Volunteer River Monitoring Program
2012 Data Report

VRMP April 2013

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Executive Summary

The Volunteer River Monitoring Program (VRMP) is a relatively new program started by Maine Department of Environmental Protection (DEP) in 2009. The program began for a number of reasons. There were groups interested in water quality monitoring but they did not have the resources to do it on their own. Other groups were monitoring on their own but were using different methods, data management systems, and quality assurance/quality control requirements. The VRMP thus provides a standardized approach with participating groups working under a single quality assurance project plan. The VRMP further provides training, volunteer certification, data archiving, and an annual water quality report.

In 2012, volunteers in seven watershed groups collected water quality data in eight river/stream watersheds throughout the State of Maine. These groups monitored Kennebunk River and Mousam River in south coastal Maine (York County); Presumpscot River in southern Maine (Cumberland County); Upper Androscoggin River in western Maine (Oxford County); Lower Androscoggin River in mid-coast Maine (Androscoggin, Cumberland, Sagadahoc Counties); Bagaduce River in east coastal Maine (Hancock County); Penjajawoc Stream in the City of Bangor (Penobscot County); and Prestile Stream in Northern Maine (Aroostook County). The volunteers provide a tremendous service collecting information on waters that the DEP could not visit on their own.

The VRMP annual report is divided into 5 chapters as follows:

- 2012 monitoring overview, VRMP background, and Clean Water Act-Maine Water Classification overview
- Explanation of water quality parameters
- 2012 weather/flow data and 2012 water quality data
- Quality Assurance/Quality Control Program
- River/stream reports (attached as separate documents)

Chapter 1
Overview and Introduction

2012 Overview

The 2012 sampling season marked the fourth year of the Volunteer River Monitoring Program (VRMP). In 2012, seven volunteer river monitoring groups, comprised of 53 monitors, participated in the program. These groups represented a range of locations and watersheds. In Northern Maine, the Central Aroostook Soil & Water Conservation District and Storm Watchers group monitored the Prestile Stream, a primarily agriculturally impacted river. The Bagaduce Watershed Association monitored the Bagaduce River, a coastal river in east coastal Maine. In the city of Bangor volunteers monitored the urbanized Penjajawoc Stream. Androscoggin River Watershed Council monitored the upper Androscoggin River in western Maine. Friends of Merrymeeting Bay monitored the lower Androscoggin River, a large point and non-point source impacted river. Presumpscot River Watch monitored the Presumpscot River, located in the highly developed area of southern Maine. The Kennebunk and Mousam rivers, located in the southern and coastal area of the state, were monitored by the Mousam & Kennebunk Alliance.

Monitoring groups covered an area of over 1000 square miles of river and stream watershed and collected a vast amount of data; a total of 500 sampling events were completed at 84 sites. Collected data parameters included water temperature, dissolved oxygen, specific conductance, bacteria, turbidity, and total suspended solids.

VRMP Background

The DEP is responsible for monitoring and assessing the State's waters. However, with limited State resources, it has long been recognized that there is value and a need for using volunteers for collecting water quality data. Therefore, there was interest in developing a statewide volunteer effort for streams and rivers, an effort similar to the very successful Lake Volunteer Monitoring Program which has been in existence since 1971. In 2007, DEP commissioned a needs assessment and determined that there was widespread support for a volunteer river monitoring program. After determining where the program would be housed and how it would be organized, the VRMP was launched in 2009.

Prior to 2009, with no or limited DEP assistance, a number of hard-working river and stream watershed groups had already developed monitoring programs on their own for a variety of reasons. According to a needs assessment done for the DEP, these reasons included: an interest in land preservation, protecting endangered species, dam removal, opening clam flats, upgrading water classification, and obtaining water quality data. The VRMP brought some of the established groups and also new groups into the program.

There are challenges with volunteer groups working independently: they may employ diverse sampling or analysis methods; they may use different data management systems; and they may adhere to a variety of quality assurance/quality control requirements. Additionally, these groups may or may not have an approved quality assurance project plan. Also, for the general public, centralized access to the results of most volunteer sampling had not been available.

The VRMP was formed as an organization to address these problems. The VRMP unifies a network of volunteer groups that participate in quality assured volunteer sampling. Volunteer sampling is governed by a program level Quality Assurance Project Plan (QAPP) which was created and is maintained by VRMP staff. Volunteer groups develop individual Sampling and Analysis Plans (SAPs) tailored to their specific project situation. To ensure consistent sampling and analysis methods, each SAP includes Standard Operating Procedures (SOPs) that detail equipment or techniques.

The creation of an approved generic QAPP and the support by VRMP staff makes it easier for interested groups to tackle the rigors of water quality monitoring with reduced difficulty and time associated with the development of QAPPs, SAPs, and SOPs.
The VRMP therefore:

1. Created and maintains a Quality Assurance Project Plan
2. Assists groups with writing Sampling and Analysis Plans
3. Maintains an equipment loan program
4. Provides annual training
5. Provides quality assurance/quality control of data and a centralized database
6. Produces an annual report

Overview of the Federal Clean Water Act and Maine's Classification System

A brief overview about water quality classification and criteria is provided here to give a better understanding of how volunteer monitoring fits into the bigger picture of protection and restoration of Maine's waters. For more details, we recommend the following website: www.maine.gov/dep/water/monitoring/classification/index.html.

In 1972, the Federal government passed the Clean Water Act (amended in 1977) which provides the overall framework for the protection and restoration of all waters of the United States. Included in the many requirements that States must implement, the Clean Water Act mandates that States establish a water quality standards program consisting of three parts: designated uses, criteria, and an anti-degradation statement.

The designated human and ecological uses reflect the goals for each water body and include: support of aquatic life, fishing (including fish consumption), recreation, drinking water, navigation, and hydropower. Narrative and numeric criteria consist of minimum requirements for parameters such as dissolved oxygen, bacteria, and the health of aquatic life communities that ensure that a water body attains its designated uses. The anti-degradation statement protects existing uses and high quality waters by requiring that, when the actual quality of any classified water exceeds the minimum standards of the next highest classification, the higher water quality must be maintained and protected.

Maine defines uses for its water bodies through the Maine Water Classification Program. There is one class for lakes and ponds, three classes for marine and estuarine waters, and four classes for rivers and streams. The four classes for rivers and streams are AA, A, B, and C. Each classification specifies the designated uses and water quality criteria described earlier, and the anti-degradation statement places specific restrictions on certain activities, such that the standards of each class are achieved and maintained. The results of the differences between the classes largely determine how they are managed and the types of activities allowed. Table 1 shows the classifications and associated designated uses for each class. Table 2 and Table 3 show the classifications and associated water quality criteria.

Table 1: Classification and Designated Uses

Water Class	Designated Uses
Class AA	Drinking water supply, recreation in and on the water, fishing, agriculture, navigation and habitat for fish and other aquatic life.
Class A	Drinking water supply, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation, navigation and habitat for fish and other aquatic life.
Class B	Drinking water supply, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation, navigation and habitat for fish and other aquatic life.
Class C	Drinking water supply, recreation in and on the water, fishing, agriculture, industrial process and cooling water supply, hydroelectric power generation, navigation and habitat for fish and other aquatic life.

Table 2: Classification and Water Quality Criteria

Water Class	Dissolved Oxygen Numeric Criteria	Habitat Narrative Criteria	Aquatic Life (Biological) Narrative Criteria[1]
Class AA	As naturally occurs	Free flowing and natural	No direct discharge of pollutants; as naturally occurs
Class A	7 ppm; 75% saturation	Natural	As naturally occurs
Class B	7 ppm; 75% saturation	Unimpaired	Discharges shall not cause adverse impact to aquatic life in that the receiving waters shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community.
Class C	5 ppm; 60% saturation; 6.5 ppm (monthly average) at 22° and 24°F	Habitat for fish and other aquatic life	Discharges may cause some changes to aquatic life, provided that the receiving waters shall 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.

[1] Numeric biocriteria in Maine rule Chapter 579; Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.

Table 3: Classification and Bacteria Criteria

Waterbody Class	Bacteria Criteria
Fresh water	
Class AA	As naturally occurs[1]
Class A	As naturally occurs[1]
Class B	Between May 15th and Sept. 30th *E. coli* of human and domestic animal origin shall not to exceed a geometric mean of 64/100mL or an instantaneous level of 236/100mL
Class C	May 15th – Sept. 30th *E. coli* of human and domestic animal origin shall not to exceed a geometric mean of 126/100mL or an instantaneous level of 236/100mL
Class GPA (for lakes and ponds < 10 acres in size)	Between May 15th and Sept. 30th *E. coli* of human origin shall not to exceed a geometric mean of 29/100mL or an instantaneous level of 194/100mL

[1] Defined in 38 MRSA §466(2): "As naturally occurs" means conditions with essentially the same physical, chemical and biological characteristics as found in situations with similar habitats free of measurable effects of human activity." In practice, the Class GPA standard for *E. coli* may be used as a surrogate target if a freshwater's "natural" bacteria levels are unknown.

While the Water Classification Program establishes goals, designated uses, and criteria, it does not necessarily mean that a water body is actually attaining water quality conditions as defined in its assigned class. Another part of the Clean Water Act is Section 305(b) which requires that states assess the condition of their waters toward meeting designated uses and prepare a report biannually to Congress. This report is referred to as the 305(b) report or "Integrated Water Quality Monitoring and Assessment Report". "The "Integrated Report" summarizes water quality data collected by the DEP; other state, Federal, and tribal government agencies; volunteer water monitoring organizations; and other sources. The report provides a general overview of the conditions of Maine's waters and the appendices give the conditions of specific water bodies. The report also includes a list of "impaired water bodies".

Chapter 2
Water Quality Monitoring

Why Monitor Certain Water Quality Parameters?

Water quality parameters commonly monitored to assess the quality of streams and rivers include dissolved oxygen (DO), biochemical oxygen demand (BOD), temperature, pH, alkalinity, suspended solids and turbidity, bacteria, and nutrients. Generally, all VRMP groups monitor D.O., temperature, and conductivity. Additional parameters may be monitored depending on a number of factors including existing natural stream/river conditions, potential impacts, the group's monitoring objectives, and funding. For more information, see "Volume 2 A Citizen's Primer on Stream Ecology, Water Quality, Hydrology, and Fluvial Geomorphology (October 2010) on the VRMP website
http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/index.html.
Another good educational resource is the U. S. Environmental Protection Agency's "Volunteer Stream Monitoring: A Methods Manual" (USEPA, 1997), which can be found online at: http://www.epa.gov/owow/monitoring/volunteer/stream/stream.pdf

Dissolved Oxygen (D.O.) and Biochemical Oxygen Demand (BOD)

One of the most important measures of water quality is dissolved oxygen – the amount of oxygen dissolved in the water. Oxygen in dissolved form is used by organisms living in the water to breathe. It is measured in milligrams/liter (mg/L) or parts per million (ppm). When measuring D.O., percent saturation should also be recorded with the meter. When using D.O. chemical kits, percent saturation can be calculated if water temperature is known. Percent saturation provides a measure of the capacity for oxygen to cross gill membrane barriers and enter the bloodstream of organisms. Both D.O. and percent saturation are used to determine whether a water body is attaining its water quality class.

If oxygen is low, it stresses aquatic organisms, affecting their growth and reproduction and, if it becomes low enough, it may kill aquatic organisms. Levels less than 5 mg/L are generally considered stressful. Levels between 5-7 mg/L are stressful to some coldwater fish if the percent saturation is low. Greater than 7 mg/L is generally considered optimal for all aquatic life. Early life stages of certain coldwater fish require higher D.O. levels.

Oxygen enters rivers and streams in several ways:

- it diffuses through the atmosphere at the water surface
- it mixes with the atmosphere as water moves over dams, waterfalls, and riffles
- algae and aquatic plants produce oxygen as a product of photosynthesis

Oxygen is used up through two processes:

- ◦ respiration
- ◦ decomposition of organic materials (i.e. leaves and other materials)

If there is an increase in organic loading (addition of organic material to a watershed), oxygen may be used up. Sources of loading include discharges, increased runoff, and increased plant (particularly algae) growth. More sophisticated sampling may warrant testing for BOD which estimates the amount of oxygen demanding substances in the water sample.

Water temperature and altitude affect dissolved oxygen levels. Cold water holds more oxygen than warm water, and water holds less oxygen at higher altitudes. The most stressful period is the summer months because water temperature is highest, and flows tend to be lowest. Over a 24 hour period, lowest DO values occur in early morning and highest values late in the day. This is due to daily plant photosynthesis-respiration cycles and is the reason some early morning samples should be collected. In highly productive streams, there can be significant swings in dissolved oxygen over the course of a day.

Temperature

Temperature is a critical parameter affecting aquatic life and, along with DO, is one of the most important to monitor. Besides its effects on dissolved oxygen, temperature affects biological activity (e.g. metabolism of individual organisms). Aquatic organisms depend on certain temperature ranges for their optimal health. Both fish and macroinvertebrates are sensitive to temperature and will move within the stream to more favorable conditions if possible.

If organisms are exposed to temperatures outside their optimal range for a prolonged period, they can be stressed or die. Stress can alter their susceptibility to disease or toxins and affect reproduction. For fish, there are two kinds of limiting temperatures – the maximum temperature for short exposures, and a weekly average temperature that varies according to the time of year and life cycle of the species. For more information about fish species requirements, see Table 4-2- Maximum average temperatures for growth and short term maximum temperatures for selected fish in “Volume 2. A Citizen’s Primer on Stream Ecology, Water Quality, Hydrology, and Fluvial Geomorphology” referenced above.

A number of human activities can affect temperature. These activities include: removal of stream bank vegetation; impoundments; discharges; and stormwater runoff (e.g. runoff from heated surfaces such as parking lots, roads, and other sources).

Conductivity

Conductivity is a measure of water's ability to carry an electrical current and is directly related to the dissolved ions (charged particles) present in water. Dissolved ions in water originate from the geology of the area as well as from human sources such as wastewater discharges and stormwater runoff. Conductivity is affected by temperature – the warmer the water, the higher the conductivity. For this reason, conductivity is generally reported as specific conductance. Specific conductance is conductivity that is adjusted to what the reading would be at a temperature of 25˚ Celsius. Conductivity and specific conductance are measured in micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm).

Conductivity is useful as a general measure of stream water quality and can be used to track down many kinds of pollution sources. The values for Maine undisturbed rivers and streams are generally low (30-50 µs/cm). Values significantly greater than 100 µs/cm may indicate that there is a potential pollution problem. Some degraded urban streams having serious pollution problems can have conductance values in the 300-400 µs/cm range or even higher.

There has been a growing concern in the Northeastern United States about potentially significant increases in chloride concentrations in freshwater surface and groundwater supplies, primarily originating from winter road and parking lot safety maintenance (salting) activities (Kausal et al., 2005; Mullaney et.al., 2009). Though conductivity is not a direct measure of chloride concentrations, high chloride concentrations are frequently associated with high specific conductance measurements, thereby making specific conductance a valuable screening tool for these types of problems.

pH

pH is a term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. The pH scale measures the logarithmic concentration of hydrogen (H+) and hydroxide (OH-) ions which make up water. When both types of ions are in equal concentration, the pH is 7.0 or neutral. Below 7.0, the water is acidic, and when the pH is above 7.0, the water is alkaline or basic. Since the scale is logarithmic, a drop in the pH by 1.0 unit is equivalent to a 10-fold increase in acidity.

Maine water quality standards allow a pH range of 6.0 to 8.5 for all freshwater quality classes (AA, A, B and C). pH outside this range reduces the diversity of aquatic organisms because it stresses the physiological system of most organisms and can reduce reproduction success. Low pH can also allow toxic elements (e.g. aluminum) to be become available for uptake by aquatic organisms. pH is generally not measured by volunteers in part due to the difficulty of accurately measuring it. pH may be affected by acid rain/snowmelt, local geology, inputs from natural organic acids from the decomposition of organic matter, photosynthesis and respiration of aquatic plants, and certain wastewater discharges.

Alkalinity

Alkalinity is a measure of the capacity of water to neutralize acids and is also known as the buffering capacity. It is due primarily to the presence of naturally variable bicarbonate (HCO_3), carbonate (CO_3^{-2}), and hydroxide (OH^-) ions; bicarbonate is the major form. Sources of alkalinity include rocks and soils, salts, algal activity, and even certain wastewater discharges.

In Maine, there are wide natural variations due to the depth and type of soil material in a watershed. Alkalinity results are typically reported as milligrams per liter of calcium carbonate (mg/L $CaCO_3$). Rivers with alkalinity values less than 10 milligrams per liter (mg/L) are considered poorly buffered. Measuring alkalinity is important in determining a river's ability to neutralize acidic pollution form rainfall, acid deposition (polluted rain and snow), and other pollutants that may affect the strength of acids in a stream.

Sediment Pollution

Streams and rivers naturally transport sediments (sand, silt, or clay) through their systems. Excess sediments, usually resulting from human activities done carelessly, may enter into and become suspended, transported, and deposited within streams and rivers. These excess sediments can cause a number of harmful effects:

- reduce visibility which interferes with fishes ability to feed
- raise water temperature (suspended particles absorb more heat)
- damage fish and aquatic insect gills
- block sunlight, which impairs photosynthesis
- carry nutrients and toxics adsorbed to sediment particles
- fill in natural gravel-stone habitat areas – eliminating habitat areas and suffocating eggs

Total Solids, Total Suspended Solids and Suspended Sediment Concentration

"Total solids" is a measure of dissolved solids plus suspended and settable solids in water. In stream water, dissolved solids consist of calcium, chlorides, nitrates, phosphates, iron, sulfur, and other ion particles as well as humics and tannins that will pass through a filter with very small pores. "Suspended solids" include: sand, silt, and clay particles; plankton; algae; fine organic debris; and other particulate matter. "Total suspended solids" (TSS) and "suspended sediment concentration" (SSC) are measurements of suspended sediments (e.g., soil particles, sands, clays) originating both from outside and within a stream. The analytical methods for TSS and SSC differ. TSS data are obtained by several methods, most of which involve measuring the dry weight of sediment from a known volume of a subsample of the original sample. SSC data are obtained by measuring the dry weight of all the sediment from a known volume of a water-sediment mixture (sample).

Total solids, total suspended solids, and suspended sediment concentration monitoring is done by collecting water samples that are analyzed by a certified lab. Results are measured in milligrams per liter (mg/L) or parts per million (ppm).

Turbidity and Transparency

Turbidity is a measure of the degree to which material suspended in water decreases the passage of light. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, and other decaying vegetation. Turbidity can be useful for monitoring the effects of runoff from construction, agricultural activities, logging activity, discharges, and other sources. Turbidity is generally measured by using a turbidity meter with values reported in nephelometric turbidity units or NTUs. During significant rainstorm (runoff events), turbidity can increase significantly (e.g. > 100 NTU), especially if substantial erosion is occurring in the watershed.

Transparency is strongly correlated to turbidity. It may be measured using a transparency tube. This is a 120 centimeter tube that has a black and white disk at the bottom of the tube. The tube is filled with the water sample and then water is slowly drained out until the disk is visible.

Sources of total solids, suspended solids/sediments, and turbidity include: in-stream erosion, waste discharges, and soil erosion from human activities and land use in the watershed (e.g. construction projects, bare soil on residential lots, logging, agricultural activities, and polluted urban stormwater runoff including eroded soil and winter sand).

Bacteria

Many types of pathogenic (disease causing) viruses, bacteria, and protozoans can be present in surface waters that are contaminated by fecal matter. When people drink, swim in, or eat shellfish from contaminated or untreated water, they can potentially become ill. Since it is not possible to test for all the possible pathogens present, members of two bacteria groups – *Escherichia coli* and enterococci – are used as indicators of possible sewage contamination because they are commonly found in human and animal feces. USEPA recommends *E. coli* as the best indicator of health risk from water contact in recreational waters. Enterrococci are distinguished by their ability to survive in salt water and are recommended as the best indicator of health risk in salt water used for recreation. Fecal coliform are used for testing shellfish areas.

Some sources of bacteria and pathogenic organisms include malfunctioning septic systems, overboard discharge systems, combined sewer overflows, discharges from boats, improperly stored animal manure, wildlife, pet waste, and publicly owned treatment works (POTWs) that are not working properly. POTWs are heavily regulated and usually do a good job of treating and disinfecting wastewater. Bacteria can increase after a rain event due to run-off from farmland, urban areas, and lawns of pet owners as well as from naturally occurring local wildlife sources.

Nutrients

Nutrients important in stream and river ecosystems include cations [calcium (Ca^{+2}), sodium (Na^{+2}), potassium (K^{+1}), magnesium (Mg^{+2}) and chloride (Cl^{-1})] and anions [sulfate (SO_4^{-2}), nitrate (NO_3^{-1}), and phosphate (PO_4^{-3})]. These elements are sometimes referred to as nutrients because in small to moderate amounts, they are essential to healthy aquatic life such as plants and animals. A nutrient that is the least abundant relative to a plant's need for it is called the limiting nutrient. Limiting nutrients limit the growth and reproduction of organisms. Phosphorus is usually the primary limiting nutrient for algal growth in freshwater while nitrogen is usually limiting for algae growth in marine waters.

The presence of algae and other aquatic plants in stream ecosystems is a natural condition, especially when adequate sunlight is available. When extra phosphorus from human activities enters freshwaters, it may, given the right conditions (e.g., adequate sunlight), fuel excess growth of algae and aquatic plants. In some extreme cases, decomposition of dead algae and plants by bacteria, and the low dissolved oxygen levels resulting from this unnatural amount of decomposition, can stress aquatic communities (e.g. fish, macroinvertebrates).

There are many sources of phosphorus, both natural and human. Phosphorus enters freshwaters from activities such as:

- agricultural sites (e.g. eroding soil, chemical fertilizer, manure, organic matter)
- residential sites (e.g. eroding soil, chemical fertilizer, manure, organic matter)
- urban development (e.g. eroding soil, roads, parking lots, automobiles)
- waste discharges (e.g. untreated or treated wastewater and sewage)

Monitoring phosphorus is challenging because it involves measuring very low concentrations by a qualified lab. Less sensitive methods should only be used to identify serious problem areas.

Nitrogen occurs in various forms (NH_3, NO_2, NO_3, TKN) and, in excess amounts, can cause significant water quality problems. It can cause excess growth of algae and dissolved oxygen problems as described above for phosphorus. High levels of ammonia (NH_3) can be toxic to some fish including trout. Excess nitrogen enters freshwaters from human activities such as:

- agricultural sites (e.g. chemical fertilizer, manure, organic matter)
- residential sites (e.g. lawn fertilizer, pet waste, failing septic systems)
- urban developments (e.g. chemical fertilizer) and
- waste discharges (e.g. untreated or treated wastewater and sewage)

Chapter 3
2012 Monitoring Data

Weather and Flow Data for 2012 Field Season

The 2012 field season was hot. By November, there had been 16 consecutive months with air temperature above the long-term average, and 2012 was the hottest year on record for the lower 48 states (the record is 118 years old). July and August were the hottest months, but there were also heat waves in April, May and June (see water temperatures in Figure 1 from northern Maine). Fortunately, there was also a lot of rain. But, Downeast Maine had summer dry spells between major summer storms. Some smaller Downeast streams dried up in August.

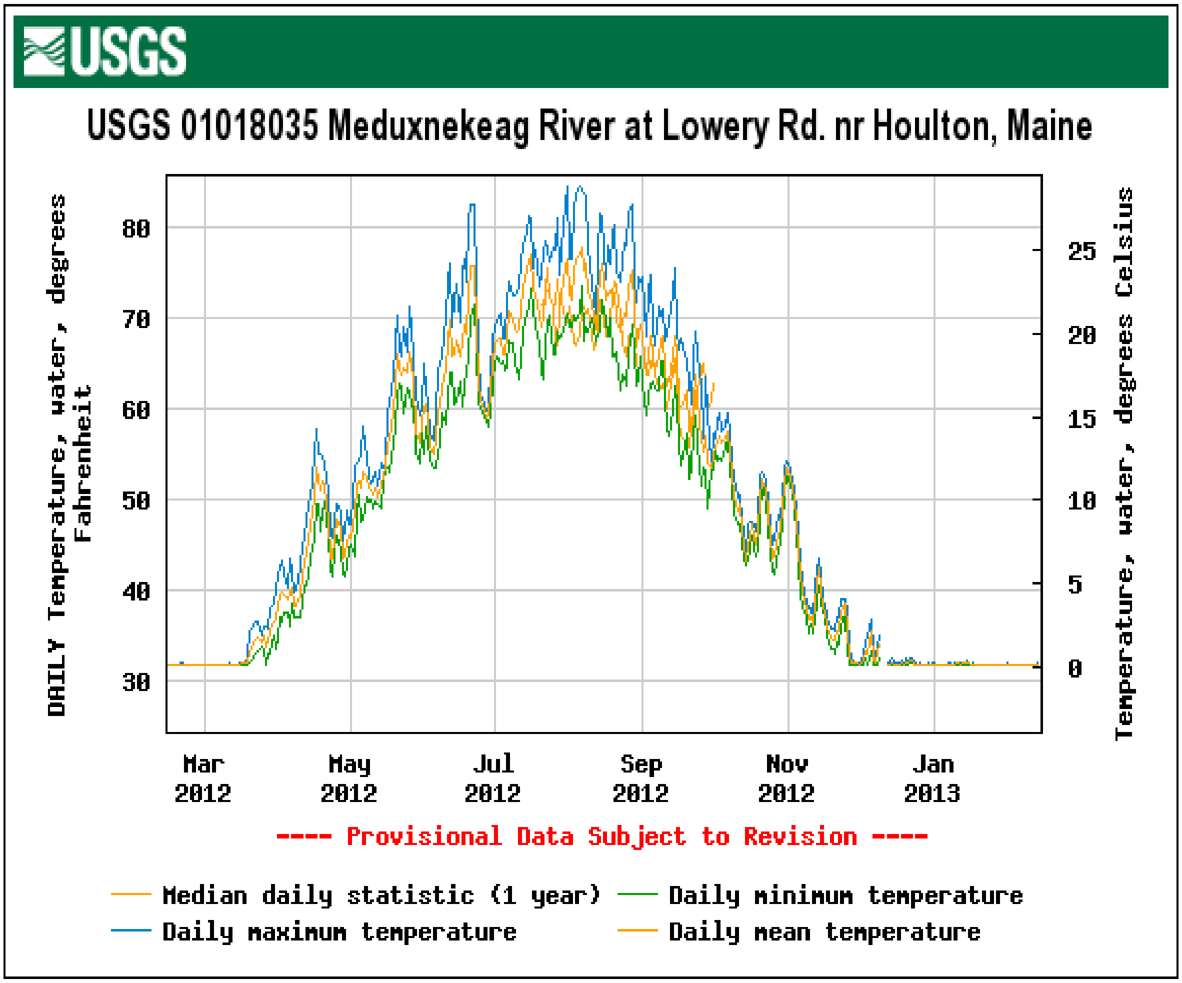


Figure 1. USGS stream gauge from the Meduxnekeag River, Houlton Maine, showing daily variations in ambient water temperature. The daily maximum, minimum, mean and median temperatures are given (the mean and median are both in yellow and often overlap). Notice the heat waves near the end of April, May and June. Also notice the sustained heat in July and August. Air temperatures at the time would have been even higher.

Speaking of the hottest temperatures on record, the Mauna Loa Observatory noted that carbon dioxide reached 397 parts per million this summer (see http://co2now.org/), the highest ever recorded (and probably the highest CO2 on planet Earth for at least the last 800,000 years). We have already exceeded the 350 ppm that climatic scientists say is the maximum threshold for the safety of our civilization. We have the ability to turn this around, but CO2 emissions today will take almost 1000 years to be scrubbed from the atmosphere by biological and physical-chemical processes.

The field season of 2012 was a normal to much wetter-than-average water year. The year was characterized by a succession of large rain events, some of them extreme (Figure 2). Coastal Maine experienced a heavy storm on April 24-25 with 4 inches or more of rain with extensive flooding. In Aroostook County, the summer was dry with the exception of a stalled frontal system that settled-in on June 22. By June 27 almost 11 inches of rain had fallen in Houlton. Superstorm "Sandy" which devastated New York and New Jersey coast lines, was relatively mild for Maine. It arrived on October 29 with light rain, building to just over 2 inches for the next two days in most coastal areas. Overall 2012 was an average water year for Aroostook County, and a wet year for the rest of the state

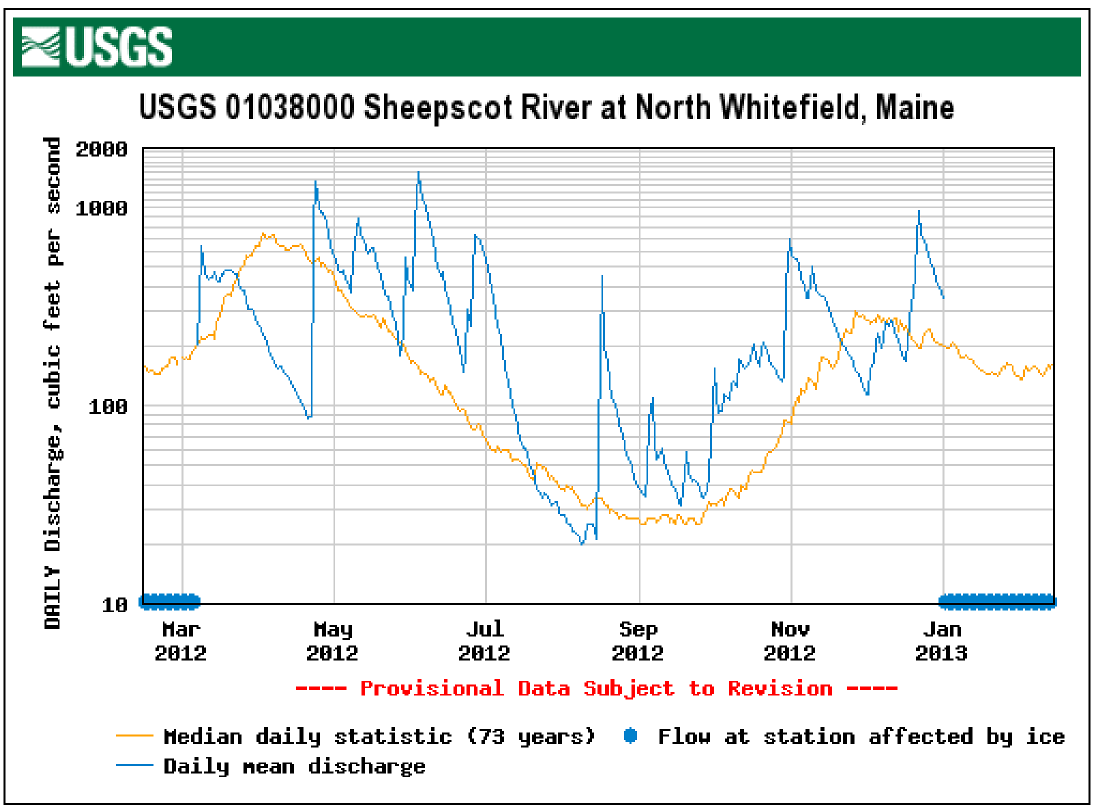


Figure 2. Stream gauge data from the Sheepscot River in Whitefield, showing daily discharge in cubic feet per second for the 2012 field season (in blue). Also shown is the 73-year median flow (in yellow). Notice the unusual weather pattern of wave-after-wave of huge storms and river flooding. Flows were mostly above normal, although there were dry spells in April and August.

Weather is important for streams because temperature and flow strongly influence water chemistry, wildlife health and behavior. For instance, during winter cold water reduces biological activity. On the plus side, cold water also has a high capacity to hold dissolved gasses, such as oxygen. In the summer heat, oxygen solubility is greatly reduced. Water temperature and/or oxygen can become limiting for fish and other aquatic organisms. Our "coldwater fisheries" (trout and salmon) are the fussiest about cold water and high oxygen.

Stream flow, both water depth and velocity, are also important. Large fish need more water than smaller fish. Water depth can limit wildlife access to upstream habitat. Culverts, dams (including beaver dams), and sometimes bridges can prevent fish migrations, especially during low flows. High flows can also prevent wildlife migrations if the flows are too fast in poorly designed culverts. The vast majority of our road crossings have improperly sized or installed culverts. Maine DEP is working with towns and contractors to make sure fish passage provisions are included each time a road culvert is replaced.

While summer heat, low oxygen, and low summer flows can be a problem for fish and other aquatic organisms, rain storms are often life savers. Deep water and high velocities tend to make up for low oxygen solubility due to the intensive mixing during storm flows (i.e., water and air are mixed together by turbulent flow). Slow moving deep water behaves differently than water in strong currents. Flowing water is generally well mixed, but stagnant or slow moving water often stratifies, collecting cold and well oxygenated water on the bottom and floating warm low oxygen water on top. These deep spots are often summer refuges for fishes like trout and salmon that require colder water. Some fish also go into deep lakes during the summer months. Trout and salmon prefer waters around 60-64 º F and will avoid waters with temperatures above 70 º F. Stagnant water is often rapidly depleted of oxygen in the summer months and can result in fish kills if the fish cannot migrate to safety.

In summary, during the summer field season in 2012 streams were generally warm. A number of strong storms arrived in waves and mostly kept streams from drying out and mitigated for the summer heat. Wet years are generally good for fish production.

Monitoring and Time of Day

In order to assess attainment of dissolved oxygen (DO) criteria within Maine's water quality standards, early morning monitoring may be necessary. DO values generally fluctuate depending on time of day with lowest values often occurring in early morning and the highest values late in the day. The fluctuation may be minimal or significant depending on a number of factors (e.g. streamflow, water temperature, and plant and algae growth). DO data collected during the early morning (between dawn and 8:00 AM) are therefore important for water quality monitoring purposes. Except as naturally occurs, if DO concentration falls below the applicable DO criteria at any time of day, this also signals non-attainment.

Not all of the samples need to be collected early in the morning, but it is important to include at least some early morning samples. Collecting water quality data at particular times of the day (e.g., very early in the morning or late in the day if looking for diurnal differences) can be difficult and inconvenient; however, it is encouraged whenever possible.

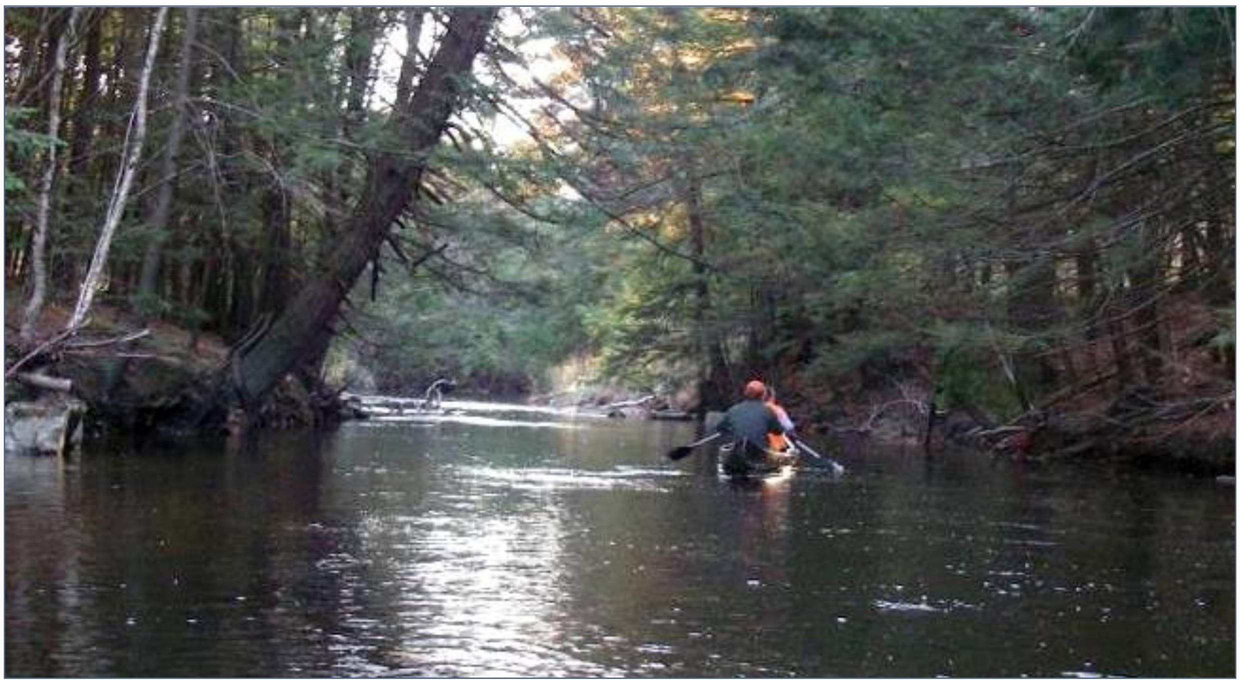
Water Quality Results and Associated Information from the VRMP Groups

Sections 5-1 through 5-8 present sampling overview, methods, result summaries, figures (graphs) of water quality data, discussion, and data for each group. The sections are as follows:

Section	River/Stream and Volunteer Group
5-1	Androscoggin River (Upper) – Androscoggin River Watershed Council
5-2	Androscoggin River (Lower) – Friends of Merrymeeting Bay
5-3	Bagaduce River & tributaries – Bagaduce Watershed Association
5-4	Kennebunk River & tributaries– Mousam & Kennebunk Alliance
5-5	Mousam River & tributaries – Mousam & Kennebunk Alliance
5-6	Penjajawoc Stream – Penjajawoc Stream Team
5-7	Prestile Stream & tributaries – Central Aroostook SWCD & Storm Watchers
5-8	Presumpscot River & tributaries – Presumpscot River Watch

Bacteria Data

The River/Stream reports contain the bacteria data collected by the volunteer groups and the calculated geometric means. The means were calculated for all the sites, regardless of the number of samples taken. To calculate a mean for regulatory purposes, at least six samples are required throughout the season (May 15- September 30) and it is subject to review by DEP Division of Environmental Assessment staff.



Chapter 4
Quality Assurance/Quality Control

VRMP Quality Assurance Project Plan [QAPP], Sampling and Analysis Plans [SAPs], and Sampling Sites

The VRMP's network of volunteer groups monitor under quality-assured volunteer sampling as governed by:

(a) A program-level Quality Assurance Project Plan (QAPP)[1], which includes data quality objectives and numerous Standard Operating Procedures (SOPs) for how to collect water samples and how to use various VRMP-approved water quality meters (Maine DEP, 2009), and;

(b) Individual Sampling and Analysis Plans (SAPs)[2] created by each volunteer group that tailor the program-level QAPP to their specific project situation and which are reviewed/approved by VRMP staff. A SAP provides specific information, including the group's goals and objectives. Project specific details include items such as detailed site location information, sampling frequency, and sample season. They also include the parameters being monitored, brands and models of equipment being used, and specific SOPs (or reference to the SOPs). Individual SAPs also allow flexibility for groups to adapt the design of the program to local situations, conditions, and available resources.

This VRMP report will not describe the details (e.g., sampling methods, sample sites), but they may be found in the documents just described. To view the QAPP, visit the VRMP website[1]. For a copy of a SAP, contact VRMP staff.

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[1] Maine Department of Environmental Protection (MDEP). 2009. Maine Volunteer River Monitoring Program (VRMP) – Quality Assurance Program (Project) Plan. Prepared by J. Varricchione and L. Vickers. Volunteer River Monitoring Program, Maine Department of Environmental Protection, Portland, ME. DEPLW-0984. Available at http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/index.html

[2] Sampling and Analysis Plans (SAPs) for individual VRMP groups, which include site descriptions and photographs, are available from the VRMP.

VRMP Quality Control Steps

The following bullets summarize the various QA/QC measures that are a part of the VRMP.

- Individual volunteers are evaluated on the adequacy of their sampling techniques and certified/recertified at annual volunteer training workshops.
- VMRP maintains and calibrates equipment lent to monitoring groups. The accuracy of monitoring equipment or techniques is tested as described in Table 3a of the Quality Assurance Project Plan (Maine DEP [QAPP], 2009).
- Monitors follow an approved SOP for each parameter monitored. Additionally, field calibration and/or accuracy determination procedures are performed for those parameters that require it, as listed in Table 3a or in the parameter's specific SOP.
- A field duplicate is obtained by each volunteer for at least 10% (1 duplicate per 10 samples collected or monitored) annually of their own sampling efforts for all parameters. Comparisons of duplicate results versus "original sample" results are expected to meet the criteria listed in Table 3a.
- For water samples requiring laboratory analyses, field duplicate samples are obtained for at least 10% of samples (i.e. 1 duplicate per 10 samples) collected per parameter (Table 3c of the Quality Assurance Project Plan).
- Sample bottles or containers, if used, are appropriately prepared (e.g. rinsed, sterilized) prior to sampling, by either a laboratory or the volunteer group according to approved SOPs.
- Laboratories that are used by member organizations must meet the criteria listed in Appendix 11 of the QAPP. Also, they are expected to provide their own internal approach to quality control for each parameter being analyzed, and their testing shall meet VRMP criteria outlined in Table 3a if the data are to be included in the VRMP's water quality database. Quality control data will be submitted by each laboratory to their patron volunteer monitoring groups who will, in turn, submit copies of this information to the VRMP. The volunteer group reviews the lab QA/QC data for potential problems first, and informs the VRMP of any problems. The VRMP will perform a secondary check to confirm the absence of problems.
- Water quality data is reviewed according to procedures outlined in the next section.

VRMP Quality Assurance Review of Data Collected in 2012

After water quality and associated data are submitted, the VRMP undertakes a thorough review of field forms (hard copies) and electronic spreadsheets to assess the accuracy of the information submitted. VRMP also reviews the data to determine whether QA/QC (quality assurance/quality control) measures stipulated in the VRMP QAPP were carried out by volunteers.

The volunteer groups continue to make improvements toward QA/QC procedures. Overall, volunteers are completing the field sheets much better and calibrating meters correctly. Duplicate sampling is almost always within acceptable precision range. There continue to be issues, however, with some of the data – a few issues are significant, but many are minor. Both the VRMP staff and volunteers should continue working toward improvement. QA/QC issues the monitors need to pay attention to are:

- make sure that all pertinent sections of the field sheet are filled in completely
- meters should be turned on for a minimum of 20 minutes prior to calibration
- duplicate sampling should be done for 10% of all sampling effort
- zero dissolved oxygen tests should be done once in mid-season and end of season

Any problems with the data are documented in the database under the “Comments” section. Some of the minor problems include: “did not record observational data”; and “did not complete chain of custody for datasheet”. Significant problems include: “did not record dissolved oxygen calibration value”; and “no vertical depth recorded”. The following explains the steps taken in review of the data and how problem data was handled:

1) VRMP water quality data are entered onto standard field forms. These VRMP datasheets include space for data elements that are entered into the VRMP database. This includes information on how samples were collected, sample location, equipment used, and other important notes or observations. The field form also includes a “QA/QC Check” section and chain of custody for the field form and lab samples.

2) Data are entered by the group’s data manager into a standardized spreadsheet template called a “pre-EDD” (Pre-electronic Data Deliverable).

3) The electronic data and hard copies of the datasheets are sent to the VRMP.

4) VRMP staff compares the group’s datasheets and electronic files to ensure the records match. A review of field duplicate data and laboratory quality assurance information is also conducted as noted below in the tracking step.

5) When reviewing the data, VRMP staff identifies any problems and enters specific comments in the VALIDATION_Comments field of the Pre-EDD.

6) An entry for each sample date is entered in a "tracking" spreadsheet. The purpose of the tracking spreadsheet is to identify QA/QC issues, track duplicates, and allow further review of the data (i.e. compare to Data Quality Objectives).

7) VRMP staff and Division of Environmental Assessment (Rivers Unit) Staff, review the Data Sheet Quality Tracking data. Some data may be excluded from the database. Reasons for possible exclusion are:

   - Data values are outside the measurement range (detection limit) [3]
   - Calibration value for the dissolved oxygen meter was not recorded and/or there was no indication on the datasheet that it was calibrated
   - There was a Pre-EDD, but no hardcopy of the datasheet
   - Calibration value for dissolved oxygen meter is outside the accepted calibration range [<97% or >103%]
   - Samples for laboratory analyses did not adhere to handling requirements (e.g. did not use sterilized containers, did not get to lab on time, samples not kept cold)

8) Data are uploaded into the DEP's EGAD database.

9) Comments/problems with the data are listed in the "Comments" column of the water quality data tables located in Appendix A-2 of each individual report.

Maine DEP Use of VRMP Data

The VRMP was designed to guide and train volunteer groups to collect high quality data that will be useful to various agencies within the State of Maine and beyond. Volunteers are able to monitor rivers and streams that state agencies may not have the staff or time to monitor on a regular basis, and the monitoring helps maintain awareness of water quality conditions. Volunteer groups are able to identify parts of rivers or streams which may have degraded water quality, thus helping organizations such as Maine DEP, Maine Department of Inland Fisheries and Wildlife, Maine Department of Marine Resources, non-profits, conservation districts, and towns prioritize where to investigate conditions further and where to focus best management practice implementation efforts. These data can also be used to gather baseline information and track trends over time.

While the data that VRMP affiliated groups gather is high quality, Maine DEP will decide how to use the data in decisions related to laws, enforcement, and other regulatory issues. In some

[3] See "Maine Volunteer River Monitoring Program (VRMP) Quality Assurance Program Plan (2009-2014)" Table 3a-Quality objectives for commonly measured stream assessment parameters under the umbrella of the VRMP.

cases, VRMP collected data will be viewed as primarily "advisory level data" since it may be difficult for DEP to defend the validity of volunteer collected data, regardless of the quality assurance steps that are in place. In other cases, DEP may use the VRMP data in decisions related to certain regulatory issues.

Approved vs. Non-Approved VRMP Sites

Approved VRMP sites are those that meet VRMP criteria as defined in the Maine DEP Quality Assurance Project Plan (2009). These criteria require that laterally (across the stream), sampling occurs in the "center half of flow" so that a flowing, well-mixed representative sample is collected. To reach the center half of flow, volunteers may need to use a variety of techniques including wading, reaching, using an extension pole, using a boat, or sampling from a bridge or culvert using a VRMP approved sampling technique or device. There are also specific depth requirements depending on whether the site is a Tier 1 or Tier 2 site. Tier 1 sites require higher quality data because these sites may be those that the volunteer group is interested in re-classifying. Therefore, if water at the site is deep, then profile data must be collected.

Each of the VRMP sampling sites is documented, and VRMP staff visit the sites to approve and certify them. Non-approved sites are those that currently: (a) are not being sampled at locations [within the river/stream] that meet VRMP criteria or (b) have not been verified as meeting VRMP criteria. It is critical that volunteers consistently sample from the same location (whenever feasible and safe) to ensure comparability of data at that particular river or stream location.

Maine DEP River Codes that Correspond to Volunteer Group Site Code Names

The VRMP creates unique River Code IDs ("VRMP Site IDs") for each of the local volunteer group sites ("Organization Site Codes"). VRMP Site IDs can be found alongside volunteer Organization Site Codes in the Stream Reports data. For example the Mousam-Kennebunk Alliance has a site named MOUR-01. The VRMP Site ID for this site is Mousam River-SMU290-VRMP. The "SMU290 is the unique identifier for the DEP database and "VRMP" identifies the site as a VRMP site. For simplicity, only volunteer Organization Site Codes were used in the figures (graphs) in this report.

Refer to Appendix A for an explanation of how Maine DEP River Codes are established for various river sites.

References

Maine Department of Environmental Protection (MDEP). June 2009. Maine Volunteer River Monitoring Program (VRMP) – Quality Assurance Program (Project) Plan. Prepared by J. Varricchione and L. Vickers. Volunteer River Monitoring Program, Maine Department of Environmental Protection, Maine. DEPLW-0984. Available at http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/index.html

Maine Department of Environmental Protection (MDEP). October 2010. Stream Survey Manual Volume 2: A Citizen's Primer on Stream Ecology, Water Quality, Hydrology, and Fluvial Geomorphology. DEP-LW0965. Available at http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/index.html

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Appendix A

Sampling Point Coding System
Maine DEP Bureau of Land & Water Quality

Design

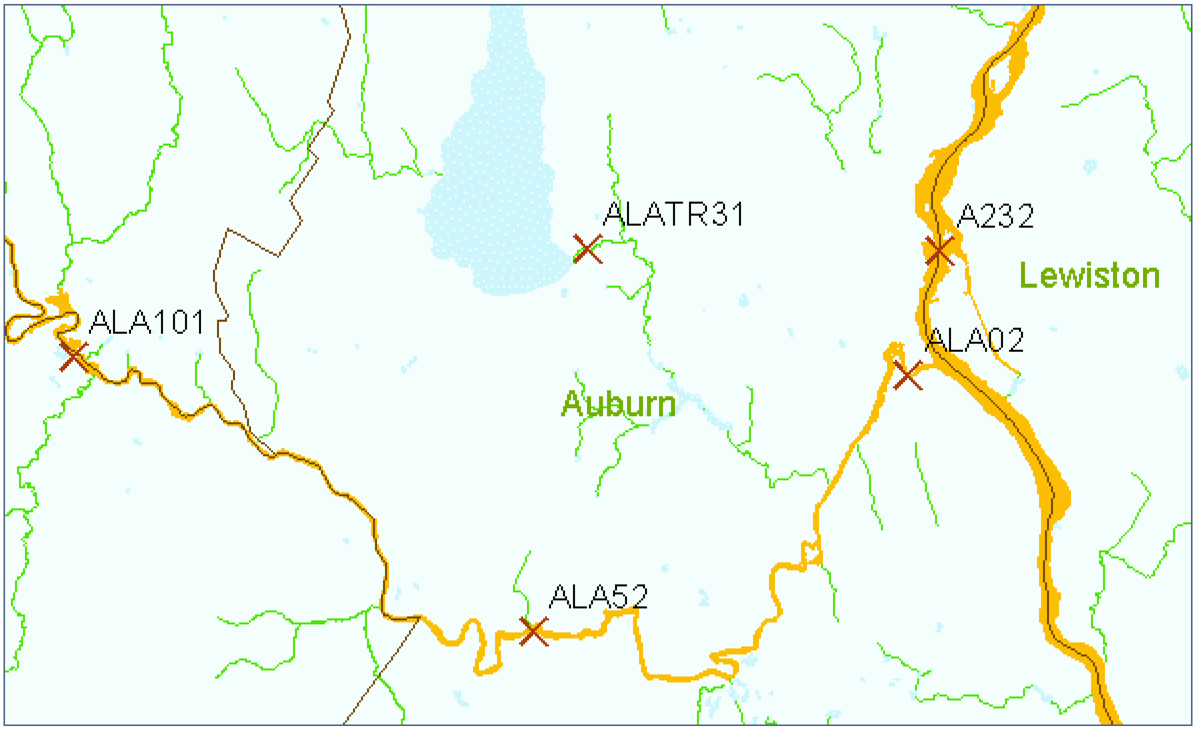
This document is designed to provide guidance on establishing unique ID's for sampling point data for Maine waters. This ID system is based on river hierarchy and the mile(s) upstream from where the target stream/river branches off from its parent water.

How sites are coded

Each order of stream is given a two digit letter code that adds to the unique ID for a specific site / sampling location. For example, the following shows part of the coding for Little Androscoggin River.

A					Androscoggin River
A	**L**	**A**			**Little Androscoggin River (01)**
A	L	A	A	N	Andrews Brook
A	L	A	B	G	Bog Brook
A	L	A	C	L	Cool Brook
A	L	A	D	S	Davis Brook
A	L	A	M	G	Morgan Brook
A	L	A	M	N	Minister Brook

A sampling point on Little Androscoggin (LA) would be assigned the prefix ALA and given a number suffix that represents, in 10^{th}'s of a mile, how far upstream it is from where it branches off the main stem of the Androscoggin River (A).



Examples:

A sampling point located 2/10th of a mile upstream from where the Little Androscoggin branches off the main stem of the Androscoggin River would be called: ALA02

A sampling point located 5.2 miles upstream stream from where the Little Androscoggin branches off the main stem of the Androscoggin River would be called: ALA52

A sampling point located 10.1 miles upstream from where the Little Androscoggin branches off the main stem of the Androscoggin River would be called: ALA101

River mile distance coding

For codes more than a mile upstream, the last digit always represents the closest 10th of the mile. For example:
11 = 1.1 miles upstream
101 = 10.1 miles upstream
1100 = 110 miles upstream