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General	General	The requirements to eliminate the drinking water pathway are too onerous, especially for smaller sites. For example, the need to determine hydraulic conductivity values from at least five monitoring wells per stratigraphic unit is extreme overkill.	Evaluation of drinking water use on a contaminated site is based on site-specific hydrogeological properties, thus site-specific testing is generally required. The number of wells required to evaluate water use will be very site specific and Protocol 21 does not contain any requirements regarding the number of wells per stratigraphic unit. Often wells that are used for contaminant characterization purposes can be used for obtaining data for evaluating water use. Section 3.2.1 and 7.0 contains language regarding the type of statistics that can be used when calculating hydraulic conductivity. The requirement of having greater than five wells to calculate hydraulic conductivity statistics is general ministry groundwater policy and found in Technical Guidance 8. The protocol provides additional investigation relief for sites on infilled former marine sites, e.g. False Creek Flats, and for unconfined aquifers with an average saturated thickness of 2 metres or less or aquifers comprised of only fill (Section 3.2.1 Aquifer hydraulic properties). Further, bedrock investigations are only required if contamination is present in overlying materials to the top of the bedrock and hydraulic data from sites within 500 m may be used for determining water use in bedrock. For smaller sites (e.g., subdivided or affected parcels) where site-specific information is missing, neighbouring data may be used (see Technical Guidance 6). To assist stakeholders when evaluating water uses, different mapping initiatives are available. These include CSAPs "Contaminated Site Legal Instrument Mapping" and the ministry's Borehole Log Database found on iMapBC.
General	General	Recommendation: The drinking water standards to not apply in cases in which the form of construction or the development will undermine the aquifer	There is no explicit drinking water standards exemption for construction or development that undermines the aquifer. Often shallow aquifers are exempt from DW use based on the criteria in Protocol 21 Section 3.2.1 or through the lines-of-evidence approach. If the shallow aquifer is considered viable and doesn't qualify for an exemption, the ministry's goal with this protocol is to protect BC's groundwater resource to ensure it is sustainable for future generations.

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			All responsible owners at contaminated sites need to assess and be aware of their impacts to the groundwater resource. Where remediation to drinking water standards is not practical or possible at contaminated sites, risk management solutions are a potential option.
General	Water Act	The Province's new Water Sustainability Act may have implications with respect to local governments' ability to restrict drinking water use for an aquifer within its boundaries. Will this be considered before P21 is finalized?	The Water Sustainability Act does not currently provide local government authority to regulate access and use of water and drilling of wells.
2.0	Intro	"*Section 12 (4) of the Contaminated Sites Regulation (the Regulation) specifies that groundwater may be used for drinking, ~~aquatic life~~, irrigation and livestock watering. Aquatic life receptors (both freshwater and marine) must also be considered*" For clarity, as groundwater is not "used" by aquatic life, per se, we recommend the revised wording.	Most surface water bodies are under direct influence of groundwater flow. Thus, groundwater near aquatic receiving environments is regulated in BC to protect aquatic life.
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*." This is not consistent with the section on future drinking water. In addition, groundwater to surface potable water pathway is typically not considered relevant, due to the large amount of dilution that any groundwater contaminants experience when they enter a large water body being used as a potable water source. We recommend revising the wording as shown.	Protocol 21 protects current use of both surface water and groundwater as drinking water. Viable groundwater aquifers are protected for future drinking water use, however there is no requirement in P21 to evaluate potential future use of surface water bodies as a drinking water source. The amount of dilution taking place when groundwater enters a surface water body or an aquifer pumping well is very site-specific and not considered a valid argument when determining applicable water use.
3.1	Current drinking water use	*"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."* This guidance is too broad and unclear. For example, if the	Surface water intakes upgradient of a source need to be evaluated on a case by case basis. The ministry relies on the judgement of the qualified professional to ensure that contaminant sources are not impacting drinking water at or near a site. If it can be shown, using scientifically defensible methods, that a surface water intake located within 500 metres or 100 metres of a site is not influenced by site groundwater, a Director's determination of water use can be made. Circumstances where contaminant plumes are proximal to surface water intakes are rare. No application for a director's determination has been received for

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		plume from the site intersects a river downstream of the potable water intake, this pathway should be able to be eliminated, even if the intake is less than 500 metres of the site. The rationale is that contaminants from the groundwater cannot migrate upstream, against the river current. Recommend revising wording as shown:	relief from this condition.
3.1	Current Drinking water use	"*Where it can be shown that site groundwater will not enter the capture zone of all nearby drinking water wells, current drinking water use does not apply."* Revise the wording as shown since not all nearby wells will necessarily be drinking water wells, which are the only ones where drinking water standards will apply.	The wording has been revised as suggested.
3.1	Current drinking water use	When assessing current groundwater use, a 500 m radius for cross-gradient wells seems very conservative. Since there is a lateral reduction to 100 m for upgradient wells, perhaps a 300 m distance would me more applicable for cross-gradient wells. This still provides a sufficient level of conservatism.	The protocol provides the option to limit the radius for current drinking water uses to 100 m upgradient of the site, but maintains a 500 m radius both cross-gradient and downgradient. Where applicable, well capture zone analysis can be carried out to show that groundwater will not enter the capture zone of wells located within the 500 m radius.
3.1	Current drinking water use	"*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."* This paragraph needs more clarity to determine when additional evaluation "may" be required. We suggest the insertion of the word "material" before preferential so that the statement reads "material preferential flow pathways are present….":	The ministry relies on professional judgement when evaluating when preferential flow pathways can impact current drinking water use. Solid arguments supported by site data must be presented to show that preferential pathways so not afford facilitated contaminant transport to nearby wells or water bodies. Guidance on the assessment of preferential pathways can be found in Technical Guidance 8, Groundwater Investigation and Characterization" and the background document "Groundwater Investigation in Site Assessment".
3.0 and 4.1	Current drinking water use	Well capture zone boundary locations vary depending on time required for gw contaminants in the zone to travel to the well. MoE should specify in this para guidance	Various methods, such as capture zones, are provided in Protocol 21 to assist the qualified professional in identifying water wells and intakes near a site. Not all listed methods are required for

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		regarding this issue or reference the specific document where this information is identified. Historically, for example, MoE considered that AW standards apply when gw travel times were less than 50 years and DW standards applied with gw travel times were less than 100 years. Does MoE still consider a 100 year travel time relevant/acceptable and that if capture zone analysis were employed that 100 year travel time capture zones are appropriate for assessing if DW standards apply? If MoE considers 100 year travel time acceptable, what is scientific justification for this rather than a smaller travel time? In principle, practitioners and land owners would like the guidance to specify the smallest defensible travel time and if 90 or 80 or 70 or fewer years travel time is scientifically defensible, such a number should be specified rather than an arbitrary 100 year value.	every site, however it is up to the qualified professional to ensure the locations of current drinking water wells and surface water intakes at or near your site are accurate. Where conditions and assumptions inherent in this method do not apply, the ministry expects the qualified professional to document the rationale for the use of alternate methods. If conducting transport assessment, a steady-state solution form should be used, which may be complemented with transient analysis if reasonable or warranted.
3.1	Current drinking water use	*"….a radial distance of 500 metres from the groundwater contamination source*" Is this meant to be read as "source site", as defined in Section 40 of the Contaminated Sites Regulation? Also, is this directly applicable to nonpoint source impacts (i.e. acid mine drainage?), or should additional wording be added to clarify?	"Groundwater contamination source" is defined in Procedure 8 as any part of the land surface or subsurface containing substances that are either known or anticipated to generate groundwater substance concentrations greater than or equal to the applicable numerical standards. For substances listed in Schedule 5, the groundwater contamination source would be the area where substance concentrations in soil exceed the standard for the applicable groundwater protection pathway.
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."* In locations where future aquifer use is not permitted (eg. cemeteries, bylaws, other?), the future drinking water use scenario should not be applicable. Example : http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/faq_grdwater.html **Q: Can I drill a well anywhere on my property? How close can I site the well to the property line?** **A:** The province does not have restrictions on how close a well can be drilled from the property line. Check with the local municipal government in your area; it may have	Protocol 21 protects viable groundwater aquifers for potential future use. The evaluation of future drinking water aquifers is independent of current land use and the potential for anthropogenic contamination from e.g. cemeteries, waste discharges, landfill or any other contaminated site. Although regulations for water wells are important for property owners, to assure not drilling in contaminated areas, Protocol 21 does not provide relief for current land use when determining the water use standards.

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		restrictions. The site of a proposed water supply well should not be: - within a horizontal distance of 3 metres (10 feet) of an existing building; - within a horizontal distance of 30 metres (100 feet) of any probable source of contamination or point of waste discharge to the ground, such as a privy vault, cesspool, septic effluent field, manure heap, stable or pig sty; or - within a horizontal distance of 120 metres (400 feet) of any cemetery or dumping ground.	
3.2	Future Drinking Water Use	"*Where drinking water aquifers are not protected by a natural confining barrier, future drinking water use ~~will~~ may apply to all geological units below the site*." It is not correct to say that if a natural confining layer is not present at a site that "future drinking water use *will* apply to all geologic units below the site". This is too broad. We recommend changing "will" to "may".	If a site is underlain by a viable drinking water aquifer and this aquifer is NOT protected by a natural confining barrier, drinking water standards will apply to all units on the site. Shallow aquifers can only be exempt (e.g., due to saturated thickness less than 2 m or groundwater flow contained within organic soil) if there is a natural confining barrier protecting the deeper drinking water aquifer or if there is no viable aquifer below.
3.2.1	Aquifer hydraulic properties	Recommendation: The proposed testing regime in draft Protocol 21 should be workable in urban areas by: · Reducing the number of wells that need to be drilled The testing regime described in section 3.2.1 of draft Protocol 21 is more applicable to large sites that are one hundred plus acres, as opposed to much smaller infill projects in urban areas such as the Lower Mainland, the Capital Regional District and Kelowna. The costs in these areas would be excessive and may discourage landowners from remediating their sites and agreeing to redevelopment opportunities.	Evaluation of drinking water use on a contaminated site is based on site-specific hydrogeological properties, thus site-specific testing is in general required. Protocol 21 does not contain any requirements regarding the number of wells that need to be drilled. Instead, Sections 3.2.1 and 7.0 contains language regarding the type of statistics that can be used when calculating hydraulic conductivity. The requirement of having greater than five wells to calculate hydraulic conductivity statistics is general ministry groundwater policy and found in Technical Guidance 8. For sites where site-specific information is limited (e.g., subdivided city lots or affected parcels), neighbouring data may be used to supplement the site-specific information (see Technical Guidance 6). Further, to assist stakeholders when evaluating water uses, different mapping initiatives are available. These include CSAPs "Contaminated Site Legal Instrument Mapping" and the ministry's Borehole Log Database found on IMapBC.

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3.2.1	Aquifer hydraulic properties	Recommendation: Drinking water standards to not apply to perched, unconfined aquifers in urban areas where the water is not currently used for drinking water purposes, and domestic water supply is provided by a local or regional water supply system	Under Protocol 21, unconfined aquifers that are present only seasonally, have an average saturated thickness of 2 metres or less or are comprised only of imported fill are not considered drinking water aquifers when they are perched above natural confining barriers that protect a deeper viable drinking water aquifer.
3.2.1	Aquifer yield	Recommendation: The 1.3 litre per minute yield threshold for application of the drinking water standard be discontinued in use; the yield should instead reflect the domestic demand that is consistent with the land use and what is being built. We are concerned that the 1.3 litre per minute requirement is again stipulated in the draft Protocol 21: Water Use Determination, which was released earlier this year. A yield of 1.3 litres per minute (representative of a single family residence) does not, in many instances, represent a yield sufficient to sustain a drinking water use for redevelopment projects. Much of the development and redevelopment in urban areas is multi-unit residential or commercial/industrial projects that are medium to high density. This is consistent with municipal Official Community Plans and the goal of ensuring that our limited land resources are used to their highest beneficial use. As a result, for most projects, the groundwater yield is insufficient to support the development that is being built. Project proponents have to incorporate future land uses in their analysis to ensure that they are meeting Ministry requirements for soil remediation. Why is groundwater treated differently? Unfortunately, our members spend considerable time and cost delineating the extent of constituents in groundwater solely because they exceed the drinking water standards. A standard that is being applied without due consideration to whether serviced water is being connected to buildings and to the land use and planning policies of the local	Many jurisdictions including the United States Environmental Protection Agency (U.S. EPA) use a minimum yield to establish water use. The Ministry has chosen 1.3 L/min (500 gallons/day) as it is the limit used for the B.C. provincial allocation of domestic surface water licences. This value is consistently used for the entire province regardless of land density and is roughly double the average household use of domestic water. In addition to yield and hydraulic conductivity limits, Protocol 21 also provides that unconfined aquifers less than 2 metres in thickness and confined aquifers less than 1 metre in thickness are not considered drinking water aquifers. The application of 1.3 L/min across all areas of the province ensures that all viable aquifers are protected for future sustainable use. Groundwater extraction for private use is known to occur in a number of municipalities in B.C. (Nanaimo, Victoria, Surrey, Langley, Kamloops, Gibsons). The severe drought experienced in 2015 in several highly populated regions throughout B.C. including the Lower Mainland, Okanagan and Vancouver Island is a reminder of the importance of clean, sustainable groundwater resources for public use. In response to a request from members of a Contaminated Sites Approved Professionals (CSAP) working group that yield be increased from 1.3 L/min to 8 L/min, it was determined that an increase of this order would have little effect on the number of aquifers captured as drinking water aquifers under the protocol. This is due to the high variability in aquifer hydraulic properties that exist in nature. To test this finding against field data, the Ministry asked members of the working group to provide examples of contaminated sites where the requested yield increase would result in a change in the determination of drinking

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		government. We suggest that the threshold either reflect the future land use in an area, or at the very least be increased to 9.5 litres per minute (equivalent to 2.5 gallons per minute as recommended to produce 300 gallons for a two hour demand). This threshold better reflects industry standard expectations for minimum yield necessary to meet the demand of a single family household. The current threshold of 1.3 L/min is substantially below what is needed to reasonably meet typical single family household demands. The result is drinking water standards are being inappropriately applied in areas where the natural aquifer conditions are simply inadequate for that purpose.	water use. No examples were provided.
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*" Should this be true for every site? There seems to be no consideration of site size, zoning or density	See response above.
3.2.1	1.3 L/min	Would the Ministry consider a yield greater than 1.3L per minute as sufficient to identify an aquifer for an urban high density setting such as downtown Vancouver?	See response above.
3.2.1	Aquifer hydraulic properties	*"Guidance for assessing aquifer yield for purposes of determining water use can be found in Technical Guidance 6".* TG6 dos not give concrete guidance on how to assess aquifer yield by doing pumping tests in the field. We recommend that TG6 be changed so that it does provide this guidance, thereby making the wording of this paragraph correct.	Technical Guidance 6 provides the Cooper-Jacob evaluation. Further guidance to estimate hydraulic conductivity can be found in the parent document to Technical Guidance 8 "Groundwater Investigation in Site Assessment" prepared by Golder in June 2010.
3.2.1	Aquifer hydraulic	"*Site-specific measurements of hydraulic conductivity and calculation of bulk hydraulic conductivity as described*	Site specific measurements are required at most sites. We have added additional language both in Protocol 21 Section 3.0 and in

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	properties	*below are required*". We understand that hydraulic conductivity tests are not required for every site. We suggest you edit/add wording to confirm that hydraulic conductivity is not required at every site.	Technical Guidance 6 regarding the use of neighbouring data for determining hydraulic conductivity in bedrock and for unconsolidated geological units in some circumstances.
3.2.1	Aquifer hydraulic properties	In an urban context where legal parcels are often quite small, going site by site seems very conservative given the typical expanse of an aquifer. In such a setting, would the Ministry consider allowing a proponent to use aquifer testing data within a certain distance from a site without seeking a determination provided it can be demonstrated the sites have the same geological formation. There is already a similar idea discussed in this Protocol for bedrock aquifers.	See response above.
3.2.1	Aquifer hydraulic properties	*"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"* The number of hydraulic conductivity measurements needed per geological unit (five or six) is far too high for small site, like a corner gas station. Suggest this be reduced to the geometric mean of the measurements for four or more wells; or the maximum hydraulic conductivity for three wells.	Evaluation of drinking water use on a contaminated site is based on site-specific hydrogeological properties, thus site-specific testing is in general required. There are no requirements in Protocol 21 regarding the number of wells required to determine hydraulic conductivity. Section 3.2.1 and 7.0 contains language regarding the type of statistics that can be used when calculating hydraulic conductivity. The requirement of having greater than five wells to calculate hydraulic conductivity statistics is general ministry groundwater policy found in Technical Guidance 8. We have added additional language both in Protocol 21 Section 3.0 and in Technical Guidance 6 regarding the use of neighbouring data for determining hydraulic conductivity in bedrock and for unconsolidated geological units in some circumstances.
3.2.1	Aquifer hydraulic properties	We requests another paragraph to describe what is to be done for wells that are dry, or where the recovery times are so slow that a reliable hydraulic conductivity value cannot be obtained? Can this lack of recovery alone be considered an acceptable argument that the hydraulic conductivity is so low that this geologic unit cannot be considered a sustainable source of domestic water supply? Does potable water need to be added to the well, so a falling head slug	To determine hydraulic conductivity of the unsaturated zone the ministry relies on the qualified professional to evaluate all lines of evidence to provide a conservative estimate. There are several empirical (e.g. grain size), lab (e.g. permeameter testing) and field (e.g. infiltrometer) methods to establish bulk hydraulic conductivity that can be used with supportive documentation. Additionally, documentation is required to demonstrate that the confining unit is free of fractures or preferential paths such as worm holes and

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		test can be attempted? Guidance must be given in this document on what to do in such situations.	sand seams.
3.2.1	Confined aquifers	*"Confined aquifers that:* - *have an average saturated thickness of 1 metre or less; and* - *are situated within a predominantly confined unit"* Clarify meaning of "predominantly" or remove the term	The exemption criteria only include confined aquifers with thicknesses < 1 m that are located within a geological unit with hydraulic conductivity < 10^{-6} m/s (i.e. does not qualify as an aquifer). The term "predominantly" is considered necessary to avoid geological units being split up in small sections with thicknesses < 1 m.
3.2.2	Aquifer natural water quality	Recommendation: The 4,000 mg per litre threshold for total dissolved solids (TSS) to be amended to reflect Health Canada and U.S. Environmental Protection Agency (USEPA) guidelines for domestic use. We are concerned that the 4,000 mg/L requirement is again stipulated in the draft *Protocol 21: Water Use Determination*, which was released earlier this year. A threshold of 4,000 mg/L yield represents water quality that is not usable for drinking water supply. Health Canada Drinking Water Guidelines also have a Technical Supporting document for TDS that states: "*An aesthetic objective of 500 mg/L has been established for total dissolved solids (TDS) in drinking water. At higher levels, excessive hardness, unpalatability, mineral deposition and corrosion may occur*." This is the same value [500 mg/L] that the USEPA is currently using. We suggest that the TDS threshold for drinking water applicability be reduced to 500 mg/L to better reflect the regulatory recommendations of other public health and environmental agencies.	Health Canada and U.S. EPA guidelines for domestic use apply to water at the point of consumption. Where groundwater is used for municipal or private drinking water, consumption based guidelines are commonly achieved following treatment for substances that naturally occur at levels exceeding the guidelines such as iron, manganese, sodium or TDS. The comparable U.S. EPA guideline to that of Protocol 21 is 10,000 mg/L TDS as set out in *Guidelines for Ground-Water Classification under the Ground-Water Protection Strategy, EPA, 1986 and 40CFR146.4 Criteria for Exemption of Aquifers, 2014.* Adoption of this limit in B.C. would result in a much greater number of aquifers being determined drinking water aquifers. Instead, the Land Remediation Section, in consultation with the Water Stewardship Division, adopted Alberta's TDS concentration limit of 4,000 mg/L as a groundwater protection limit in BC based on commonly available water treatment technologies. To address stakeholder concerns regarding the over capture of aquifers under marine influence, Protocol 21 includes relief from drinking water use for sites located within filled former marine and estuarine foreshore (Protocol 21, Section 3.2.2 Aquifer natural water quality). Further, relief is provided for sites located within 500 metres of a marine and estuarine foreshore with natural chloride and sodium concentrations greater than the drinking water standards. If not meeting these requirements, drinking water exemptions can be sought for these sites under Section 9.0 of the Protocol – Requesting a Director's determination of water use.
3.2.2	Aquifer natural water quality	The USEPA regulated total dissolved solids (TDS) in drinking water as a secondary contaminant meaning that the concerns relate to aesthetic quality of water rather than	See response above.

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		health concerns. Health Canada, the USEPA, the World Health Organization and other international jurisdictions have established an aesthetic objective of 500 mg/L for TDS in drinking water. In the absence of Na as a PCOC, perhaps the Na standard should be the indicator and not TDS? Note that groundwater extraction can cause salt water intrusion and affect groundwater quality near the extraction wells. I suggest using the CDWG as a basis, particularly for Na since Cl can cling to other cations. I suggest that the criteria be (1) 200 mg/L Na ion, and (2) proximity to a marine water body and (3) an alternative drinking water source exists. A two-tiered rule would have a better chance for success, where the lower standard would be used within 100m of a marine environment.	
3.2.2	Aquifer natural water quality	*"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. <u>If groundwater in tidally influenced fill and foreshore contain >4000 mg/L TDS, and/or >250 mg/L chloride and /or >200 mg/L sodium, current and future drinking water use does not apply to these geological units."</u>* Could this exemption be further expanded to exclude drinking water use in areas that are tidally influenced? Suggested additional sentence as shown.	See response above.
3.2.2	Aquifer natural water quality	Is there a reference for 4,000 mg/L threshold for TDS? This seems highly conservative given that Health Canada and the EPA both use 500 mg/L as a threshold for drinking water suitability?	See response above.
3.2.2	Aquifer natural water quality	Given the allowance for geological units within and below former filled marine/estuarine foreshore, could a salinity criterion be provided instead of saying "elevated". In TG15, the MoE defines marine/estuarine water as having a salinity of 1.5 mg/L or greater.	See response above.
3.2.2	Aquifer	*Saturated geological units containing naturally occurring*	Given the large difference in size of contaminated sites and the

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	natural water quality	*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.* We request more detail on the TDS specification of >4000 mg/L being unsuitable quality for drinking water supply. This should not be the average TDS across the site. If even one well has TDS values >4000 mg/L at the site, then current and future drinking water use should not apply to the aquifer that this well is screened in.	potential large variation found in TDS values across a site, the ministry relies on the judgement of the qualified professional to evaluate how many wells are required to show the natural water quality of a site is considered unsuitable. Note that it is possible to have different water uses apply to different sections of a site.
4.1	IW/LW use	Suggest that for ALR land where groundwater or surface water is not being used for IW or LW purposes, current IW or LW standards do not apply; is this interpretation correct? If not, please revise to clarify the guidance	Yes, this interpretation is correct. IW/LW use only apply where water at or nearby a site is currently used for IW/LW. Protocol 21 is drafted with consideration of non-domestic IW and LW uses (i.e., hobby farm or commercial). This is because, except in limited circumstances, the DW standards are broadly protective of other uses. Based on site specific circumstances, the director could determine the standards for IW and LW apply based on future uses under 12(5) of the Regulation.
4.2	IW/LW use	As per the regulation, the definition of agricultural land use is as follows: "the use of land for the primary purpose of producing agricultural products for human or animal consumption including, without limitation, livestock raising operations, croplands, orchards, pastures, greenhouses, plant nurseries and farms". The definition of irrigation water use is: "the use of water for the purpose of producing hay, forage crops, pasture, cereal crops, vegetables and fruit." I have had sites where risk assessors or other AP reviewers have indicated AL/IW apply because the resident has a garden on their property. Do the definitions in the regulation refer to crop production for commercial use and not domestic residential use?	See response above.
4.2	IW/LW use	- *"have a bulk hydraulic conductivity less than 1 x 10-6 m/s,* - *are unconfined aquifers that are present only*	The requirement to evaluate future IW/LW use has been removed from the final version of Protocol 21. Under previous versions of the protocol, future IW/LW use was evaluated similar to future DW

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		seasonally or have an average saturated thickness of 2 metres or less or are comprised only of imported fill" We suggest splitting the discussion between confined and unconfined aquifers, similar to as was done for drinking water	use. By simplifying the protocol and removing the future IW/LW evaluation, only drinking water use will be applied.
4.2	IW/LW use	*"If groundwater in tidally influenced fill and foreshore contain >4000 mg/L TDS, and/or >250 mg/L chloride and /or >200 mg/L sodium, current and future irrigation or livestock watering use does not apply to these geological units ~~are located within or below filled former marine and estuarine foreshore.~~"* We suggest revising the wording as shown, similar to revision in section 3.2.2	See response above
4.2	IW/LW use	P21 also indicates that future IW/LW use can be ruled out on the basis of TDS (>4000 mg/L) or groundwater flows through muskeg. I guess this makes sense for livestock, but why for irrigation? This step does not appear on the appended flow chart.	See response above.
5.0	Aquatic life water use	Does "*aquatic receiving environment*" include wetlands or muskeg or bog etc. where aquatic life lives? If there are no mapable surface water bodies within 500 m of my site but a mapped wetland or muskeg or bog etc. area is within 100 m of my site and I have not demonstrated that gw at my site does not discharge into these areas, do the AW standards apply to my site?	Procedure 8 defines "aquatic receiving environment" as any surface water, watercourse, wetland, sediment or porewater containing aquatic life. The ministry relies on the judgement of the qualified professional to ensure that contaminant sources are not impacting any aquatic receiving environments at or near a site.
5.0	Aquatic life water use	*"When the groundwater flow direction is known, an aquatic receiving environment can be eliminated as a receptor if it is 500 metres downgradient or cross-gradient – or 100 metres upgradient.~~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~~	The ministry relies on the judgment of the qualified professional to demonstrate that there is no potential for a contaminant plume to migrate within 500 m surrounding the surface water body containing aquatic life. Methods used will inherently depend on the chemical properties of the contaminant of concern (i.e. attenuation), the size of the source, the distance of the site to the 500 m zone, hydrogeology of the site, preferential pathways etc. Compliance may be demonstrated by installing groundwater monitoring wells downgradient of the source or by using contaminant transport equations (such as those listed in Protocol 13 "Screening Level Risk Assessment") to show that groundwater

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		~~*that are conveyed along preferential flow pathways such as buried creek channels or underground utility corridors*~~*."* Recommend that the broad reaching wording as is in place currently be replaced with wording similar to DW "When the groundwater flow direction is known, an aquatic receiving environment can be eliminated as a receptor if it is 500 metres downgradient or cross-gradient – or 100 metres upgradient." We suggest that this sentence be deleted as the reference to preferential flow confuses the matter. The basic principle is that if >AW is present it must be further than 500 m, and be stable at a minimum or shown to not have a potential to migrate to within 500 m at >AW. That potential is unrelated to preferential pathways. Contaminant plumes are not significantly more likely to be non-stable in preferential pathways than they are in adjacent soils.	contaminants will sufficiently attenuate prior to the 500 m zone. If conducting transport assessment, a steady-state solution form should be used, which may be complemented with transient analysis if reasonable or warranted.
6.0	Bedrock	Could the Ministry provide a reference for what it defines as bedrock?	The advice of a qualified professional geologist should be obtained to plan and conduct a bedrock aquifer investigation. The paper "Fractured Bedrock Field Methods and Analytical Tools, Volumes I and II" published by the Science Advisory Board for Contaminated Sites in British Columbia (http://www.sabcs.chem.uvic.ca/) provides detailed guidance and presents helpful case studies.
6.0 3.2.1	Bedrock aquifers	For example, how deep would we need to drill to show that 1.3 L/min is not feasible? What if there is minimal groundwater present 1 m into bedrock indicating low yield but not enough water for sampling?	See response above.
6.0	Bedrock aquifers	P21 states that DW (and IW/LW) standards apply to bedrock for current use if there are any bedrock wells located ***nearby*** a site. It does not specify a distance from Site	The text in Protocol 21 has been modified to clarify the assessment of bedrock aquifers for current drinking water, irrigation or livestock water use.
6.0	Bedrock aquifers	The web link to BC Water Resource atlas is no longer valid	The link has been updated.
6.0	Bedrock aquifers	Future use of bedrock aquifer applies if aquifer is mapped (BC Water Resource Atlas). The bedrock aquifer must be assessed if DW/IW/LW (whatever applies) contamination extends to bedrock surface. What does assessed mean? Figure 4 indicates hydraulic properties and water quality but	These questions are based on the old bedrock flowchart. The bedrock flowchart in draft P21 Figure 4 was incorrect and has been revised to clarify the requirements. The flowchart must be used in conjunction with the narrative contained within P21.

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		what if yield isn't sufficient but groundwater exceedances are present in bedrock? Can yield be assessed first to determine that DW use doesn't apply without groundwater sampling?	
6.0	Bedrock aquifers	*"Future drinking water use applies to bedrock aquifers mapped in the BC Water Resource Atlas".* 1) The criteria for aquifers to be included in the BC Water Resource Atlas are unclear. 2) Have aquifers included in the BC WRA been determined to be viable?	The map based Aquifer Classification System was developed to identify, map and categorize aquifers using data from the provincial water well database (i.e. based on past or current use). The objective of this aquifer classification system is to inventory and prioritize aquifers for planning, management and protection of the Province's ground water resource.
6.0	Bedrock	With respect to the 500 m radial distance for bedrock aquifer testing, is this data easily obtainable?	Different mapping initiatives are available to assist stakeholders when evaluating water use at a contaminated site. These include CSAPs "Contaminated Site Legal Instrument Mapping" and the ministry's Borehole Log Database found on IMapBC which includes hydraulic conductivity data. Specific reports can be obtained through the ministry Site Information Request process.
6.0	Bedrock	Regarding "in-situ field investigations conducted at the site or within a 500 m radial distance of the site property boundary" - I would suggest removing this 500 m radial distance rule and rather rely only on site-specific hydraulic testing results. This is because flow within most bedrock systems is controlled by secondary porosity features such as fractures. Fracture density, connectivity and transmissivity has been shown in scientific literature to vary by up to 10 orders of magnitude over very short distances (i.e. few metres). As such, we cannot assume that testing done 500 m away will yield similar results as those that would be conducted on the site. For example, on mining projects in BC, we have to assess the permeability of fault zones and how their K varies compared to the rest of the bedrock K in the same unit, and almost always there are several order magnitude differences in K estimates. The MOE regulators require this assessment for Environmental Impact submissions, therefore at the very least we should conduct site specific measurements at contaminated sites and not rely on data collected 500 m away.	The requirement for site-specific hydraulic data for bedrock units can often be costly and time consuming. The option of using nearby data is only available on sites where the bedrock is not currently used for drinking water use or where the bedrock is not mapped on the BC Water Resource Atlas. Thus the option of using nearby data is mainly used to show that the bedrock unit does not qualify as a viable aquifer (yield < 1.3 L/min). When utilizing nearby data it must be shown that the bedrock is of the same geological formation.
6.0	1st paragraph regarding	The standards should apply to geological units above the natural confining barrier and the bottom 5 m only of the	A natural confining barrier is the part of a geological unit that protects an underlying aquifer from shallow groundwater

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	confining barrier	natural confining barrier to be consistent with information identified in TG6	contamination. The standards of the underlying aquifer apply to the part of the geological unit that constitutes the natural confining barrier, i.e. the bottom 5 m (Type A) or the equivalent thickness satisfying the ratio of thickness to hydraulic conductivity greater than 5 x 10-7 m/s (Type B). Further language has been added to provide clarity and the Q&As updated.
6.0	Bedrock aquifers	Assume DW+ gw extends to bedrock at your site where MoE has not mapped presence of a bedrock aquifer and where no nearby bedrock or other wells are present. This conditions triggers a requirement to assess bedrock conditions: does shallow bedrock qualify as a natural confining barrier or are bedrock aquifers present. If bedrock qualifies as a natural confining barrier, site owners may seek a site-specific determination of water use under Section 9.0; presumably the determination could specify that required use of DW standards is not triggered by presence of DW+ groundwater at the bedrock surface. Q1) If investigated bedrock does not qualify as a natural confining barrier but does not qualify as a bedrock aquifer what are the implications? Q2) If bedrock qualifies as a bedrock aquifer then DW standards apply to the bedrock aquifer and, presumably, the DW standards applying to bedrock will or will not trigger a requirement to apply the DW standards to overlying geological formations as outlined in the above para for current wells in a bedrock aquifer. If this is possible, presumably via issuance of a water use determination, this should be clearly identified.	The flowchart for bedrock has been updated to provide further clarity. A1) If the bedrock does not qualify as a confining barrier, but the bedrock is not mapped and has yield less than 1.3 L/min, then DW would not apply to the bedrock. A director's determination does not need to be made. A2) If yield or the BC Water Resource Atlas indicates the presence of an aquifer, one does not need to seek a determination of water use, since DW automatically applies. Where bedrock investigations indicate that the bedrock unit 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.
6.0	Bedrock aquifers	It seems that a Water Use Determination would be required for <u>all</u> bedrock sites, regardless if there is no underlying mapped aquifer? Can it be clearly stated when a determination is NOT required for a bedrock site if a water use can be ruled out?	The flowchart for bedrock has been updated to provide further clarity. A Director's Determination for bedrock is only required if the applicant wants to prove that a bedrock unit acts a natural confining barrier protecting a more permeable bedrock unit below (typically bedrock mapped on the BC Water Resource Atlas). If the bedrock is not mapped and the yield is < 1.3 L/min, then DW would not apply to the bedrock. A Director's Determination would not be required.

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6.0	Bedrock aquifers	Regarding "The assessment of bedrock aquifers for 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". I would suggest the bedrock be treated the same as unconsolidated deposits, in that an aquitard as defined in the protocol should be shown to present at sufficient thickness and bottom 5 m clean to protect a potential bedrock aquifer. This is because there are several bedrock aquifers in BC that are comprised of permeable sandstone or fractured crystalline rock that are actually more permeable than the unconsolidated deposits above them. So just because the contamination has not reached the bedrock, we shouldn't exclude their investigation to confirm whether or not they are aquifers.	Protocol 21 treats bedrock aquifers slightly different than unconsolidated media due the high cost of bedrock investigations. Bedrock aquifers that are currently used for drinking water or are mapped on BC Water Resource Atlas have drinking water use apply. Note, the requirement for evaluate future IW/LW use has been removed from the protocol. Aquifers are only evaluated for future DW use.
7.0	Natural confining barriers	Add "natural confining barrier" to procedure 8 and reference this section	The definition of "Natural confining barrier" is found in the latest version of Procedure 8.
7.0	Natural confining barriers	*"between 1 x 10-7 m/s and 1 x 10-6 m/s where the ratio of unit thickness to hydraulic conductivity is greater than 5 x 107 (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 x 107, with no potential for future contamination."* The following text needs to be better defined: what is "reasonable uniform", what is "continuous", what is :free of contamination". We offer the following upgrade: "are free of contamination across the bottom 5 metres, excluding wide area contamination, background contamination, and/or beneficial use contamination…."	The ministry relies on the professional judgement of the qualified professional to determine reasonably uniform, continuous and free of contamination. Area wide contamination and background contamination is addressed within other ministry guidance and protocol documents.
7.0	Natural confining barrier	"*Natural confining barriers are reasonably uniform in composition and are unfractured*".	The ministry relies on the professional judgement of the qualified professional to determine whether the barrier is uniform and unfractured.

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		This would exclude marine clays, would it not, based on bioturbation criteria? Separate bullet excluding marine clays, if applicable?	
7.0	Natural confining barrier	The ratio of unit thickness to hydraulic conductivity given in the protocol is 5 x 10^7 with no units. It seems like it should have a unit of seconds.	Correction has been made.
7.0	Natural confining Barrier	Suggest that a "geometric mean" of hydraulic conductivity measurements be permitted for 6 or more tests conducted within aquitards, as permitted for aquifers in Section 3.2.1. The leading text books on hydrogeology always use a geometric mean to average K values in unconsolidated deposits regardless of whether they are fine or coarse grained (i.e. aquitard versus aquifer).	The supporting document for Technical Guidance 8 “Groundwater Investigation in Site Assessment” prepared by Golder in June 2010, provides guidance for using the 90th percentile (if more than five tests) or the highest K value (if less than 6 tests). In a natural confining barrier, groundwater will preferentially flow in the areas with highest hydraulic conductivity, thus using the 90th percentile is considered appropriate. When evaluating if an aquifer has sufficient yield to produce 1.3 L/min, it is the overall aquifer properties that are important, thus using the geometric mean is considered appropriate.
7.0	Natural confining barriers	*“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”* This is not consistent with what is presented in Section 3.2.1, where the geometric mean (not the 90th percentile) was used. The criteria used in both sections need to be the same. It is recommended that the geometric mean criteria from Section 3.2.1 be used.	See response above.
7.0	Natural confining barriers	P21 has classified two types of confining layers. Types A and B. Type A is less than 10-7 m/s. Type B can be between 10-6 m/s and 10-7 m/s, however ratio between unit thickness and K must be greater than 5*10 7 (50,000,000). The free contamination bullet should be made clearer to indicate that the unit is “free of contamination across the bottom 5 metres (*Type A*), or the thickness satisfying the ratio…..(*Type B*)…	Correction has been made.
7.0	Natural confining	*“are free of contamination across the bottom 5 metres, or the thickness satisfying the ratio of 5 x 107, ~~with no~~*	The text has been modified to “stable or shrinking site contamination”.

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	barriers	~~*potential for future contamination.*~~*"* This bullet is far too onerous and restrictive, and differs from the practices of other regulators (which require determination of the lowest depth of contamination above the applicable standards in soil at the site, then start the five metre confining layer at that point). Concerned that CSAP APs will take a conservative approach and never agree that there is "no potential for future contamination".	
7.0	Natural confining barriers	Guidance needs to be provided for both Type A and Type B as to where the soil and groundwater samples are to be taken from. At the top of the barrier (we recommend this for soil)? Five metres into the barrier (we recommend this for groundwater)? Guidance needs to be provided.	The required sampling depth for soil and groundwater will be site specific. Data needs to confirm at least 5 m natural confining barrier (or equivalent thickness) below the deepest known level of contamination.
7.0	Natural confining barriers	***"Type B*** *Substance concentrations in soil and water are:* - *less than or equal to the applicable regulatory standards".* We suggest this statement lacks clarity. It is not clear what the applicable regulatory standard is.	The applicable regulatory standards will depend on the water use of the underlying deeper aquifer (DW, IW, LW or AW standards).
7.0	Natural confining barriers	Type A and B confining units also have different rules with respect to what standards apply to confirm that they are not contaminated. Type B is same as Site standards. For type A, one only needs to confirm "clean" soil or where soil standards don't exist confirm "clean" groundwater with respect to the contaminant of concern. It isn't clear if this is the same for Type B or if both soil and groundwater have to be "clean" according to DW/IW and/or LW uses in order to rule these uses out	The text has been modified to provide further clarity.
7.0	Natural confining barriers	In the case where bedrock would act like a natural confining barrier, why is it necessary to seek a site-specific determination	Due to the prevalence of bedrock fracturing, bedrock is not automatically considered a natural confining barrier under Protocol 21. If site owners can provide sufficient documentation that a part of the bedrock unit acts as natural confining barrier protecting a deeper more permeable unit, an application for a Director's Determination can be made.
7.0	Natural confining	It isn't clear when a determination for water use is required for bedrock sites. Bedrock cannot be considered a confining	The requirements to show that a bedrock unit acts as a natural confining barrier will be very site specific and the advice of a

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	barriers in bedrock	unit under P21 unless an bedrock investigation indicates that bedrock is a confining barrier. What type of bedrock investigation would satisfy the MOE that bedrock is competent and provides a natural barrier? I would imagine that this would be fairly intensive and expensive. Further to this, P21 states that "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." Is this in reference to sites with underlying mapped aquifers only?	qualified professional should be obtained to plan and conduct the bedrock investigations. Typically confining barrier applications are for sites that have mapped bedrock aquifers, however the ministry stresses that only the director can make this bedrock confining barrier determination regardless of whether there are underlying mapped aquifers present.
7.0	Natural confining barriers in bedrock	Replace "unit" by "barrier"	Correction has been made.
8.0	Applicable water standards	*"Where multiple water uses apply at a site, the presence of contamination must be determined on the basis of <u>using the most stringent</u> of all of the applicable numerical water standards*." Suggest that wording be revised as shown.	Correction has been made.
9.0	Director's Determination	*Such requests must be accompanied by a completed Contaminated Sites Services Application form and a supporting technical report prepared by a qualified professional.* This statement has potential to be misinterpreted to mean Approved Professional. Canadian Fuels wouldn't support these applications being limited to being submitted by Approved Professionals.	As defined in Procedure 8, a qualified professional means a person who (a) is registered in British Columbia with his or her appropriate professional association, acts under that professional association's code of ethics, and is subject to disciplinary action by that professional association, and (b) through suitable education, experience, accreditation and knowledge may be reasonably relied on to provide advice within his or her area of expertise.
9.0	Director's Determination	Clarify if the application must be accompanied by a completed Summary of Site Condition	A Summary of Site Condition is not required for a Director's Determination of Water Use.
Figure 1	DW Flowchart	Regarding the bubble that reads "*Is the aquifer comprised only of imported fill or present only seasonally or has an average saturated thickness of < 2m*": Can you please confirm whether the < 2m is valid for	No, the <2m is only valid for unconfined aquifers. The flowchart has been updated to provide further clarity.

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		confined aquifers.	
Figure 1	DW Flowchart	*"Evaluate all confined and unconfined aquifers following the flowcharts below. Evaluate deepest aquifer first."* This needs clarification as it could be interpreted to mean further deep aquifers require testing beyond what is required for us to achieve delineation in a DSI. For example, a shallow 0 to 10 m aquifer where contamination is found and vertically delineated in the top 6 m. Let's say its underlain by clay and below that is another aquifer we have no reason to assess. This could be misinterpreted to mean it requires assessment. We think you mean 'evaluate the deepest aquifer explored in your DSI first".	The ministry relies on the judgment of the qualified professional to evaluate the potential for a deeper confining barrier or suitable DW aquifers. Where information is unavailable or inadequate to demonstrate an absence of drinking water aquifers below a site, drinking water aquifers are considered to exist. The flowcharts must be used in conjunction with the narrative contained within P21.
Figure 3	AW Flowchart	*"Does contamination have the potential to migrate to within 500 m of a surface water body containing aquatic life?"* Clarify that 'contamination' refers to groundwater concentrations >AW in this box.	The flowchart has been modified to provide further clarity.
Figure 4	Bedrock Flowchart	*"Has contamination reached the bedrock?"* What is the definition of contamination in this context? GW? Soil (bedrock is considered soil in CSR and is tested on some projects) and GW? Against what standards (i.e. DW and/or GW standards)?	The flowchart has been modified to provide further clarity. The flowchart must be used in conjunction with the narrative contained within P21.
Appendix 1	Weight-of-Evidence	Recommendation: The proposed testing regime in draft Protocol 21 should be workable in urban areas by: - Not requiring proponents to identify multiple reasons that drinking water standards cannot be met. In Appendix One of draft Protocol 21, it is not clear what is meant by the following statement: "*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."*	The requirement to demonstrate multiple site-specific conditions is required for applications seeking a site-specific determination of water use from the Director under Section 9.0 and Appendix 1 "Director's Decision Framework for Site-Specific Determination of Water Use". Protocol 21 establishes criteria for the determination of water use across the province pursuant to CSR, Section 12(5). A Director's determination of water use based on alternative considerations must be supported by defensible and documented rationale that is consistent with factors outlined in Section 12(5). The Director's Decision Framework is intended to assist land owners seeking such decisions by first allowing a multiple-lines of evidence approach and second, listing examples of valid lines of evidence that may be forwarded as supporting rationale. In general, the more lines of evidence that apply, the stronger the

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		If a proponent finds that one issue makes the use of the groundwater on a site unsuitable for drinking, we do not understand why further analysis would be needed. Even if no other issues are discovered, the water is still not suitable for drinking.	rationale for a determination of no drinking water use. This additional flexibility of Protocol 21 is supported by Ministry staff available to advise proponents and their environmental consultants regarding the circumstances of their sites.
Appendix 1	Weight-of-Evidence	Suggest additional guidance on water quality guidance considered in a multiplelines-of-evidence approach: - Water quality exceedances reflect aesthetic factors and not human health risk factors. For example, this condition may be considered where there is excess of sulphate in groundwater.	Protocol 21 includes criteria for determining the applicable groundwater standards on contaminated sites. In areas, where natural groundwater quality exceeds the applicable standard, a background determination can be obtained as described in Protocol 9 “Determining Background Groundwater Quality”. Please note, that the proposed Omnibus CSR Standard Update includes replacing the majority of the aesthetic based drinking water standards with toxicological derived standards.
Appendix 1	Weight-of-Evidence	Include the following argument in the weight-of-evidence approach: Remediation to achieve water quality guidelines or site specific objectives is to maximum extent practicable, taking into account the factors described in section 56(1) of EMA including (a) potential for adverse effects (b) technical feasibility (c) remediation costs	Protocol 21 sets criteria for determining the applicable groundwater standards on contaminated sites. Relevant provisions in the regulation include sections 12(2), (4) and (5). Full delineation of contamination to the applicable standards is a prerequisite for selecting appropriate remediation options for a contaminated site. Draft Protocol 5 specifies criteria for setting remediation requirements at contaminated sites as described in section 56(1). These factors are not considered valid arguments when determining the applicable standards.