WATER FILTRATION GUIDE

TECHNICAL BULLETIN

When assessing water for potential contaminants of concern, field technicians are faced with the question of whether to filter or not filter for specific analytical parameters in their testing program. To assist our customers in understanding and implement proper filtration protocols as part of setting data quality objectives for your projects, we have assembled this guide which provides recommendations with reference to the regulatory guidance and requirements across Canada.

BACKGROUND

Maxxam receives water samples from many different types of sites that vary from landfill monitoring, contaminated sites, mine operations, industrial effluent and many more. "Water" may include: drinking water, industrial wastewater, surface water or ground water. In some cases, data will be submitted to regulators for compliance purposes and in other cases, it is for preliminary investigations with less concern for legal defensibility. Given this background, it is unreasonable to set a single filtration recommendation to meet all sampling programs. What is important is that as part of your data quality objectives, you define what you want the laboratory to measure.

THE SCIENCE OF FILTRATION

Depending on the sample preparation procedure, water can be measured as "total", "dissolved", "mobile" or "suspended". Samples can be analyzed unfiltered and preserved ("total"), or filtered with a wide range of filter sizes from 0.2 µm to 5 µm to measure "suspended", "mobile" and "dissolved". Historically, the general approach taken by the industry is that groundwater is analyzed for dissolved constituents with the objective of measuring mobile contaminant levels. Surface water, drinking water and wastewater are typically measured as "total" with no filtration in order to estimate total contaminant exposure or loadings.

We have however, seen this general approach change over the years where the analysis is designed to measure a specific form of an analyte which may have different toxicity. This list of exceptions to the historical rules continues to grow. As an example, in Alberta, regulators are now often requesting groundwater in a drinking water aquifer to be analyzed both as "total" and "dissolved". This is requested presumably to evaluate the risk of transport of metals through particulate matter > 0.45 µm.

As a general guide, Provincial Regulatory standards indicate which parameters are to be analyzed as "dissolved" thus requiring filtration prior to analysis. Unless noted as "dissolved" when a parameter is listed in regulatory standards, it is typically is interpreted to mean "total" with no filtration required. The most common parameters measured as "dissolved" that require filtration include:

- Dissolved Metals
- Dissolved Mercury
- Dissolved Chromium VI
- Dissolved Organic Carbon (DOC)
- Dissolved Phosphorus (phosphate)
- Chlorophyll A
- Dissolved Nitrogen

GROUNDWATER

USEPA guidance consistently states that filtration for groundwater samples is not acceptable to correct for improperly designed or constructed monitoring wells, inadequate well development, inappropriate sampling methods, or poor sampling techniques. The reality is, that in many regions in Canada, introducing particulate into monitoring wells is unavoidable due to clay and till geology. To arrive at dissolved or mobile concentrations, filtration is required.

The term “dissolved” is a bit of a misnomer, as in the case of metals, truly dissolved or free ion forms of metals would exclude any particle sizes > 1 nm (the size of typical hydrated metal ions). A “dissolved” metals analysis is meant to address the concern of increased environmental mobility through groundwater systems which may eventually reach a receptor.

The particle size considered “mobile” remains the subject of significant technical debate within the technical community. 0.45µm has emerged as the default filter size, with very little available science to support this approach. It has found its way into most Provincial regulatory documents and CCME. Interestingly enough, field filters are available in sizes from 0.2 µm – 5 µm. waterra.com

ORGANICS

Low solubility organic compounds including hydrocarbons, PCBs, PAHs and dioxins are not suitable for filtration, whether in the field or at the laboratory. Several studies, including those conducted by Maxxam have demonstrated that these organic compounds sorb to the filtration media and lead to significantly biased low results. As such, the laboratory results for these organics should be considered as “total”. This leads to a significant challenge where laboratory results for low solubility compounds such as benzo(a)pyrene and PCBs routinely exceed solubility limits.

Most jurisdictions do not permit decanting of the sample to segregate suspended particulate as this can lead to biased low data. Many organic compounds are hydrophobic and tend to adhere to the interior surface of the glass and are left behind when decanted. Most groundwater field filters are constructed of polyethersulphone material, which is organic based and has a strong affinity to sorb organic compounds. Water soluble organics such as phenols and phenoxyacid herbicides may be suitable for filtration. Contact the laboratory.

FIELD FILTRATION VS LAB FILTRATION

Canadian regulatory guidance consistently recommends and in some cases prescribes field filtration for specific tests in groundwater. Surface water filtration in the field versus laboratory appears to be less prescriptive. With changes to oxygen, temperature and pH post collection, some elements (such as iron) are known to precipitate out of solution and lead to significantly biased low data if not field filtered and preserved immediately. This is particularly of concern in groundwater, which is why regulators often prescribe field filtration.

Filtration of surface water can be accomplished through a number of techniques and we recommend consulting CCME guidance for details. One option suitable for low turbidity samples is field syringe filtration. Maxxam is pleased to supply our customers with syringe filter kits (upon request) suitable for low volume filtration in surface water.

In all cases, field filtration will provide the most representative and highest quality data. However, for ultra-low level methods it is often difficult to field filter without introducing contamination. Where field filtration just is simply not an option, Maxxam offers laboratory filtration. Maxxam will filter and preserve as soon as practical upon receipt. For our filtration rate structure and syringe kit fees (effective, January 1, 2018), please refer to the table at the end of this guide.

SPECIAL FILTRATION CONSIDERATIONS

Dissolved Organic Carbon (DOC)

Dissolved Organic Carbon is composed of a diverse array of compounds, predominantly humic substances, and is found in most natural groundwater . It is imperative to ensure that the field filters you are using do not contribute background DOC. In our experience, organic based filters will release background organic carbon above laboratory reporting limits.

Organic filters are typically proofed by the supplier, however only for metals and mercury. We recommend that you work with your field filter supplier to select the right filter for your application. As with any filters, we recommend including a filter blank in your QA/QC plan to ensure that any "hits" in filtered samples are not coming from the filter itself.

Dissolved Aluminum in Surface Water (Ontario PWQO)

Ontario Surface Water Guidelines (PWQO), require that surface water samples to be tested for aluminum be filtered with a 0.2 µm filter prior to analysis to provide a "clay free" sample. Filtering the sample prior to analysis isolates the forms of aluminum that are toxic to aquatic life in low pH regimes. Inorganic aluminum, particularly inorganic monomeric aluminum, is the form considered to be most toxic in acid stressed environments, organic aluminum being relatively non-toxic. Filtering with a 0.2 µm reduces the amount of clay bound and organic monomeric aluminum, which can bias results high compared to the guideline value. Please refer to Ontario MOE's comprehensive rationale document for more details. agrienvarchive.ca pdf

Dissolved Hexavalent Chromium & Mercury

Chromium VI in neutral or acidic media is a strong oxidizing agent which reacts with organic carbon and oxidizable metals such as ferrous iron forming trivalent chromium. Without immediate preservation in the field, results will be significantly biased low. Field filtration should occur as soon as possible after sampling followed by immediate preservation with base which stabilizes the CrVI .

Mercury is also susceptible to rapid losses without immediate preservation, thus samples should be field filtered and preserved and laboratory filtration not considered an option despite regulatory guidance.

PROVINCIAL REGULATORY POSITION ON FILTERING

Maxxam has reviewed each Provincial regulatory guidance or Protocol document and have summarized the findings below for quick reference:

REGION	REFERENCE	EXCERPTS FROM REGULATORY REFERENCE DOCUMENT
British Columbia	*BC CSR Lab Method Manual, Sample Preservation and Holding Time Summary Table, Nov 2015*	▪ Dissolved ICPMS Metals and Mercury to be field filtered, if lab filtered, data must be qualified ▪ BC CSR hold time and preservation table does not indicate field filtration is required for Chromium VI, but does require immediate preservation. ▪ Dissolved phosphorus may be filtered in the field or lab without qualifiers ▪ If not field-preserved, water samples for total metals analysis must be acidified at the lab in their original containers by addition of HNO3 (within 14 days of sampling), then equilibrated at least 16 hours prior to sub-sampling or analysis (otherwise, qualify as "received unpreserved"). This approach is also applicable to dissolved metals if field filtered but not preserved. Not applicable to mercury.
Alberta	*Environmental Quality Guidelines for Alberta Surface Waters, July 2014*	▪ Surface water guidelines are based on total metals, with the exception of Iron and Aluminum which are dissolved. No filter size is prescribed.

PROVINCIAL REGULATORY GUIDANCE / PROTOCOL (continued)

REGION	REFERENCE	EXCERPTS FROM REGULATORY REFERENCE DOCUMENT
Ontario	*R153 Analytical Protocols, July 2011* *Provincial Water Quality Objectives, Feb 1999* *Practices for the Collection and Handling of Drinking Water Samples, April 2009*	▪ *Groundwater must be filtered for ICPMS Metals, Hg and CrVI. If lab filtered, data must be qualified by the lab.* ▪ Hg (0.45 µm) and Aluminum (0.2µm) require filtration prior to analysis. ▪ *Drinking water samples shall not be filtered in the field or at the laboratory prior to analysis. As it is not expected that the consumer filters their water prior to drinking it, unfiltered samples will provide a more representative sample of what the consumer is drinking*
Quebec	Guide d'intervention - Protection des sols et réhabilitation des terrains contaminés. Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, Juillet 2017	▪ Metals including CrVI are recommended to be field filtered and preserved.
CCME Surface Water Guidelines	*Protocols Manual for Water Quality Sampling in Canada, 2011*	▪ Section 5.0 - *To find the concentration of dissolved constituents, water samples must be filtered through a 0.45 µm cellulose acetate membrane filter. This can be done in some cases by the laboratory but often involves filtration in the field* ▪ Section 5.1 of the CCME Surface Water Protocol document outlines recommendations on how to filter for nutrients (Nitrogen, Phosphorus) in the field ▪ Section 6.8 provides guidance on field filtration for Chlorophyll A
CCME Volume 4	*Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment, Volume 4, 2016*	▪ *"In general, for metals, mercury and hexavalent chromium, groundwaters are field filtered and preserved, surface and potable waters are unfiltered and preserved. If field filtration is not possible, lab filter and preserve asap. This must be noted on the C of A. Total metals samples and field filtered dissolved metals may be preserved at the laboratory in the original container. Samples must sit for 16 hours prior to subsampling"*
CCME Interim Groundwater Guidelines	Guidance Document on Federal Interim Groundwater Guidelines, Nov, 2012	▪ *"For inorganics, the Federal Interim Groundwater Quality Guidelines generally apply to dissolved concentrations, and therefore filtration of groundwater samples is required."*

2018 LABORATORY FILTRATION FEE SCHEDULE

PARAMETER	FILTER SIZE	FILTER CONSTRUCTION	$ PER FILTRATION (INCLUDES FILTER COST + LABOUR)
ICPMS Metals	0.45 µm	PVDF, PTFE or PES	$10.00
Mercury	0.45 µm	PVDF, PTFE or PES	$10.00
Aluminum (Ontario PWQO)	0.2 µm	PVDF or PTFE	$10.00
Dissolved Organic Carbon	0.45 µm	PTFE (organic carbon free)	$10.00
Dissolved Nutrients (P,N)	0.45 µm	PES	$10.00
Chlorophyll A	0.45 µm	Mixed cellulose ester	$10.00

Note: PVDF=Polyvinylidene Fluoride PTFE=Polytetraflouroethylene PES=Polyether Sulphone

PRODUCT	CONSTRUCTION	UNIT RATE
10ml Luer Lock Syringe	HDPE	$2.00
0.2 µm syringe filter	PVDF, PTFE or PES	$3.00
0.45 µm syringe filter	PVDF, PTFE or PES	$3.00

Syringe filters must be ordered separately and are not automatically included in container orders unless requested