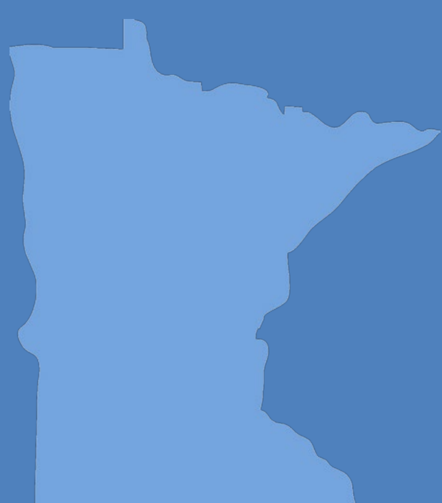
Chloride Monitoring Guidance for Streams and Stormsewers



Minnesota Pollution Control Agency

March 2015

Minnesota Pollution Control Agency

520 Lafayette Road North | Saint Paul, MN 55155-4194 | www.pca.state.mn.us | 651-296-6300

Toll free 800-657-3864 | TTY 651-282-5332

This report is available in alternative formats upon request, and online at www.pca.state.mn.us .

Document number: wq-iw11-06w

Contents

Procedures

Purpose

The Chloride Monitoring Guidance for Streams and Stormsewers was developed as a result of the Twin Cities Metropolitan Area (TCMA) Chloride Project. The purpose of this guidance is to provide recommendations for collecting water samples from streams and storm water pipes for the purpose of chloride monitoring. The chloride data will be used to assess streams and stormsewers, evaluate trends, and determine the effectiveness of best management practices (BMP).

As part of the TCMA Chloride Project, a Monitoring Sub-Group was formed and assisted in the development of the Chloride Monitoring Guidance documents. The Monitoring Sub-Group included partners from the US Geological Survey, Metropolitan Council Environmental Services, Minnesota Department of Natural Resources, Capitol Region Watershed District, Ramsey-Washington Metro Watershed District, Rice Creek Watershed District, Minnehaha Creek Watershed District, Minneapolis Park and Recreation Board, Ramsey County, Mississippi Watershed Management Organization, and Three Rivers Park District.

Several local partners are collaborating on the current winter chloride monitoring effort; therefore, this guidance reflects general guidance for streams. For detailed procedures please see Metropolitan Council Environmental Services Quality Assurance Program Plan: Stream Monitoring. For the specific procedures for monitoring stormsewer sites please see the Capitol Region Watershed District 2012 Monitoring Report and the Mississippi Watershed Management Organization Annual Monitoring Report 2013.

Scope and application

This general guidance document is applicable to the collection of water samples from streams and stormsewers for the purpose of chloride monitoring. It is applicable to samples taken from the surface and at any depth along a vertical column between the surface and bottom. For this application, samples should be collected at mid-stream and mid-depth whenever possible. This guidance is limited to samples collected for physical and chemical analysis.

Sampling method

No single sampling procedure can be used for all sampling situations; therefore, no single procedure is recommended. Water samples from surface waters are generally collected in one of the following ways:

- **Hand-collected sample** – direct immersion of bottle by hand for collection of surface sample on shallow narrow streams
- **Pole or Swing sampler** – bottle is attached to extended rod to reach the desired location and depth
- **Weighted Bucket** – a weighted bucket or Van-Dorn style sampler for sampling in open water off of bridges

Analytical methods

It is important that a uniform analysis method is used by all groups participating in sample collection. It is the responsibility of each partnering group to confirm the proper analytical methods with their individual certified lab. The proper analytical method for chloride is the US Environmental Protection Agency (EPA) reference method 325.2.

It may be important to consider additional analytes, such as hardness and sulfate. The EPA has found empirical relationships between hardness and sulfate and chloride's toxicity. The EPA is expected to promulgate new ambient aquatic life criteria for chloride that account for these relationships. Calcium, magnesium, and alkalinity may also be considered, as they are closely related to hardness.

Sample seasons

Ice conditions must remain the determining factor for all winter monitoring. Water sampling periods are generally defined as the following for streams:

- **Winter** – December through February (target sampling following winter thaw and rain events – see section below)
- **Spring** – March through April (sampling frequency to be determined by length of snow melt period, target sampling during melt and rain events)
- **Growing Season** – May through September

Winter thaw and rain events

The primary goal for the winter chloride monitoring effort is to collect grab samples at existing flow stations during winter thaw and rain events. The following information on winter thaw events was provided by Bruce Wilson of the MPCA (September 22, 2010).

Thaws of snow accumulations over the winter months have the potential to deliver accumulated pollutants offsite and into municipal stormwater flow networks. In general, the melting of snow cover and ice from impervious surfaces is a result of the daily solar/thermal fluxes that we call winter thaws. However, there is no working definition for winter thaws so we used Mark Seeley's general description to the Minnesota Public Radio (MPR) audience in 2008. Dr. Seeley, MPR Meteorologist, defined a "thaw" as a period of two or more days with daily temperatures above 32 ^{o}F. The broad patterns defined by these analyses are being advanced for chloride and winter stormwater monitoring planning purposes. Data was provided by Greg Spoden of MDNR Climatology Office.

From this analysis, the probability of January thaws is very high in southern Minnesota and parts of central Minnesota, and somewhat lower in Northern Minnesota (~ 50% likelihood (Table 1)).

Table 1. Historical Frequency of January Thaws since 1948 (From Mark Seeley, 2008). (Defined as two or more consecutive days with daytime temperatures greater than 32^{o} F).

City	Frequency of Thaws (%)
Twin Cities	92
Rochester	95
Pipestone	92
Fairmont	93
St. Cloud	87
Morris	80
Crookston	62
Duluth	60
International Falls	50

Expanded monthly analysis

In an attempt to better describe the number of winter thaw periods that result in measureable stormwater runoff, several analyses of the meteorological data were completed focusing on the Twin Cities area. Future analyses will incorporate representative cities from around Minnesota.

Daily thaws likely occur frequently due to sunshine on exposed road surfaces, ambient temperatures, degree of sun exposure/slopes, and other factors. We are advancing these first cut analyses of the number of thaws that can typically be expected in the Twin Cities based on two or more consecutive days of ambient air temperatures greater than 32 ^{o}F recorded at the Minneapolis-St. Paul Airport. If two days reported consecutive maximum temperatures of 32 ^{o}F, a "thaw event" was recorded. If maximum temperatures of 32 ^{o}F were recorded for three consecutive days, two "thaw events" were noted.

The Period of Record (POR = 1891-2010) data show that the Twin Cities averages 5.3 "thaw events" in January, 7.8 in February, and 8.5 in December. There is a great deal of inter-annual variation in “thaw events” (Figure 1; Table 2). There were also several months with zero "thaw events". Conversely, we have observed many months where more than one-half of the days were at the back end of a two-day "thaw event". It is interesting to note that for a 14-year period beginning in 1969, we had seven Januarys with one or zero "thaw events".

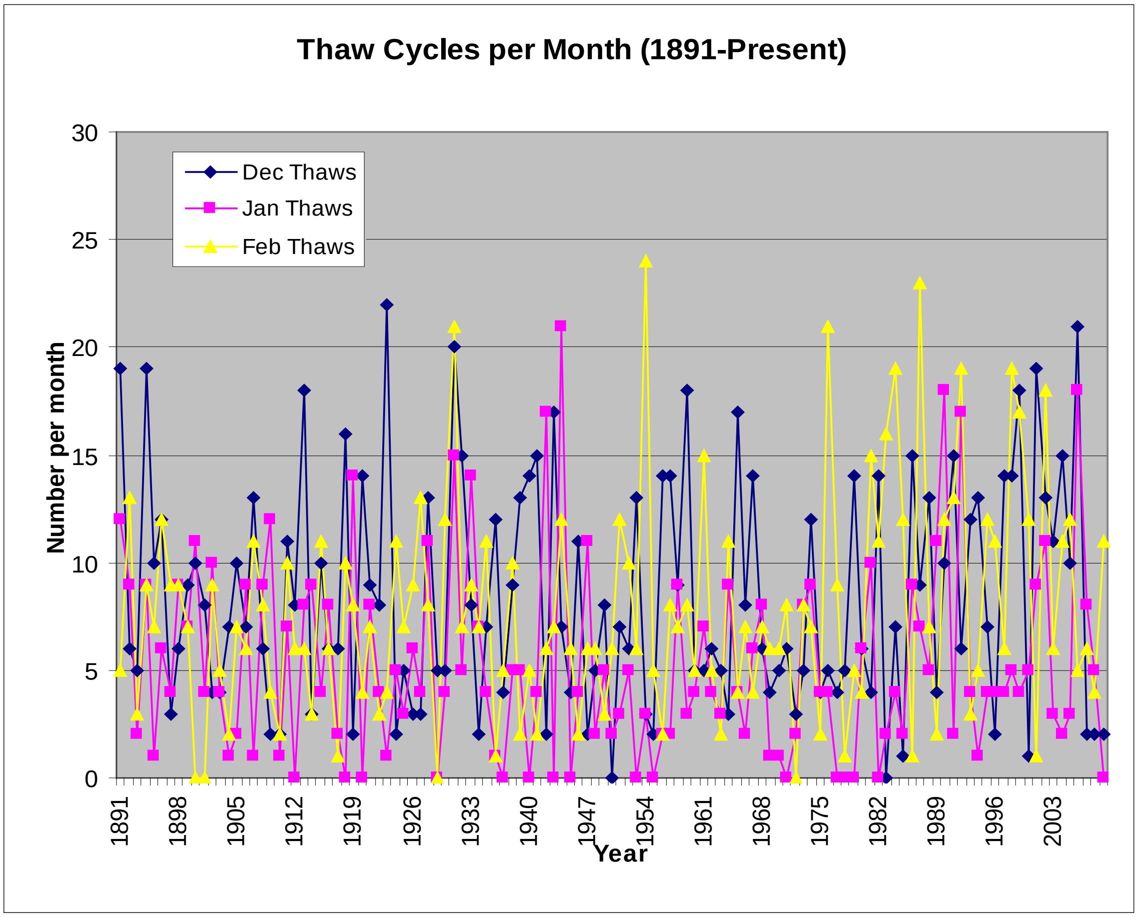


Figure 1. Thaw cycles per month from 1891 to present.

Table 2. Minneapolis, St. Paul International Airport (MSP) Station 215435 Data. Number of occurrences where TMAX => 32 °F in two or more consecutive days.

POR 1891 to 2010	**December**	**January**	**February**
Median	4.0	7.0	7.0
Average	5.3	7.8	8.5
Maximum	21.0	24.0	22.0
Minimum	0.0	0.0	0.0
POR 1970-2010			
Median	4.0	8.0	7.0
Mean	5.3	9.4	8.6
Maximum	18.0	23.0	21.0
Minimum	0.0	0.0	0.0

Given the variability in "thaw events", an attempt was made to define broader patterns using a 10-year moving average for data from the Minneapolis St. Paul International Airport (MSP, NWS Station 215435). Values in Table 2 were summarized from the annual data with the 10-year moving averages plotted for POR and 1950 to present. This type of analysis has its drawbacks as the data is bounded by zero events and is not appropriate for trend detection including changing climate inferences.

Nonetheless, there is an increasing pattern of number of thaws for December, January and February from 1950 to 2009 (Figure 2). Based on this analysis, the number of thaws (monthly median) varies from about 4 to 8 occurrences per month. The broad patterns are being advanced for chloride and winter thaw stormwater monitoring planning purposes.

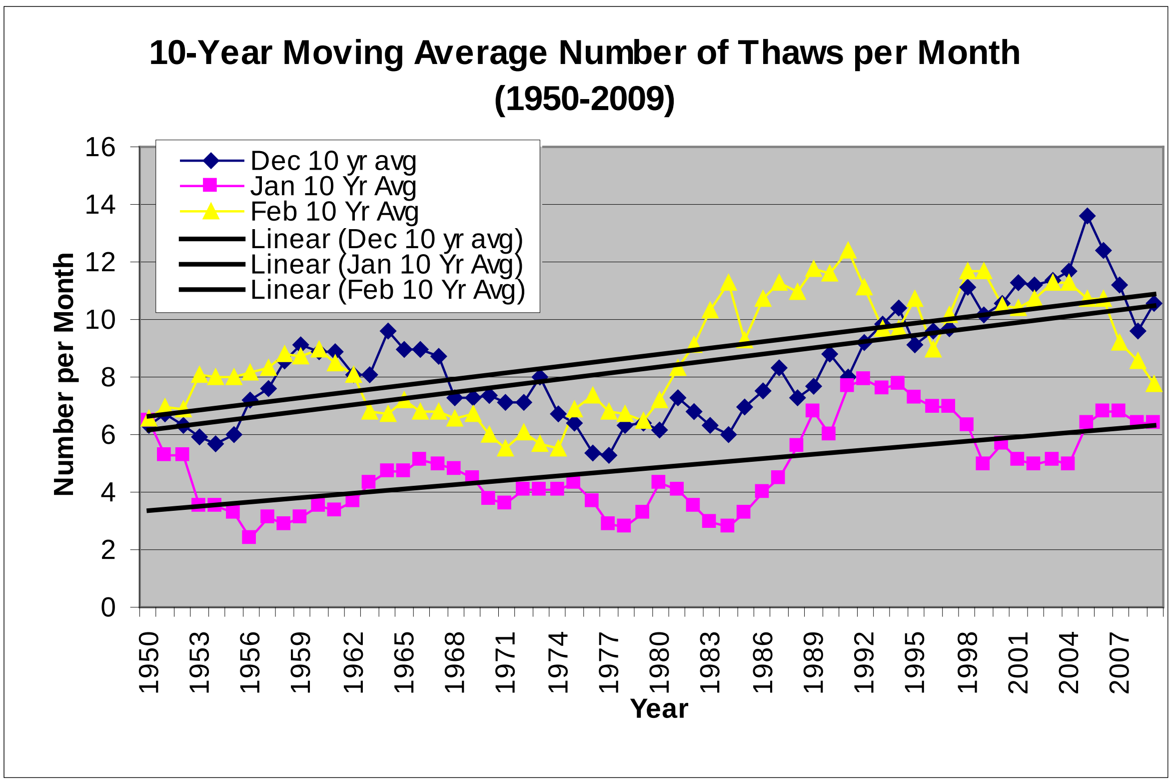


Figure 2. 10-year moving average of the number of thaws per month from 1950-2009.

Health and safety

Staff should not sample during adverse conditions (presence of lightning, swift current/flooding, gusts/waves or unsafe ice conditions). The individual collecting the sample should not attempt to sample from the ice if the water depth plus ice thickness is greater than 2 feet. Individuals entering confined spaces to collect samples should abide by all rules and regulations regarding confined space entry.

During winter events, samples must not be collected when the ice is not of adequate thickness to support the weight of staff and/or a vehicle. The person collecting the sample should not sample from the ice if the water depth plus ice thickness is greater than 2 feet. It is recommended that all personnel wear ice safety picks and life jackets at all times while on the ice in the event of breaking through.

Cautions and interferences

Contamination of the sample can occur if the sampling device is not properly rinsed prior to sample collection. For standard sampling equipment (e.g., weighted bucket samplers) the sample device should be rinsed three times from the opposite side of the boat from where the sample will be collected. For depth samplers, the lowering of the device through the water column provides the necessary rinsing.

Sample contamination can also occur if the bottom sediments are disturbed during the sample collection. In the event that this occurs, the sampling device should be emptied, rinsed, and the sample collection should be attempted at a lesser depth to avoid this contact.

Personnel qualifications/responsibilities

Field staff must be familiar with proper sampling techniques, sample handling, safety procedures, and record keeping. New staff and student workers must be trained and accompanied in the field by experienced staff until competence is assured. Refresher training events are held each spring for permanent field staff; these must be attended by all returning field staff. Student workers will be provided written Standard Operating Procedures (SOPs)/instruction and be trained in the field.

Equipment and supplies

A variety of sampling equipment may be utilized for surface water sample collection. Examples of general equipment needed for chloride monitoring are listed below:

Swing Sampler	Multi-Parameter Sonde	Permanent Markers	Ice Auger (and spares)
Weighted Bucket	Personal Flotation Device	Lab Sheets	Ice Scoop
Field Notebook	Sample bottles	Camera	Ice Chisel
Coolers	Preservatives (acid, methanol, Lugol's)	GPS Unit	Ice Cleats
Ice	Confined Space Safety Equipment (if applicable)	Foul weather clothing	Ice Safety Picks

Procedure

The following details the steps necessary to collect a sample, process the sample, and prepare it for delivery to the designated laboratory.

Pre-trip requirements

Probe calibration

Probe calibration is required for pH, conductivity, and dissolved oxygen. These calibrations should be completed a minimum of monthly with the exception of dissolved oxygen, which should be calibrated at the beginning of each sampling day. All manufacturers recommended calibration instructions should be followed.

Equipment preparation

Equipment should be prepared to complete sampling trip. Ensure the correct number of bottles and preservative necessary to complete all regular and duplicate sampling. Ensure the ice auger is sufficiently fueled and operational and blades are sharp. On multi-day trips, sufficient tap water is necessary to conduct dissolved oxygen calibration. Coolers, ice, bottles, preservative(s), depth sampler, integrated sampler, lab sheets, Global Positioning Systems (GPS)/maps, and multi-parameter probe should be loaded into the trip vehicle. Staff should have reviewed the MPCA's aquatic invasive species (AIS) SOP, DNR's infested waters list, and planned monitoring trip accordingly. It is recommended that a spare set of equipment be included for use in infested waters or plan sampling trips to ensure that infested waters are the last sites visited. At the conclusion of all monitoring trips all equipment must be cleaned and laid to dry before being used for further monitoring. Additional information regarding infested waters and procedures to reduce the threat of spreading aquatic invasive species can be found at: http://www.dnr.state.mn.us/invasives/index.html.

Onshore requirements

Data collection preparation

Prior to collecting data, the data retrieval device must be prepared to store data or data sheets should be prepared to accurately record data. Field measurements (i.e., sonde data) data should be collected at mid-stream/mid-depth if possible.

Equipment preparation

The sample bottle should be labeled with the sample location. Sampler, profile equipment, GPS/maps, camera, and field sheets/field notebook should be prepared. It should also be determined if the site is safe to sample at this time.

Sampling requirements

Travel to sampling location

During winter sampling events ensure ice is of adequate thickness to support staff and/or the vehicle before proceeding to the predetermined location. Travel to the location via maps or dash mounted GPS units. Make sure the sampling vehicle is parked in a safe location with the safety hazards on and safety beacon is visible. Safety cones should also be used when working off the bridge, near the vehicle, or alongside the road.

Field Measurements

1. Place device in water and lower until the probes are estimated to be at mid-depth, near the thalweg, if stream velocities and sampling location allow. Allow values to stabilize.
2. Record data either electronically or on a field sheet.
3. Record any stream condition notes that are applicable (e.g. overland flow, air temp, watershed observations).

Sample Collection – taken in stream

1. Lower the sample bottle into the water and rinse 3 times.
2. Collect a representative sample near the thalweg of the stream, in well mixed areas.
3. Add preservative to sample bottles if required.
4. Place and tighten caps on the sample bottles.
5. Double check to see if bottle is labeled properly.
6. Place bottle in a cooler with ice.

Surface Sample – taken through ice

1. Using a hand or gas powered ice auger or ice chisel, cut a hole in the ice.
2. Remove free floating ice shavings so the hole is completely open.
3. Lower swing sampler, or collect sample by directly immersing sample bottle in stream. If using a dipper or any device to scoop water, rinse the equipment 3 times. Caution must be taken to ensure that no rinse water flows back into the hole.
4. Collect a representative sample near the thalweg of the stream, in well mixed areas.

5. Add preservative to sample bottles if required.
6. Place and tighten caps on the sample bottles.
7. Continue with field measurements.
8. Place sample bottles in a cooler with ice.

Quality Assurance/Quality Control sampling

The project manager will designate streams as Quality Assurance/Quality Control (QA/QC) water bodies to ensure that adequate QA/QC samples are collected. The amount of QA/QC samples collected must equal 10% of the total number of regular samples. A QA/QC will be sent to the lab as a field duplicate and a sample must be collected for each analyte.

Onshore – aquatic invasive species (AIS) field decontamination

1. Visible aquatic plants and animals should be removed from the waders, and sampling equipment.
2. Sampling equipment should be sprayed with a pressure washer if plant residue remains after initial cleaning.
3. If the stream to be sampled is known to have AIS, the stream should be sampled at the end of a trip and/or should be sampled with separate equipment. If necessary, stop at a car wash and spray down the equipment to minimize the possibility of transferring species between streams.
4. Use a completely different set of equipment if the equipment is possibly contaminated with AIS.

Post-trip requirements

End of trip processing

1. Unload all samples from vehicle – transfer to staging area.
2. Organize bottles and field sheets by stream.
3. Ensure that bottles containing samples from AIS waters are labeled as such.
4. Fill out lab sheet verifying that the information matches the sample bottles.
5. Deliver samples in a cooler of ice to lab.

Guidance for monitoring high risk waters

The following guidance applies to waters that have been assessed for chloride, but were not included on the 2014 303(d) list of impaired waters due to (1) insufficient data or, (2) were found to be unimpaired. These waters are considered high risk because they either (a) showed a strong indication of impairment, despite insufficient data, (e.g., only one or two exceedances far apart in time), or (b) showed a high risk of impairment because of frequent high concentrations close to (but not exceeding) the standard.

The Class 2B, 2Bd, and 2A chronic standard for chloride is 230 mg/L and applies as a 4-day average. In practice, impairment is often assessed from monthly sampling results when there is a clear pattern of prolonged concentrations exceeding the standard. In the cases cited above, we expect that weekly or twice-weekly sampling would provide the basis for a clear determination of impairment or non-impairment. Long-term sampling at such high frequencies, however, is unreasonably expensive in most cases.

With the above in mind, the MPCA suggests the following guidance for additional monitoring of the high risk waters described above:

1. Identify dates or periods of past chloride concentrations that include:
    a. Exceedances (exceeded the chronic chloride standard), or
    b. "High" occurrences, defining "high" as less than but within 10% of the chronic standard (thus >207 mg/L)
2. Select a 4-week period centered on each such date or period, and for each:
    a. Sample for chloride weekly, always on the same day of the week
    b. Sample at the same depth(s) as past sampling
3. If an electrical conductivity meter is available, take and record a "matching" conductivity reading with each lab sample collected:
    a. "matching" = from the same primary sample that provides the lab subsample, if the primary sample is a sufficiently larger volume than the laboratory bottle used; or
    b. "matching" = same location and depth as the lab sample
4. Possible expanded effort:
    a. Monitor twice weekly rather than once, always on the same days of the week (e.g., Mon. and Thurs.) including, as resources permit:
        i. Chloride sample and “matching” conductivity measurement if possible
        ii. Chloride sample only, if lacking conductivity meter
        iii. Conductivity measurement only on the increased frequency, if laboratory costs limit sampling but a meter is available

To clarify, sampling for chloride at least weekly during the selected 4-week period(s) is a necessary minimum effort for ensuring the value of this additional monitoring; conductivity measurements alone will not suffice at present. This could change in the future if a reliable and accurate relationship between chloride and conductivity is developed for the water body or for an area including the water body.