



Ministry of
Environment

PROTOCOL 21 ***FOR CONTAMINATED SITES***

Water Use Determination

Version 1.0 **Draft 10**

Prepared pursuant to Section 64 of the
Environmental Management Act

Approved:

Director of Waste Management

Date

1.0 Definitions

The following words, acronyms and expressions used in this document are defined in ministry [Procedure 8, “Definitions and Acronyms for Contaminated Sites”](#):

aquatic receiving environment	numerical water standards
dense nonaqueous phase liquid	organic soil
drinking water use	preferential flow pathway
groundwater contamination	qualified professional
source	receiving environment
muskeg	Regulation
natural confining barrier	

2.0 Introduction

This protocol provides criteria for determining groundwater uses at a site.

Section 12 (4) of the Contaminated Sites Regulation (the Regulation) specifies that groundwater may be used for drinking, aquatic life, irrigation and livestock watering. The Regulation contains requirements to ensure that groundwater at a site is suitable for current and future uses and is of adequate quality to protect adjacent water uses. Relevant provisions in the Regulation include sections 12 (2) and (5).

This document supersedes former Technical Guidance 6 “Water Use Determination” dated July 2010. Technical guidance supporting the application of this protocol is provided in revised [Technical Guidance 6, “Assessment of Aquifer Yield for Water Use Determinations”](#) and [Technical Guidance 8, “Groundwater Investigation and Characterization”](#).

3.0 Drinking water use

Site-specific information is required to determine the applicability of current and future drinking water use at a site. The flowchart in Figure 1 is provided to assist with navigation of the drinking water use evaluation process.

3.1 Current drinking water use

Drinking water use applies where the groundwater or surface water at or near a site is currently used for drinking water. For site investigation purposes, nearby drinking water wells or surface water intakes are those located within a radial

distance of 500 metres from the site property boundary or, where the groundwater contamination source extends beyond the property boundary, a radial distance of 500 metres from the groundwater contamination source. If the groundwater flow direction has been reliably determined using approved methods (see [Technical Guidance 8](#)), nearby current uses may be limited to include drinking water wells or surface water intakes located 100 metres upgradient and 500 metres cross-gradient and downgradient of the site property boundary or outer extent of the groundwater contamination source where it extends beyond the property boundary.

The presence of current drinking water wells or surface water intakes can be determined using the following methods:

- (a) A search of the Ministry of Environment's [WELLS Database](#).
- (b) Performing a door to door survey.
- (c) A search of B.C.'s [Water License Database](#).
- (d) Contacting local municipalities, water utility owners, Medical Health Officers and local Drinking Water Officers.

The use of all the search methods listed above may not be required in every circumstance, provided the locations of current drinking water wells and surface water intakes can be demonstrated to be accurate.

At some sites, there may be potential for adverse impacts on current drinking water uses located greater than 500 metres, or 100 metres upgradient of a site property boundary or groundwater contamination source. This could include sites where preferential flow pathways are present, where there are high volume groundwater extraction wells or where contaminant plumes are large and expanding. At such sites, additional evaluation of the groundwater flow pathway may be required to rule out current drinking water use.

If current drinking water wells are limited to a deeper aquifer that is protected from shallow groundwater contamination sources by a natural confining barrier, current drinking water use does not apply to geological units above the confining barrier. Section 7.0 of this protocol describes procedures for assessing the presence of natural confining barriers.

Where applicable and scientifically defensible, well capture zone analysis may be carried out by a qualified professional on drinking water wells located within 500 metres or 100 metres upgradient of the site property boundary or groundwater contamination source. Where it can be shown that site groundwater will not enter the capture zone of all nearby wells, current drinking water use does not apply.

If it is determined that groundwater and surface water at or nearby a site are not currently used for drinking water purposes, future drinking water use may apply and must also be evaluated.

3.2 Future drinking water use

Future drinking water use applies to all drinking water aquifers below a site whether or not current drinking water use applies. Drinking water aquifers are saturated geological units that have suitable hydraulic properties and natural water quality to support a single family domestic water supply. Where information is unavailable or inadequate to demonstrate an absence of drinking water aquifers below a site, drinking water aquifers are considered to exist.

Where drinking water aquifers below a site are protected from shallow groundwater contamination sources by a natural confining barrier and no shallow drinking water aquifers exist, future drinking water use does not apply to geological units above the confining barrier. Where drinking water aquifers are not protected by a natural confining barrier, future drinking water use will apply to all geological units below the site.

3.2.1 Aquifer hydraulic properties

Saturated geological units with yields greater than or equal to 1.3 L/min are capable of supporting a single family domestic water supply (B.C. provincial allocation for domestic surface water licenses) and are considered drinking water aquifers. Future drinking water use applies to these aquifers.

Unconsolidated geological units with aquifer yields greater than or equal to 1.3 L/min typically have bulk hydraulic conductivities greater than 1×10^{-6} m/s. Therefore, saturated unconsolidated geological units with hydraulic conductivities greater than or equal to 1×10^{-6} m/s are considered drinking water aquifers, unless aquifer yield has been measured and is found to be less than 1.3 L/min. Future drinking water use does not apply to saturated unconsolidated geological units with hydraulic conductivities less than 1×10^{-6} m/s. Guidance for assessing aquifer yield for purposes of determining water use can be found in Technical Guidance 6.

Bedrock units show a poorer correlation between yield and hydraulic conductivity. Therefore, hydraulic conductivity alone cannot be used to rule out drinking water use in bedrock. Section 6.0 of this protocol describes procedures for assessing bedrock aquifers.

Site-specific measurements of hydraulic conductivity and calculation of bulk hydraulic conductivity as described below are required to evaluate whether a geological unit below a site qualifies as a drinking water use aquifer. Bulk hydraulic conductivity is calculated as follows:

- the geometric mean of hydraulic conductivity measurements obtained from six or more wells, spatially distributed across a site and located within the same geological unit; or
- the maximum hydraulic conductivity where measurements are obtained from five or fewer wells.

Confined aquifers that:

- have an average saturated thickness of 1 metre or less; and
- are situated within a predominantly confined unit;

are not considered sustainable sources of domestic water supply. Future drinking water use does not apply to these aquifers.

Unconfined aquifers that are:

- present only seasonally or have an average saturated thickness of 2 metres or less; or
- are comprised only of imported fill;

are not considered sustainable sources of domestic water supply. Future drinking water use does not apply to these aquifers.

3.2.2 Aquifer natural water quality

Saturated geological units containing naturally occurring total dissolved solids concentrations of 4,000 mg/L or greater or groundwater flow systems contained within organic soils or muskeg (see [Procedure 8, "Definitions and Acronyms for Contaminated Sites"](#)) are considered to have unsuitable water quality for domestic water supply. Therefore, future drinking water use does not apply to these units.

Geological units located within and below filled former marine and estuarine foreshore typically contain elevated concentrations of dissolved sodium, chloride and total dissolved solids and are vulnerable to seawater intrusion in response to pumping. Future drinking water use does not apply to these geological units.

4.0 Irrigation and livestock water use

Site-specific information is required to determine the applicability of current and future irrigation or livestock water uses. The flowchart in Figure 2 is provided to

assist with navigation of the irrigation and livestock water use evaluation.

4.1 Current irrigation and livestock water use

Irrigation or livestock water use applies where the groundwater or surface water at or nearby a site is currently used for irrigation or livestock watering. Nearby irrigation or livestock water wells or surface water intakes are those located within a radial distance of 500 metres from the site property boundary or, where the groundwater contamination source extends beyond the property boundary, a radial distance of 500 metres from the groundwater contamination source. If the groundwater flow direction has been reliably determined using approved methods (see [Technical Guidance 8](#)), nearby current uses may be limited to include irrigation and livestock water wells or surface water intakes located within 100 metres upgradient and 500 metres cross gradient or downgradient of the site property boundary or outer extent of the groundwater contamination source where it extends beyond the property boundary.

If current irrigation or livestock water wells are limited to a deeper aquifer that is protected from shallow groundwater contamination sources by a natural confining barrier, current irrigation or livestock water uses do not apply to geological units above the confining barrier.

Well capture zone analysis may be carried out on current livestock or irrigation wells within 500 metres distance or 100 metres upgradient of the site property boundary or groundwater contamination source. Where it can be shown that site groundwater will not enter the capture zone of any nearby irrigation or livestock water wells, current irrigation or livestock water uses do not apply.

If it is determined that water is not currently used for irrigation or livestock water use, future irrigation or livestock water use may apply and must also be evaluated.

4.2 Future irrigation and livestock water use

Future irrigation and livestock water uses apply to all groundwater located at sites with agricultural land use unless it can be demonstrated that the saturated geological unit or units where contamination occurs:

- have a bulk hydraulic conductivity less than 1×10^{-6} m/s,
- are unconfined aquifers that are present only seasonally or have an average saturated thickness of 2 metres or less or are comprised only of imported fill,

- contain naturally occurring total dissolved solids concentrations of 4,000 mg/L or greater or groundwater flow systems within organic soils or muskeg, or
- are located within or below filled former marine and estuarine foreshore.

5.0 Aquatic life water use

Aquatic life water use applies to all groundwater located within 500 metres of an aquatic receiving environment unless it can be demonstrated that the groundwater does not flow to that receiving environment (e.g., groundwater in confined aquifers below shallow ponds or creeks).

Aquatic life water use applies to groundwater located beyond 500 metres of an aquatic receiving environment if the groundwater contains substances with concentrations above the aquatic life water use standards and has the potential to migrate within 500 metres of the aquatic receiving environment. Examples include groundwater plumes that cross or continue to migrate towards the 500 metre setback boundary or plumes that are conveyed along preferential flow pathways such as buried creek channels or underground utility corridors.

The flowchart in Figure 3 is provided to assist with navigation of the aquatic life water use evaluation.

6.0 Bedrock aquifers

If current drinking water, irrigation or livestock water wells are located in a bedrock aquifer below or nearby a site, the corresponding water use applies to the bedrock aquifer and to overlying geological units. If current drinking, irrigation or livestock water wells are limited to a bedrock aquifer that is protected from shallow groundwater contamination sources by a natural confining barrier, current drinking, irrigation or livestock water uses do not apply to geological units above the confining barrier.

Future drinking water use applies to bedrock aquifers mapped in the [BC Water Resource Atlas](#). Where bedrock investigations indicate that the bedrock at a site would operate as a natural confining barrier, site owners may seek a site-specific determination of water use from the Director under Section 9.0 of this protocol. Where no bedrock aquifers are mapped, the bedrock must be assessed for future drinking water use when groundwater containing substances above the drinking water standards extends to the bedrock surface. Figure 4 provides a flowchart showing the evaluation of current and future drinking water use in bedrock.

The assessment of bedrock aquifers for future irrigation and livestock water uses is only required at sites where groundwater containing substances above the applicable water use standards extends to the bedrock surface.

Where required to determine applicable water uses, bedrock hydraulic properties and yield must be assessed on the basis of *in situ* field investigations conducted at the site or within a 500 metre radial distance of the site property boundary where the bedrock can be shown to be of the same geological formation.

The assessment of bedrock aquifers for aquatic life water use should be evaluated as described under Section 5, “Aquatic life water use”, above.

7.0 Natural confining barriers

Natural confining barriers are unconsolidated geological units that:

- are greater than or equal to 5 metres in thickness;
- have a bulk hydraulic conductivity:
 - less than 1×10^{-7} m/s (*Type A*); or
 - between 1×10^{-7} m/s and 1×10^{-6} m/s where the ratio of unit thickness to hydraulic conductivity is greater than 5×10^7 (*Type B*)
- are reasonably uniform in composition and are unfractured;
- are continuous across the extent and predicted migration pathway of contaminant plumes; and
- are free of contamination across the bottom 5 metres, or the thickness satisfying the ratio of 5×10^7 , with no potential for future contamination.

Site-specific measurements of hydraulic conductivity are required to evaluate whether a geological unit below a site qualifies as a natural confining barrier.

Bulk hydraulic conductivity is calculated as follows:

- the 90th percentile of hydraulic conductivity measurements obtained from six or more wells, spatially distributed across a site and located within the same geological unit; or
- the maximum hydraulic conductivity obtained from five or fewer wells.

For purposes of this protocol only and with the exception of dense nonaqueous phase liquids (DNAPL), natural confining barriers are considered not contaminated where the conditions described below for each barrier type are satisfied.

Type A

Substance concentrations in soil or water are:

- less than or equal to the commercial land use soil standards listed in Schedule 4 and 10 of the Regulation;
- less than or equal to the commercial land use soil standards for the site-specific factor of groundwater used for drinking water, irrigation water or livestock water listed in Schedule 5 of the Regulation, depending on the applicable water use of the deeper aquifer; or
- less than or equal to the drinking, irrigation or livestock water standards in Schedule 6 of the Regulation, depending on the applicable water use of the deeper aquifer, where there are no soil standards protective of the applicable water use in Schedule 5.

Type B

Substance concentrations in soil and water are:

- less than or equal to the applicable regulatory standards.

Where DNAPLs are present, contamination of natural confining barriers must be determined on the basis of substance concentrations in both soil and groundwater.

Due to the prevalence of bedrock fracturing, bedrock is not considered a natural confining unit. However, where bedrock investigations indicate that the bedrock at a site would operate as a natural confining barrier, site owners may seek a site-specific determination of water use from the Director under Section 9.0 of this protocol.

8.0 Applicable water use standards

Numerical water standards for investigating the presence of contamination in surface water (non-aquatic life receiving environment) and groundwater at sites in BC are provided in Schedules 6 and 10 of the Regulation. The numerical standards are provided for each of the water uses described in this protocol. Where multiple water uses apply at a site, the presence of contamination must be determined on the basis of all of the applicable numerical water standards.

9.0 Requesting a Director's determination of water use

Where water uses determined to apply at a site under this protocol are considered unlikely or unreasonable, site owners and operators may request a

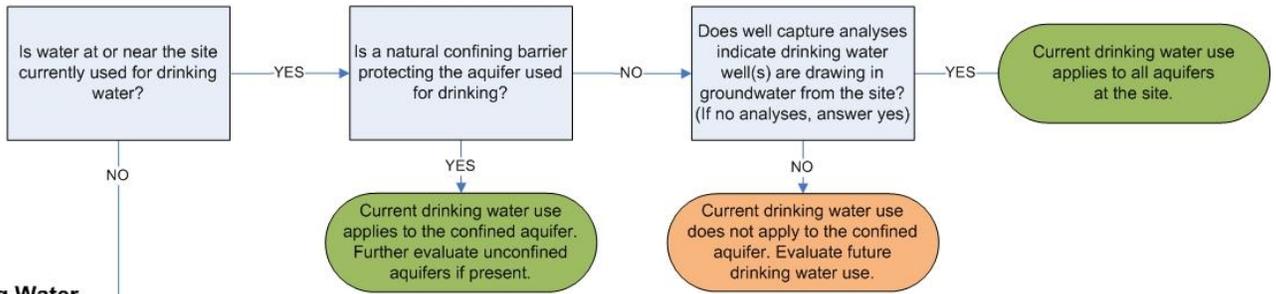
Director to make a site-specific determination of water use. Such requests must be accompanied by a completed [Contaminated Sites Services Application form](#) and a supporting technical report prepared by a qualified professional. For applications requesting a determination of no drinking water use, Appendix 1 provides the Director's decision framework for making such determinations.

For more information, contact the Environmental Emergencies and Land Remediation Branch at site@gov.bc.ca.

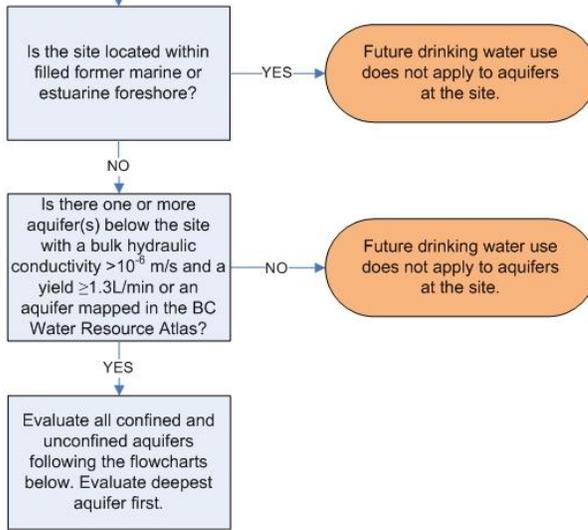
Revision history

Approved Date	Effective Date	Document Version	Notes

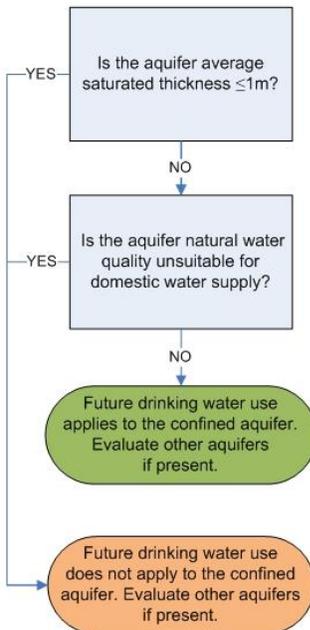
Current Drinking Water Use Evaluation



Future Drinking Water Use Evaluation



Confined Aquifer Evaluation



Unconfined Aquifer Evaluation

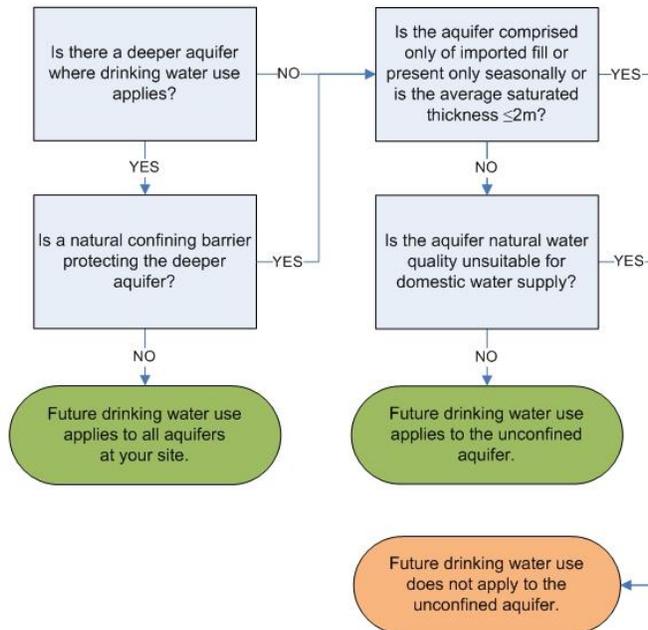


Figure 1. Current and future drinking water use evaluation for unconsolidated aquifers.

Current Irrigation and Livestock Watering Use Evaluation

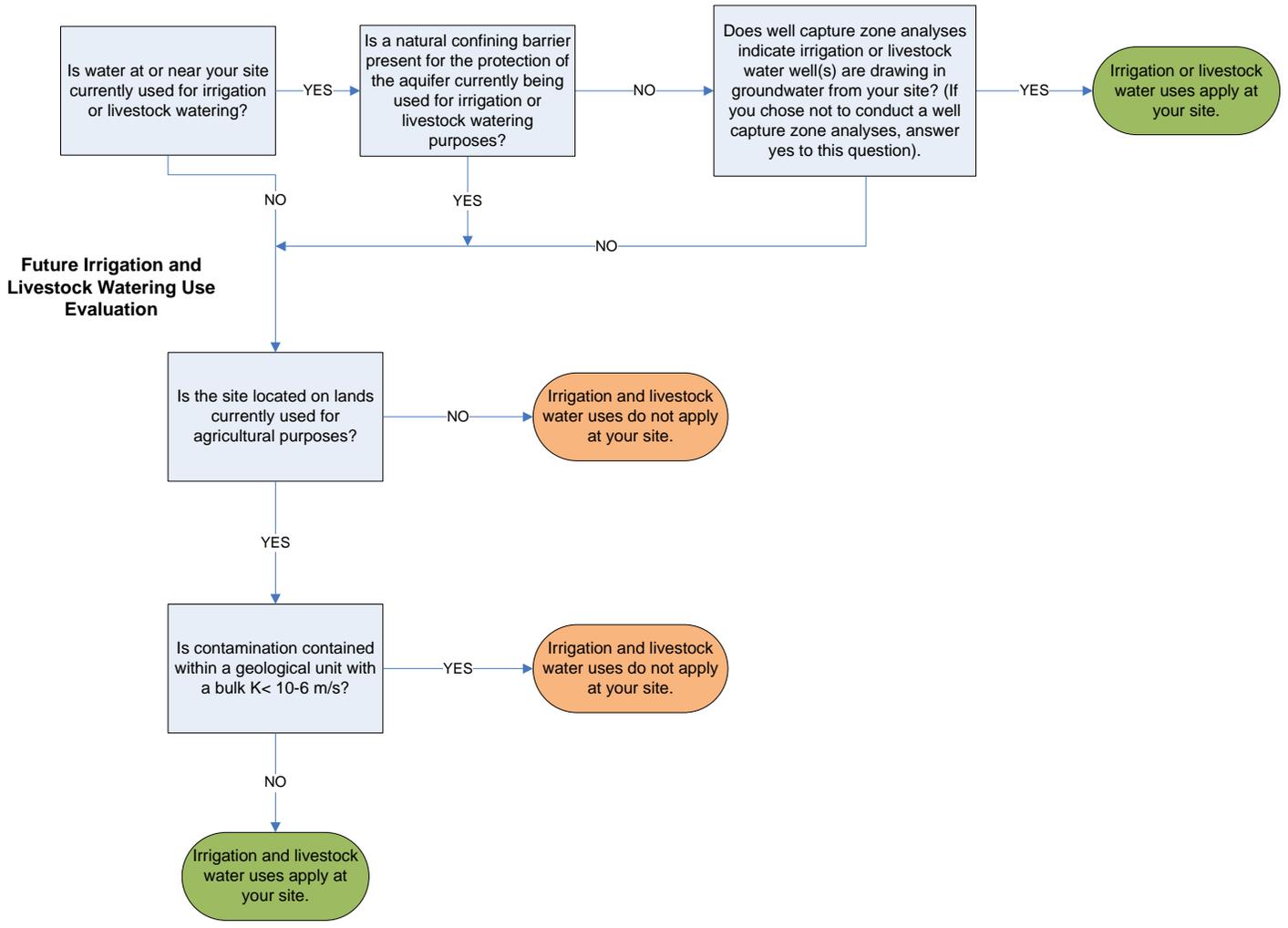


Figure 2. Current and future irrigation and livestock water use evaluation.

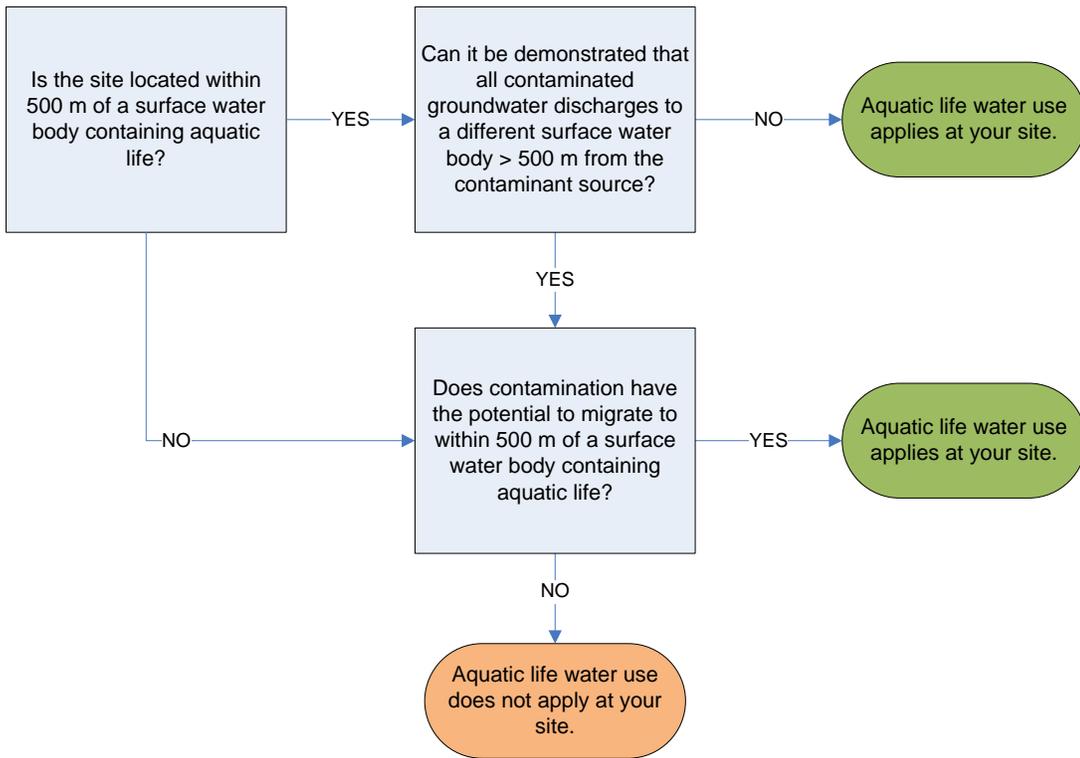


Figure 3. Aquatic water use evaluation.

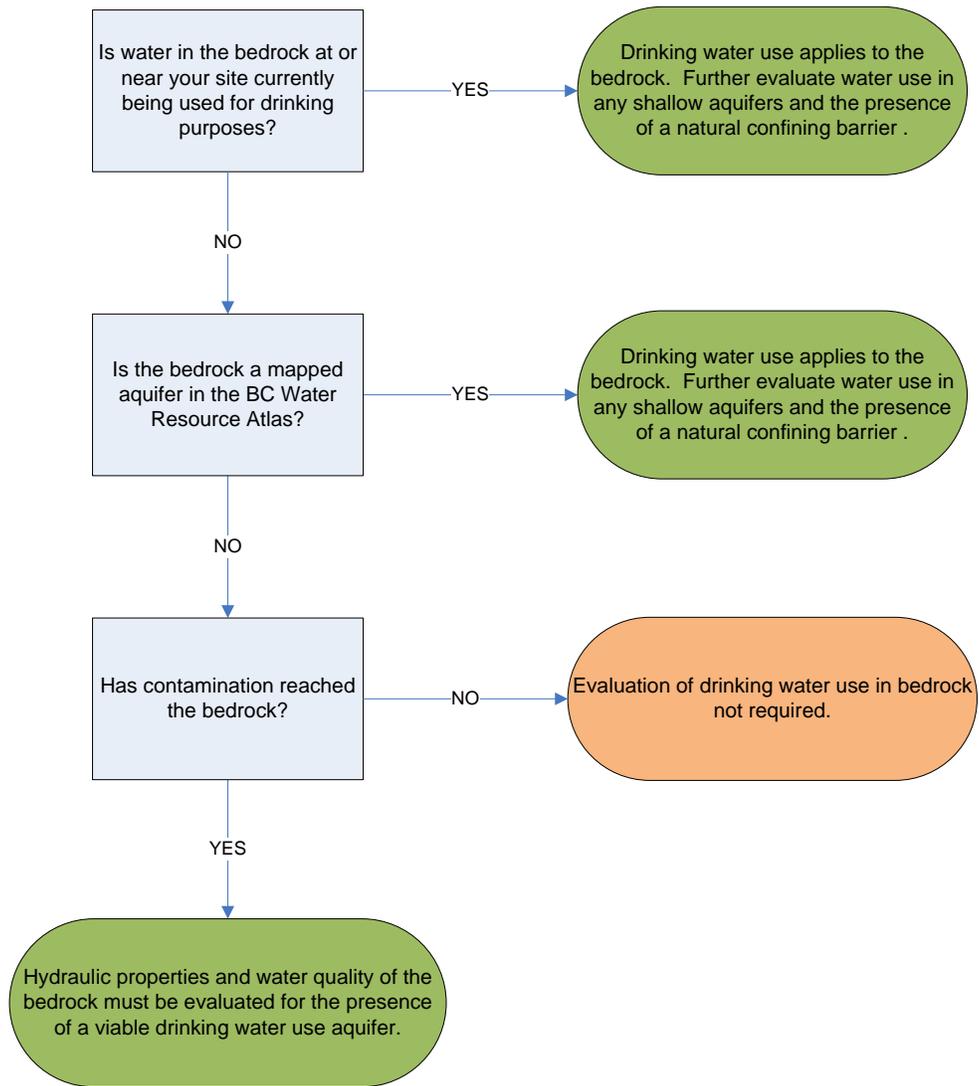


Figure 4. Current and future drinking water use evaluation for bedrock aquifers

Appendix 1

Director's Decision Framework for Site-Specific Determinations of Water Use

Where drinking water use has been determined to apply at a site under Protocol 21 and site circumstances indicate that it is unlikely or unreasonable to anticipate that water from the site or nearby the site would be used for drinking, site owners and operators may apply to the Director for a site-specific determination of no drinking water use. Applications for a determination of no drinking water use must be accompanied by a completed [Contaminated Sites Services Application form](#) and a supporting technical report prepared by a qualified professional.

This decision framework describes a multiple-lines-of-evidence approach for demonstrating that water use for drinking water purposes would be unlikely or unreasonable to anticipate at a site.

Site-specific conditions considered valid lines of evidence for supporting a determination of no drinking water use are listed below. The conditions listed are not exhaustive and may be augmented by other relevant information on a site-by-site basis. However, multiple site-specific conditions should be demonstrated to apply. Satisfying a single listed condition or two or more conditions that fall under a single category (e.g., groundwater demand) is unlikely to provide sufficient justification for a determination of no drinking water use. In addition, some of the listed conditions are relevant to shallow aquifers only and may, in combination with other demonstrated conditions, be sufficient to support a determination of no drinking water use in a shallow aquifer but not be sufficient for a determination of no drinking water use in a deeper aquifer. Where deep drinking water aquifers are present below a site, applications for a Director's determination of no drinking water use in a shallow aquifer must be accompanied by evidence of a natural confining barrier above the drinking water aquifer.

Water quality

- The site is located in an area of long industrial use with multiple landowners, multiple sources, and widespread contamination which has not been attributed to particular responsible person(s).
- The site is located adjacent to the marine receiving environment and groundwater pumping for drinking water use would result in seawater intrusion. Under this condition groundwater flow and contaminant migration must be toward the marine environment and not to neighbouring parcels.

Aquifer productivity

- The sustainable yield in the shallow aquifer cannot support a single family dwelling at 1.3 L/min for more than a limited number of years.

Groundwater demand

- A municipal water supply is in place that does not rely on groundwater.
- The aquifer underlying the site is not classified as a high demand aquifer according to the Ministry of Environment's [Aquifer Classification System](#)
- The site is not located in an area of known limited water resources.
- Groundwater at the site is not restricted for drinking water use under a Local Government Water Management Plan.
- The future use of the site and surrounding area is industrial.