should attract interest from academics and funders. Such studies should be encouraged since the information gathered through them can improve the management of Long Creek (and potentially other urban impaired streams elsewhere). Such studies, however, are distinct from the base monitoring effort we are concerned with in this plan.

MAJOR PARAMETERS

WATER QUALITY STANDARDS

The following parameters have been selected for monitoring because there have either been documented failures to meet water quality standards in Long Creek, or such failures are strongly suspected based on other evidence.

- Hydrology and Flow (this is the most direct effect of impervious surfaces, the primary stressor identified in the TMDL)
- Biological Monitoring – Invertebrates

- Biological Monitoring – Fish Community
- Dissolved Oxygen (continuous monitoring at Primary sites)
- Chloride
- Metals

INFORMATION AND UNDERSTANDING

In addition to the parameters that are directly connected with known or suspected failures to meet water quality standards (above), other parameters can help us understand the forces shaping the water quality of Long Creek. The following additional data will be collected. (Some of these parameters are inexpensive to measure; others are thought to be directly related water quality standards violations.)

- | | | |
|---|---|---|
| <ul style="list-style-type: none"> • Temperature • Specific Conductance | } | Collected nearly continuously during the summer months using automated water quality "sondes" |
| <ul style="list-style-type: none"> • pH • Phosphorus • Bacteria (<i>E. coli</i>) • Organic toxics – especially polycyclic aromatic hydrocarbons (PAHs) • Geomorphology, stream channel stability, habitat complexity (e.g., in-stream large wood) and channel morphology | | |

DOCUMENT EFFECTIVENESS OF ACTIONS

Urbanization triggers major hydrologic changes in urban streams. In fact, Vermont's approach to monitoring and managing urban impaired watersheds focuses on comparing the hydrology of impaired versus non-impaired streams. Maine's approach to developing urban watershed TMDLs emphasizes control of directly connected impervious area, in large part because of the impact that impervious surfaces have on stream hydrology.

However, the impacts of urbanization on stream ecosystems are multifaceted. A number of actions planned for the Long Creek Watershed (e.g., good housekeeping practices, street sweeping, installing tree box filters) to reduce pollutant loadings, but these may have little effect on storm event hydrology. Therefore, documenting the effectiveness of actions undertaken in Long Creek, cannot focus solely on hydrology, but will examine effects on other stressors as well, such as high temperatures, toxic pollutants and chlorides.

Fortunately, no additional parameters must be tracked solely to document effectiveness of restoration efforts. Instead, the sampling design for measuring the parameters already listed will be developed to ensure that we can document changes that occur AT THE WATERSHED LEVEL in four focus areas:

- System hydrology

- Pollutant loading or concentrations
- Habitat structure
- Biological response

SAMPLING DESIGN AND METHODOLOGY

The sampling design allows both longitudinal documentation of trends at single locations and upstream-downstream comparisons to evaluate changes occurring within the watershed.

Ongoing monitoring will be focused at seven pre-determined monitoring stations (Map 1). Sampling at those locations repeatedly generates a long-term record that will be informative of changing conditions in the Long Creek and its tributaries.

HYDROLOGIC MONITORING

Monitoring of hydrology is central to the monitoring program. We need good flow data not only to document changes in hydrology (which may be affected by actions undertaken in the watershed), but also to guide collection and interpretation of water quality samples. Detailed hydrologic monitoring will be conducted at all primary monitoring stations around the watershed, and two meteorological monitoring stations will be installed and monitored in partnership with two landowners.

Water flow (stream discharge) will be measured based on empirical stage-discharge relationships developed for all primary monitoring stations. These relationships will be statistically derived based on simultaneous field measurements of stage (water surface elevation) and discharge at particular locations in the stream. Stage-discharge curves have been developed for each site. The stage-discharge relationship will be checked twice annually for monitoring year 2, annually thereafter, and following any storm event that alters the stream morphology in such a way as to affect the stage-discharge curves.

For understanding the effects of restoration, however, good flow data alone is probably insufficient. Precipitation and storm patterns differ year to year. Thus a simple comparison of flow in Long Creek prior to restoration with flow after significant work has been completed confounds the effects of restoration efforts with year to year variation in the weather.

A comprehensive understanding of the hydrologic effects of restoration will require a combination of field data and hydrologic modeling. A watershed model of Long Creek can be calibrated based on data collected in the first year or two of the restoration effort, and then used in the future to estimate how the observed hydrologic response of the watershed to storms differs from what would have been predicted if no restoration activities were to take place.

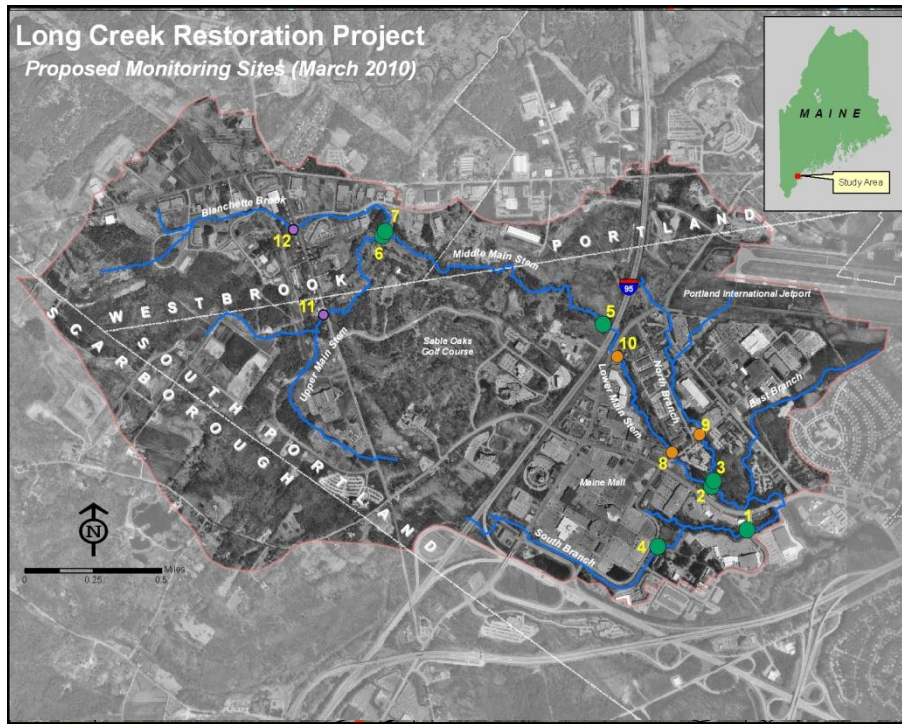
WATER QUALITY MONITORING

The water quality monitoring portion of the program consists of two components:

- (1) Continuous seasonal monitoring for field parameters (temperature, specific conductance, and dissolved oxygen) from approximately April until November; and,
- (2) Periodic grab sample collection and analysis for phosphorus, metals, chloride, and polycyclic aromatic hydrocarbons (PAHs).

PROPOSED SAMPLING LOCATIONS

We have identified 7 locations (4 permanent / 3 rotating) for primary sampling stations; 3 locations for secondary sampling stations; and 2 locations for tertiary sampling stations. Primary sampling locations are sites for hydrologic monitoring, and data addressing most parameters will be collected at those locations. They are located at the downstream end of each sub-watershed, and at several locations higher in the watershed to facilitate upstream-downstream comparisons and improve mechanistic understanding of stream hydrology. Secondary and tertiary sites include locations where violations of water quality standards have been observed in the past and should therefore provide an especially useful mechanistic understanding of impairment causes. The sites are shown on Map 1 and listed in Tables 1 and 2.



Legend

Monitoring Stations

- Primary
- Supplemental
- Tertiary

Long Term Monitoring Sites

Proposed Monitoring Sites Long Creek

Data available from:
The Maine Office of GIS, NOAA,
Casco Bay Estuary Partnership
(207) 780-4820

A LIMITATION OF PROPOSED SAMPLING LOCATIONS

It is important to point out that these proposed locations do NOT represent all locations where violations of water quality have been observed or could be observed, but have been selected to provide a synoptic view of conditions in Long Creek. Regulatory agencies may wish to carry out sampling at additional locations to determine whether Long Creek meets water quality standards everywhere.

Table 1: Listing of permanent sample locations for monitoring of Long Creek.

Site No.	Primary Monitoring Location	Site Type	DEP Site Code
1	South Branch above Clarks Pond access road	Primary	LC-S-0.186
2	Main Stem above confluence with North Branch	Primary	LC-M-0.380
3	North Branch above confluence with Main Stem	Primary	LC-N-0.415
4	South Branch below Econolodge Motel	Primary	
5	Main Stem above turnpike	Primary	
6	Main Stem – above confluence with Blanchette	Primary	LC-Mn-2.270
7	Blanchette Br. – above confluence with Main	Primary	LC-M-2.274
8	Main Stem above Foden Rd. crossing	Secondary	
9	South Branch above Foden Rd. crossing	Secondary	LC-M-0.6 (Station 752)
10	Main Stem below Maine Mall Rd / Turnpike	Secondary	
11	Upper Main Stem above Spring St. crossing	Tertiary	LC-M-2.754
12	Blanchette Br. above Spring St. crossing	Tertiary	

Table 2: Where to sample what: Major parameters associated with each sample location.

Site No.	Type	Sondes	Hydro	Bio-monitoring	Nutrients	Metals	Chloride	PAHs
1	Primary	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Primary	Yes	Yes	Yes	Yes	Yes	Yes	
3	Primary	Yes	Yes	Yes	Yes	Yes	Yes	
4	Primary	Yes	Yes		Yes	Yes		
5	Primary	Rotating	Yes	Yes	Yes	Yes	Yes	
6	Primary	Rotating	Yes	Yes	Yes	Yes		
7	Primary	Rotating	Yes	Yes	Yes	Yes		
8	Secondary							Yes
9	Secondary			Yes				Yes
10	Secondary							Yes
11	Tertiary				Yes			
12	Tertiary				Yes			

METHODOLOGY

Sondes: Data will be collected year-round when risk of ice damage is low (to protect equipment) for dissolved oxygen (D.O.), temperature, and conductivity using continuous water quality sondes at all 7 Primary stations (4 permanent and 3 rotating).

Hydrology: Collected at Primary stations only. The goal of the hydrology monitoring is to collect sufficient data to develop and calibrate hydrological models. Data to be collected includes continuous water surface elevation monitoring and periodic stage-discharge curve calibration. Continuous monitoring will be implemented from approximately April through November, depending on temperature conditions. Periodic curve calibration will be conducted a minimum of twice annually during monitoring year 2, annually thereafter, and as needed following major storm events.

Bio-monitoring: Biomonitoring samples for stream invertebrates will be collected at all 7 Primary stations twice in every 5 year period (e.g., in years 3, 5, 8 and 10). One additional site (#9) has previously failed to meet invertebrate-community based water quality criteria, so that site will be sampled at least once every five years. We anticipate that DEP will be able to support some of this work every five years, as the state's Biomonitoring Program returns to the Cumberland County area as part of their ongoing sampling program.

Water Quality Sampling: Analytical samples will be collected throughout the flow season, targeting spring runoff, summer storm flow, and base flow in the summer and fall. The purpose of these data is to identify primary and secondary contributors to degraded water quality in Long Creek and to subsequently correlate water quality with seasonal variations in stream flow. These data will provide baseline information to evaluate stream restoration options and progress toward site goals. The following analytical parameters will be evaluated:

- **Phosphorus and Orthophosphate:** Data will be collected at the seven permanent stations as well as at two stations on the Main Stem, upstream of Spring Street. These upstream locations contribute to our understanding of sources and sinks for nutrients within the watershed and floodplain, as well as help us understand the potential role of nutrient enrichment in generating low dissolved oxygen conditions. Data will be collected ONLY on phosphorus and orthophosphate, not on other macronutrients. While data on other macronutrients, especially nitrogen, would be of interest with regards to impact of stormwater pollution in Casco Bay, nitrogen loads are less likely to contribute to failure of the stream to meet water quality criteria.
- **Other Nutrients:** If outside funding is available, LCWMD or their Contractor may collect other macronutrient data such as total kjeldahl nitrogen (TKN), nitrite (NO₂), nitrate (NO₃), ammonia (NH₃), and total inorganic nitrogen. These analytes will be collected in accordance with the sampling methodology presented in the QAPP as well as any requirements by the funding agency.
- **Metals:** High levels of metals can create toxic conditions that may contribute to the failure of urban streams to support sensitive invertebrate species, thus contributing to a stream's failure to meet the invertebrate biomonitoring-based water quality criteria. Data on metals will be collected at all seven Primary stations under base and storm flow conditions. The Target Analyte List (TAL) for metals includes: cadmium, copper, lead, nickel, and zinc.

- **Chloride:** High chloride levels are associated with high input of salts (especially sodium and calcium chlorides) derived from deicing activities that enter the stream during snow melt or via groundwater. In most urban watersheds not influenced by ocean waters, chlorides are highly correlated with specific conductivity, which will be measured nearly continuously with water quality sondes. Chloride data will be collected at the seven primary sites to check for such an association in Long Creek and develop a statistical model to estimate chlorides based on conductivity data.

Polycyclic Aromatic Hydrocarbons: Polycyclic aromatic hydrocarbons (PAHs) are a class of organic compounds found in a variety of petroleum products and produced as a byproduct of combustion of hydrocarbons. They tend to be found in higher concentrations in areas with heavy automobile use. To control costs, PAHs will be sampled at only four sites – those where elevated levels are most likely to occur. The goal is to use data from limited sites to ascertain whether organic toxins are contributing to failure of the stream to meet water quality criteria. The first year of monitoring data showed all PAHs to be below detection limits. Based on these results as well as data collected by EPA that showed elevated PAHs, one additional round of sampling will be conducted in order to ensure that the results from Year 1 are representative of stream conditions. If these values are also non-detect, we will sample only once every five years. If levels are higher, we will sample twice in every five year period. Since PAHs are not generally water-soluble, unfiltered samples will be collected and analyzed in order to determine the total fraction of PAHs in water, including those bound to suspended particles. The PAHs to be sampled include those detected by EPA as well as those detected in street dust samples analyzed in December 2010. The PAH target list is: 2-Methylnaphthalene, Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(a)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h,)anthracene, Fluoranthene, Fluorene, Naphthalene, Phenanthrene, Pyrene, 2-Chloronaphthalene, and Indeno(1,2,3-cd)pyrene.

TABLE 1: METHODOLOGY

Parameter	Method	Locations
<u>Hydrologic Alteration</u>		
Stream Hydrology	Stage-discharge curves	Primary Sites
Precipitation	Precipitation monitoring at two hosted sites	Sites TBD, supplemented by Portland Airport data
Weather	Air temperature, relative humidity, solar radiation	Portland International Jetport
<u>Addressing WQ Standards</u>		
Continuous water chemistry – DO, conductivity, temp	Data sondes	Sites 1, 2, 3 and 7 with additional deployments as availability of sondes allows
Biomonitoring -- invertebrates	Rock baskets	Primary Sites
Biomonitoring -- fishes	Electrofishing	Primary Sites
Chloride	Establish a dataset for the watershed during Monitoring Year 2, then	Primary Sites

	reduce analytical collection and evaluate via established chloride - conductivity relationships confirmed with limited analytical data.	
<u>Documenting Watershed Processes</u>		
Conventional Pollutants: Phosphorus, turbidity, hardness, SSC	Base flow samples	Primary Sites
	Storm event sampling	Primary Sites
Water Temperature	Sondes	Data collected with sondes at all primary sites. Other sites to be selected to enhance watershed-wide coverage and test thermal impacts of specific outflows
Stream Geomorphology	Rapid assessment	Selected stream channel reaches (including J. Field's survey areas)
	Permanent monitoring	Restoration project sites
Conductivity	Base flow samples	Collected with sondes at all Primary sites
	Storm event sampling	Collected with sondes at all Primary sites
<u>Toxicity and Toxic Chemicals</u>		
Indicator Metals - Cadmium, Copper, Nickel, and Zinc	Base flow samples	Test as surrogate for other metals; all Primary stations
	Storm event sampling	Test as surrogate for other metals; all Primary stations
PAHs	Base flow samples	Sites 1, 8, 9 and 10
	Storm event sampling	Sites 1, 8, 9 and 10

SAMPLING SCHEDULE

While these parameters are all related to specific documented or suspected failures of conditions on Long Creek to meet water quality standards, they vary in cost and in how much information they provide about what is going on in the stream.

During the Year 1 (2010) monitoring season, the following approach was implemented:

- (1) Identify monitoring goals,
- (2) Identify parameters to track,
- (3) Document resources needed to collect that data, and

- (4) Propose a schedule for monitoring that offers a balance between frequency of data collection and cost.

Based on the findings of the Year 1 monitoring and the data needs, the monitoring schedule will meet the following criteria:

- (1) Sondes and stream stage monitoring equipment (i.e., transducers) will be deployed as early as practicable once weather conditions allow (estimated to be late March).
- (2) Sondes and transducers will be maintained throughout the flow season until consistent freezing temperatures necessitate removal (estimated to be April through early November).
- (3) Grab samples will be collected throughout the monitoring season and the program will be designed to evaluate snowmelt, base flow, and storm flow. Storm samples may be collected using storm sampling device(s) or grab methodology as described in the Quality Assurance Project Plan (QAPP).

PROPOSED SAMPLING SCHEDULE 2010- 2014

<u>Parameter</u>	<u>Timing</u>	<u>Year</u>				
		<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
<u>Addressing WQ Standards</u>						
Continuous DO, specific conductivity, temperature	Continuous monitoring from ice-out until the overnight temperature is consistently below 25 °F (Approx. April to November).	X	X	X	X	X
Periodic pH, DO, specific conductivity, temperature, turbidity	These field parameters to be collected with portable water quality instrumentation at the time of grab sample collection.	X	X	X	X	X
Biomonitoring -- invertebrates	Twice every five years	X			X	
Biomonitoring – fish community	Every three to five years				X	
Chloride	Weekly sampling during snowmelt period followed by monthly sampling through November plus 4 storm events.		X			X
Toxic organic compounds	Limited (4 station) sampling events: 1 during snowmelt and 1 midsummer storm event. Optional (depending on results of spring/storm) events in midsummer low flow and late fall. If constituents non-detect or low detections, will resample once every 5 years.		X			X
Subset of Metals -- Copper and Zinc	Monthly sampling May through August plus 2 storm events.	X	X	X	X	X
Metals	Weekly sampling during snowmelt period followed by monthly sampling September through November plus 2 storm events.	X		X		
<u>Documenting Watershed Processes</u>		-	-	-	-	-

Conventional Pollutants (phosphorus)	Weekly sampling during snowmelt period followed by monthly sampling through November plus 4 storm events.	X	X	X	X	X
Weather (precipitation, temperature)	Continuous	X	X	X	X	X
Temperature	Continuous during the summer months, using sondes and data loggers	X	X	X	X	X
Stream flow	Continuous monitoring from ice-out until the overnight temperature is below 25 °F (Approx. April to November), based on rating curves for each Primary site (developed in 2010)	X	X	X	X	X
Stage-Flow Rating Curves	Rating curve check twice during year 2, annually thereafter and if channel changes significantly due to a storm event.	X	X	X	X	X
Stream Geomorphology	Every 3-5 years				X	
<u>Document Effectiveness of Actions</u>						
Stream Geomorphology	Restoration site monitoring every 2 years, minimum	X	X		X	