Northern Virginia Salt Management Strategy (SaMS) Monitoring Criteria Outline

Water Quality Monitoring and Research Workgroup

1.0 Purpose of the Monitoring Criteria

The monitoring criteria were developed for the Northern Virginia SaMS effort. Under this effort a monitoring program designed to evaluate the impact of winter salt application and deicing operations Best Management Practices (BMPs) on quality of surface freshwaters is envisioned. The main parameters to be measured include chloride, other related ions (e.g. sodium), conductivity, and flow. The purpose of this document is to provide recommendations on sample collection, possible methods used for analysis and guidelines on protocols that need to be developed. Additionally, considerations for designing and implementing a robust BMP effectiveness/monitoring study are provided.

2.0 Scope and Application

The scope of this guidance document is generally limited to collection of surface water samples from streams and other waterbodies.

3.0 Sampling Methods

No single method can be recommended for all sampling situations. It is recommended that a sampling kit be put together for sample collection. The items in the kit can be as follows

- Two or more sampling bottles depending on the number of ions to be analyzed
- Cooler for sample preservation
- Sample preservative, if needed for a particular parameter
- Ice
- Powder free Nitrile Gloves (PPE)
- Bag of Kay-Pees® or other lint-free paper towels
- Ziploc® bags
- Chain of Custody (CoC) form (placed in Ziploc® bag)
- Bottle labels with Sharpie® or other water proof pen
- Disposable lab coat/ overalls (PPE)
- Plastic beaker with handle
- Long handle sample pole
- Rope
- GPS unit for accurate location
- Weighted bucket (if needed)
- Field measurement equipment, such as pH meter, conductivity meter, temperature, etc.

Water samples from surface waters can be collected in any one of the following ways, at or near the thalweg (deepest point in cross-section) of the stream:

- Hand-Collected Sample – immersing bottle directly in the stream to collect a sample. Rinse the bottle three times in flowing stream water, then collect sample with bottle mouth facing upstream and hand holding bottle downstream to avoid contamination of the sample. If sampling from a boat, the sample should be collected upstream of the boat.
- Pole-or swing sampler – attaching a bottle to an extended pole sampler to collect the sample. Rinse the sample collector 1-3 times in stream water, then collect the sample. If sampling from a boat, the sample should be collected upstream of the boat.
- Weighted bucket – used for sampling in open water off bridges. Immerse the bucket without touching the bottom (which will release sediments). If sediment is released, wait some time for it to settle, or move a few feet away and repeat sampling.

pH of the sample should be measured either by direct immersion of the probe into the stream, or via a sample collected in a bottle (and then discarded). If on site conductivity measurements are feasible (via probe or portable meter, etc.), then these should be done in the same manner.

Sample temperature should be recorded when conductivity measurements (whether on site or later in the lab) are made so as to relate conductivity to a specific temperature (typically 25°C) for comparison with other conductivity values. Conductivity values cannot be related or compared to each other or to other parameters to reach conclusions if they are not temperature corrected to a standard temperature. To eliminate this issue, values should be measured in Specific Conductance (SC) units, which relate conductivity to standard temperature (25°C). SC units are microsiemens per centimeter (µS/cm). SC readings are instantaneously provided on most common, multi-parameter water quality meters and allow for value comparisons without needing further conversions. It is strongly recommended that all conductance values used be in terms of SC.

Any samples that require preservation other than cooling should be collected in a separate bottle and the appropriate preservative added.

4.0 Analytical Methods

The analytical methods that are generally used by DEQ are listed in Table 1. Many of them are the United States Environmental Protection Agency (EPA) recommended methods. It is not necessary that methods listed in Table 1 be exclusively used. A few other examples are provided below. It should be noted that the examples listed below do not constitute an all-inclusive list. While any method can be used, it is important that a uniform and consistent method and approach for collecting and analyzing samples be used for all sites under the program.

Table 1 – Analytical Methods used by DEQ

PARAMETER NAME	LOWER REPORTING LIMIT	MEASURE UNIT	METHOD DESCRIPTION	ANALYTICAL METHOD
SPEC CONDUCTANCE, UMHOS/CM @ 25C	n/a	µmhos/cm	Electrode	SM 2510 B
ALKALINITY, TOTAL (MG/L AS CACO3)	5.00	mg/L	Titrametric	SM 2320 B
NITRATE NITROGEN, DISSOLVED (MG/L AS N)	0.05	mg/L	Ion Chromatography	EPA 300.0
CALCIUM, DISSOLVED (MG/L AS CA)	1.00	mg/L	Ion Chromatography	ASTM D 6919-09
MAGNESIUM, DISSOLVED (MG/L AS MG)	0.50	mg/L	Ion Chromatography	ASTM D 6919-09
SODIUM , DISSOLVED, MG/L AS Na	1.00	mg/L	Ion Chromatography	ASTM D 6919-09
POTASSIUM, DISSOLVED, MG/L AS K	0.50	mg/L	Ion Chromatography	ASTM D 6919-09
CHLORIDE, DISSOLVED IN WATER MG/L	5.00	mg/L	Ion Chromatography	EPA 300.0
SULFATE, DISSOLVED, MG/L AS SO4	5.00	mg/L	Ion Chromatography	EPA 300.0

For chloride samples, a few examples of possible methods for analyzing samples are listed below:

- EPA 325.2 method which is a colorimetric test.
- Chloride specific test kits are available for purchase.
- Ion selective electrodes.

Some examples of possible ways to analyze sodium samples are listed below:

- Ion selective electrodes.
- Inductively Coupled Plasma (ICP) Mass Spectrometer.
- ICP Optical Emission Spectrophotometer.
- Atomic Absorption Spectrophotometer

Conductivity in streams can be measured by the following methods:

- Multi parameter Sondes equipped with conductivity sensors with data logging capability (i.e., capable of recording data to either be downloaded periodically in the field or remotely reported to the cloud). This is an expensive option but can be used where there is a need to collect data on multiple parameters like pH, specific conductance, ORP etc. at the same site.
- Single continuous conductivity meter and probe with data logging capability.
- Portable field and/or laboratory conductivity meter and probe capable of specific conductance conversion.

5.0 Sampling Season and Sample Collection

Sampling seasons for measuring the impact of deicing on water quality can include the following seasons

- Winter – December through February; for measuring the impact of deicing operations and winter precipitation events, and the freeze-thaw cycle.

- Spring – March through May; for measuring the impact of deicing operations and winter precipitation events and the freeze thaw cycle, plus flushing from some large rain events in the latter part of spring.
- Growing season – June through November for measuring the impacts of deicing operations on background concentrations and impacts of salt from other watershed sources.

Some considerations while collecting samples are listed below:

- Conductivity, temperature and flow data can be collected at preset intervals, such as an hourly time step. The frequency of data collection can be programmed beforehand and changed as needed. It might be necessary to increase the frequency of data collection during storm events, as needed.
- Grab samples for sodium, chloride and for confirming continuous conductance can be collected on a weekly, biweekly or monthly frequency, as feasible on a regular basis.
- One discrete sample can be collected during fall (early October) to establish pre-salt application baseline. Sampling during the fall can also provide a way to track salts under baseflow conditions over time, which can be an important measure of long term success. If sample concentration is higher than expected, repeat sample 1-2 weeks later, and consider sampling only when it has not rained for at least 48 hours.
- One discrete sample can be collected during spring (late April) to establish post-salt application baseline. If sample concentration is higher than expected, repeat sample 1-2 weeks later, and consider sampling only when it has not rained for at least 48 hours.
- Samples for sodium and chloride also need to be collected during storm events or other times when conductivity is above the baseline.
- Discrete samples should be analyzed for conductivity, for better correlation and comparison to conductivity probe readings and for correlation to sodium and chloride concentrations. Please note the warning above about temperature correction of conductivity measurements before comparisons can be made if not using temperature corrected specific conductance.

6.0 Monitoring Study Design Considerations

Because specific conductance in streams can be influenced by a variety of sources and dissolved constituents, it is strongly suggested that reliable relationships (regressions) between SC and chloride must be established and maintained. This requires taking regular ion suite grab samples concurrently with in-stream meter readings of SC at various flow stages (base and storm flows) across the seasons in order to capture as many seasonal and flow variances as possible. Doing so will allow for the proper characterization of which ions are dominant of a stream's conductance (e.g., Magnesium Chloride or Sodium Chloride). In certain areas of Virginia, SC of stream baseflows are also elevated due to geologic factors. It is critical to

determine baseline/background conditions of the water quality in terms of major ions and SC before attempting to attribute changes in SC to salt-related BMP activities being implemented in the catchment. Only after reliable, catchment-specific relationships between SC and chloride have been developed, can SC be used as a surrogate for chloride and associated ion concentrations. Examples of these catchment specific regressions can be found in the Accotink Creek Chloride TMDL[1] and a 2012 USGS report[2] (see page 27).

In the absence of a derived relationship between chloride and SC, conclusions as to actual chloride levels should be avoided. Nonetheless, in-stream conductance values can be used as a monitoring tool that provide the general ionic concentration of surface waters and may imply the potential trends related to contamination from deicing salts.

Establishing several monitoring locations around salt BMP locations, and focusing monitoring sites with small drainage areas treated by a limited number of applicators will help to eliminate confounding effects on water quality parameters. The collection of pre-BMP implementation data at these monitoring locations in order to establish baseline levels of chloride or SC is critical to measuring the effectiveness of the BMPs once they are implemented. This requires setting aside resources and time to pick sites to assess pre-implementation conditions. Consider using control areas paired with your area of salt application BMP implementation that are either not participating in the larger implementation effort or do not drain areas where salt is applied. In certain situations, an upstream/downstream paired monitoring approach may be appropriate (e.g., above and below a culvert). Dilution effects can be quite pronounced in high flows, so any monitoring program should attempt to accommodate flexible sampling timeframes that include targeting initial thaw and runoff following a salt application event.

7.0 Health, Safety and Training

The following health, safety and training guidelines should be followed:

- It is important that sampling site conditions are evaluated for potential risks before collection of samples. In-river sampling shall not take place if unsafe conditions are present. This includes but is not limited to extremely cold weather, ice, high flows, and darkness.
- Collection of samples from storm pipes can include individual entering confined spaces. All rules and regulations regarding confined spaces should be adhered to.
- It is also important that sampling personnel are dressed for the weather with slip resistant footwear and/or snow boots as needed.
- Field staff should be trained and familiar with proper sampling, handling, safety and record keeping procedures. It is recommended that a Standard Operating Procedure

[1] https://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/apptmdls/potrvr/Vol_III_Final_CL_TMDL.pdf
[2] https://pubs.usgs.gov/sir/2011/5198/pdf/2011-5198.pdf

(SOP) be developed to aid field staff with the proper techniques and methods for sample collection and shipping.

- Sampling at some sites may require that sampling personnel work in two-member teams. All sampling sites should be evaluated for this aspect.

8.0 Precautions for Sampling/ Data Collection

The following precautions must be taken while handling samples

- Proper rinse protocols should be followed for the sampling devices.
- Care should be taken to not disturb the sediments while sampling, as this can contaminate the sample.
- If a continuous monitoring probe is used to collect data, it should be calibrated at least monthly and all manufacture recommended calibration instructions should be followed. Dissolved oxygen and pH probes, if used, need to be calibrated each sampling day. It is recommended that all other probes be calibrated weekly.
- Sampling kits can be assembled and kept ready before hand.
- A CoC form containing sample details should be included with the samples.
- All Quality Assurance/Quality Control (QA/QC) procedures as outlined in the SOP should be followed. These may include the taking of duplicate samples, field blanks, trip blanks, and other QA/QC samples. All sampling programs typically require some level of these types of samples.