# Proponent's Guide

## Water Information Requirements
## for Quartz Mining Project Proposals

YESAB
Yukon Environmental and Socio-economic Assessment Board

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## ACKNOWLEDGEMENTS

This Guide was developed to provide added clarity on water information requirements for proponents for quartz mining proposals. It has been developed with Yukon Government (Executive Council Office – Development Assessment Branch, Environment – Water Resources), Yukon Water Board staff and Environment Canada – Environmental Protection.

YESAB produced a final draft of the Guide and approached local technical experts and First Nations for their input. This draft guide was also circulated and made available for public comment. The Guide benefited from the comments and input received from:

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YESAB anticipates that this Guide, like others, will undergo a regular process of review and updating. Please forward any comments you have on this Guide via email to yesab@yesab.ca or by fax to 867-668-6425. Your input will continue to make this Guide better

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## 1.0 INTRODUCTION

The approvals process for the management of water in Yukon includes an assessment stage and a regulatory stage. This document deals with the assessment stage under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA). Once the YESAA process is completed, the regulatory stage will follow. Additional water information requirements required for your project to meet the needs of the regulatory processes should be identified through discussions with regulators.

Environmental and socio-economic assessments are conducted to ensure that if projects proceed, they are undertaken in a way that does not undermine the environment and social systems of individuals and communities. This is done by minimizing or avoiding adverse environmental and socio-economic effects before they occur. YESAA applies to every project that requires a water use license.

Assessments under YESAA result in recommendations to decision bodies regarding if, and under what conditions, a project may proceed without resulting in significant adverse environmental and socio-economic effects. The assessment process identifies valued environmental and socio-economic components that may be affected by a project and then assesses the effects of the project on these components. Both surface and ground water are valued environmental and socio-economic components in Yukon.

## 2.0 PURPOSE

This document provides proponents with general guidance, to be supplemented with specific discussions with assessors and regulators, regarding details of appropriate water data required in their project proposal submitted under YESAA. How these data are collected, calculated, analysed and interpreted influences confidence in the understanding of baseline water conditions as well as predictions of future conditions. This guide focuses on the assessment process; additional water information will likely be required by regulators.

This guide was developed specifically for proponents of quartz (hard rock) mines in Yukon but may also be relevant for proponents of other large projects that could have effects on surrounding waters.

## 3.0 PROJECT OVERVIEW

Proponents are required to provide sufficient information in their project proposal for a proper assessment of project effects on water. This means that information must be provided regarding:

- water quality, quantity and variability pre-project (baseline data); and
- predicted water quality, quantity and variability as a result of project activities (during all phases of the project).

The assessment of project's effects on water focuses on comparing the baseline to the predicted project-affected water and concludes whether or not the changes are adverse and significant. This

process also establishes the conditions from which monitoring programs can measure potential change.

It is in the best interest of proponents, assessors, and regulators that appropriate data are collected to support good project decision making, minimize project liabilities and costs, and facilitate timely assessment and regulatory processes.

The water information required for a particular project proposal will depend on specific aspects of the project like: project type, location, timing; the volumes and sources of water required/affected, and other users of the water. YESAB recommends that proponents discuss their project details and baseline water data collection programs with assessors and regulators prior to initiating those programs.

# 4.0 INFORMATION ON BASELINE WATER CONDITIONS

## 4.1 SURFACE WATER QUANTITY INFORMATION REQUIRED (HYDROLOGY)

- Identify catchment areas/watercourses/waterbodies that may be affected by project activities.
- Collect/calculate climate data relevant to surface water for the project area including: precipitation, snowfall, temperature, and evaporation.
- Provide measurements of water quantity relevant to the project on a minimum monthly basis for a minimum period of one year to estimate seasonal variability. Sensitivity/uncertainty analyses and multi-year sampling should be considered to estimate inter-annual variability.
- Identify annual dates for watercourse/body freeze-up and break-up. Record locations that are consistently early or late for open-up or freeze.
- If relevant, determine if, and when, the watercourse/body freezes to ground.
- Identify past activities, projects influencing baseline conditions.
- Identify other anthropogenic water users and uses.

### 4.1.1 Information for Flowing Water (Creeks and Rivers)

- Provide representative measurements of annual stream flow/volume distribution to describe the temporal and spatial variability of the surface water flow regime, including annual peak and low flows. The measurements should be sufficient to develop proper stage-discharge curves for the watercourses. At a minimum, during periods of flow, measurements should be taken on a monthly basis over one year.
- Capture timing and flow information surrounding spring freshet, annual peak and winter low flow/zero flow conditions.
- Based on the flow information collected, characterize runoff conditions for the catchment areas using runoff coefficients, etc. Model extreme flow conditions for both wet and dry

events. For both wet and dry conditions, events of appropriate durations and return periods need to be predicted, evaluated and considered.

### 4.1.2 Information for Wetlands, Ponds and Lakes

- Provide estimates of water body volume as well as inputs and outputs.
- Provide estimates of retention time for the water body.
- Demonstrate if and when the water body stratifies and when the water column mixes (turnover).
- Demonstrate any monthly/seasonal patterns of water movement near proposed points of project discharge.

## 4.2 SURFACE WATER QUALITY INFORMATION REQUIRED

- Identify catchment areas/water courses/water bodies that may be affected by project activities.
- Provide measurements of water quality parameters relevant to the project on a minimum monthly basis for a minimum period of one year to estimate seasonal variability. Sensitivity/uncertainty analyses and multi-year sampling should be considered to estimate inter-annual variability.
- The water quality sampling program should characterize spatial and temporal (seasonal) variation in water quality through the year (when watercourse/body is not demonstrated to be frozen to ground/zero flow). Sampling should capture annual peak and low flows in flowing waters and stratified and non-stratified conditions in ponds/lakes. The program should be designed in consideration of when the project could affect the local water regime (i.e., operating, discharging, extracting).
- Water quality parameters to be measured are site and project specific, and should be determined in discussion with assessors and regulators. Such parameters will likely include, amongst others:
    - parameters with baseline concentrations above guidelines (e.g., "Canadian water quality guidelines for the protection of aquatic life: CCME Water Quality Index 1.0, User's manual" CCME, 2001) in receiving waters;
    - parameters associated with the ore/waste rock geology (ore deposit model) that may become elevated with the project;
    - parameters associated with processing effluent/waste streams that may become elevated with the project;
    - parameters that are indicators of other water quality issues (e.g. sulphate); and,
    - toxicity modifying parameters (e.g., hardness, pH, dissolved organic carbon).

- The detection limits used when analyzing each parameter should be less than the concentration ranges in the applicable guidelines in order to allow a comparison between the measured water quality and the guideline.
- Sampling stations should be situated to provide adequate spatial coverage relative to the project. Baseline water quality should be established at sampling locations that are suitable as future monitoring and compliance points (i.e., proposed discharge locations). This includes both upstream reference/control locations and downstream potentially affected stations. Discussions with assessors and regulators in this regard are recommended.

## 4.3 GROUND WATER FLOW INFORMATION REQUIRED (HYDROGEOLOGY)

Develop a conceptual model of the hydrogeologic setting to demonstrate an understanding of boundary conditions and aquifer properties. The conceptual model should include depiction by cross-section(s) to provide a generalized view of boundaries and hydrostratigraphic units potentially affected by project activities.

Establish and map flow rate and gradient of groundwater (water table) including measures of spatial and temporal variability. The frequency of the baseline/monitoring will be relative to the flow rate and should be sufficient to adequately define the baseline physical hydrogeological conditions (e.g. hydraulic conductivity [K], porosity, average gradient, velocity, and travel time) at the site through seasonal variability.

Provide a table indicating key details of groundwater monitoring points from which the baseline data were collected. At a minimum, this should include: location (latitude, longitude and elevation), effective screen length and depth or sensor depth, geologic/hydrostratigraphic unit screened, water table/potentiometric surface readings and date reading taken.

- Identify linkages between groundwater and surface flows particularly for base flow conditions.
- Identify where groundwater reports to surface (i.e. groundwater discharge areas).
- Identify if, and where, permafrost may affect groundwater flows.
- Identify any potential changes to groundwater flow (quantity or direction) due to the project.

## 4.4 GROUND WATER QUALITY INFORMATION REQUIRED

Baseline groundwater quality sampling should characterize spatial and temporal (seasonal) variation in groundwater quality parameters over the project area. Water quality parameters to be measured are site and project specific, and should be determined in discussion with assessors and regulators. Such parameters will likely include, amongst others:

- Parameters with groundwater baseline concentrations above guidelines (e.g., "Federal Interim Groundwater Quality Guidelines");
- Parameters associated with local and ore deposit geology that may become elevated with the project; and,

- Parameters associated with processing effluent/waste streams that may become elevated with the project.
- Sampling stations should be situated to provide adequate spatial coverage relative to the project including both reference/control locations (up-gradient) and potentially affected stations (down-gradient). Where possible, sampling stations should be established at sites suitable as future monitoring and compliance points. Discussions with assessors and regulators in this regard are recommended.
- Provide measurements of baseline water quality where project-affected groundwater reports to surface (i.e., seeps).
- Identify other possible anthropogenic users and uses of groundwater potentially affected by the project.

## 5.0 CONSIDERATIONS FOR DATA COLLECTION PROGRAM DESIGN

In order to scope the baseline data collection program, proponents should examine their proposed project activities, and be able to present an understanding of the extent to which, in time and across space, their project may result in changes to local water. Proponents are expected to present enough, sufficiently accurate, data into the assessment to support their understanding of the hydrologic system their project will be located in and may affect. The following questions can help inform decisions when designing a water data collection program.

- Is the project using or extracting water?
- Is the water balance net positive or negative? How will any excess/deficit be managed?
- Does the water balance vary monthly or seasonally? Do the monthly predictions change over the life of the project? How does the water balance vary during wet and dry years?
- How significant are the implications to the project, or the surrounding environment (including infrastructure and people) of a maximum flood/precipitation event? Low flow/drought event? For more significant effects, incorporate longer return periods in the models (i.e. more extreme events).
- What are the project activities that could result in changes in water quality and/or quantity? Do these activities, and the potential effects, change during the year?
- Consider and quantify the spatial extent to which project effects on water might extend. Will the effluent change the water quality/volumes in the receiving waters? Do you expect any changes to be observed in downstream waterbodies? How far downstream?
- Will the project release effluent? What is the predicted water quality of this effluent? How much effluent is predicted to be released? Does the volume of effluent to be released change during the year?

- Will the effluent contain higher or lower concentrations of potential contaminants than baseline conditions? What are the predicted concentrations in the receiving environment considering loadings from effluent?
- Estimate volumes of water in contact with mined materials (e.g. waste rock, tailings, and exposed bedrock). What is the resulting quality and volume of runoff/seepage expected?
- Potential effects on water should be described during all stages of the project from construction, operation, closure and post-closure.
- What are your project goals for maintaining receiving water flow and quality? During operations? Post-closure?

The design of the water sampling network and program will be specific to the proponent's project. The data from this program will be detailed enough to provide an appropriate understanding of the spatial and temporal variability of water quality and quantity across the project site and allow comparison between site conditions and surrounding watersheds (e.g. upstream, downstream, reference etc.). Rationale for the locations, frequency and analytical methods included in the sampling design must be provided in order to be confident in the program results. The sampling network should be designed to support ongoing monitoring and adaptive management though all phases of the project and should be developed in coordination with the assessors, experts and regulators.

## 6.0 PREDICTING FUTURE WATER CONDITIONS

The proposal will demonstrate an understanding of baseline water quality, quantity and variability (spatially and temporally). Proponents will then predict if, and how, these parameters will change during construction, operations, closure and post-closure of the project. The effects of a project on water will be assessed by first examining the accuracy (i.e., understanding the error) and appropriateness of the methods and data used for the predictive modelling. The predictions, or model output, are then compared to the baseline (reference) conditions and to applicable guidelines – either generic or site-specific. Sufficient information must be provided in order to understand the significance of potential changes in the water as a result of the project and to allow assessors and regulators to verify statements made in the proposal.

### 6.1 FUTURE WATER VOLUMES/WATER BALANCE

Proponents must develop and provide details of a defensible water balance for the project. The water balances should be presented on monthly cycles for annual intervals and, in addition to surface hydrology, consider where appropriate:

- precipitation inputs and evaporation/evapotranspiration/sublimation outputs;
- snow-pack conditions in the immediate area;
- glacial and permafrost melting (i.e., negative storage);
- other inputs (e.g., surface reporting of groundwater from adits, pumping, natural seeps, springs, etc.);

- existing and project-affected runoff conditions;
- displacement of water volumes from one watercourse/watershed to another;
- groundwater withdrawals;
- the influence of project components that could affect the water balance;

As part of the model, report on the water balance proponents should provide a discussion of hydrological variability between wet years and dry years and should consider more extreme conditions of flood and drought (volumes, duration and frequency). A discussion should be provided of climate change implications on the water balance and any influences this has had on project design. The model report should report and interpret the results of sensitivity analyses on the water balance model.

Proponents should consider providing a functional electronic version of their water balance model. This allows reviewers to fully understand the assumptions, inputs, mass balances, etc. which were used.

## 6.2 FUTURE WATER QUALITY

The proponent will use a variety of tools and information to produce defensible water quality models including: site and project water balances, baseline water quality data, standardized leaching tests, geochemical equilibrium models, etc. For mining projects exposing unweathered rock, rock sampling and testing programs should reflect the practices outlined in *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (Price 2009, MEND Report 1.20.1) and the *Guidelines for Metal Leaching and Acid Rock Drainage at Mine sites in British Columbia* (Price and Errington, 1998).

A load balance model must be provided that combines the water balance with predictions of contaminant loading and concentrations from mine sources (e.g. mill/heap effluent, pits, underground, waste rock, tailings, sludge, etc.). The load balance model should reflect changes in loadings predicted through all phases of the project.

Water quality models should predict both concentrations and loadings for relevant water quality parameters (identified under s4.2 of this Guide). Predictions should describe spatial and temporal variation in these parameters in local receiving waters, particularly where important values are present. The predictions, or model output, are then compared to the baseline (reference) conditions and to applicable guidelines – either generic (e.g. "Canadian water quality guidelines for the protection of aquatic life: CCME Water Quality Index 1.0, User's manual" CCME, 2001) or site-specific.

Water quality model reports should describe and consider variability in describe all phases of the project, consider changing on-site water balances and consider a variety of conditions (e.g. low flow periods, high sensitivity periods – e.g. when modifying parameters are low, etc.).

Water quality models should reflect variability in water balances, inter-annual variation, uncertainty in project-related effects, error in worst-case scenarios, etc.

Where mitigations are being proposed to maintain or improve water quality, these processes will be demonstrated to work, at a minimum, with bench test project waste streams, and preferably in field-scale trials or similar scale applications to that being proposed.

## 7.0 CONCLUSION

Proponents are required to collect baseline data so that quality, quantity and variability of water are understood and that these baseline conditions can then be compared against predicted changes due to the project. This information is required for both assessment and regulatory processes in Yukon. Appropriate data and adequate modelling can support good project decision making, minimize project liabilities and costs, and facilitate timely assessment and regulatory processes.

Water information requirements will be specific to each project. This general guidance should be supplemented through specific discussions with assessors and regulators.

## 8.0 REFERENCE AND RESOURCE LIST

### BIBLIOGRAPHY

Canadian Council of Ministers of the Environment (CCME). 2001. "Canadian water quality guidelines for the protection of aquatic life: CCME Water Quality Index 1.0, User's manual." In: *Canadian Environmental Quality Guidelines*, 1999, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba www.ccme.ca/assets/pdf/wqi_usermanualfctsht_e.pdf

Price, William A. 2009. MEND Report 1.20.1. Prediction Manual of Drainage Chemistry from Sulphidic Geologic Materials. (December 2009) http://www.mend-nedem.org/reports/files/1.20.1.pdf

Price, William and Errington, J. 1998. Guidelines for Metal Leaching and Acid Rock Drainage at Mine sites in British Columbia. British Columbia Ministry of Energy and Mines http://www.em.gov.bc.ca/Mining/Permitting-Reclamation/ML-ARD/Pages/Guidelines.aspx

### RESOURCES: PUBLICATIONS

Canadian Council of Ministers of the Environment (CCME). 2005b. *Canadian Environmental Quality Guidelines*. Update 5.0. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba, www.ccme.ca/publications/cegg_rcqe.html

Canadian Council of Ministers of the Environment (CCME). Federal Interim Groundwater Quality Guidelines for Federal Contaminated Sites http://www.ccme.ca/assets/pdf/pn_1007_e.pdf

Health Canada 2008. The Guidelines for Canadian Drinking Water Quality www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index-eng.php

Manual of British Columbia Hydrometric Standards http://www.ilmb.gov.bc.ca/risc/pubs/aquatic/hydro/index.htm or http://www.ilmb.gov.bc.ca/risc/pubs/aquatic/hydro/assets/hydro.pdf

Yukon Contaminated Sites http://www.env.gov.yk.ca/monitoringenvironment/contaminated_sites_regs.php

Metal Mining Effluent Regulations (SOR/2002-222) http://laws-lois.justice.gc.ca/eng/regulations/SOR-2002-222/

Protocols for the Contaminated Sites Regulation under the Environment Act.

Protocol No. 6: Application of Water Quality Standards http://www.env.gov.yk.ca/monitoringenvironment/documents/protocol 6 water quality standards_mar-11.pdf

Protocol No. 7: Groundwater Monitoring Well Installation, Sampling and Decommissioning http://www.env.gov.yk.ca/monitoringenvironment/documents/protocol_7_well_installation_sampling_decommissioning_mar-11.pdf

Yukon Water: An Assessment of Climate Change Vulnerabilities 2011
http://www.env.gov.yk.ca/mapspublications/documents/yukonwater_climatechange_report.pdf

## RESOURCES: WEBSITES

Canadian Council of Ministers of the Environment
http://www.ccme.ca

ClimateWNA: A program to generate climate normal data for genecology and climate change studies in western North America
http://www.genetics.forestry.ubc.ca/cfcg/ClimateWNA/ClimateWNA.html

Environment Yukon Department: Water Resources
http://www.env.gov.yk.ca/monitoringenvironment/aboutwaterresources.php

National Climate Data and Information Archive
http://www.climate.weatheroffice.gc.ca/Welcome_e.html

Yukon Water
http://yukonwater.ca

Yukon legislation related to managing water
http://yukonwater.ca/ManagingYukonWater/Legislation

Yukon Water Board
http://www.yukonwaterboard.ca