

The Technical Advisory Committee (TAC) for the Elk Valley Water Quality Plan (the “Plan”) held their 6th meeting on June 9-11, 2014. This document is a record of the technical advice received after this meeting, and is Appendix B to the Meeting Notes.

The TAC process is structured around a review of work packages submitted to the TAC in advance of their meetings by Teck. These work packages relate to the analytical process that Teck is undertaking to inform decisions around the selection of water quality targets, management scenarios, and any additional monitoring and studies that will be included in the Plan. The advice in this table relates primarily to work packages that were reviewed and discussed at TAC Meeting #6.

Ecological Effects Assessment, Targets, Water Quality Model, Implementation Plan

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Review of: <i>Evaluation of the Effects of Selenium on Early Lifestage Development of Mountain Whitefish from the Elk Valley, BC (Nautilus Environmental 2012)</i>	6B-1	<p>Priority for Plan Implementation:</p> <p>The study concluded that the threshold for adverse effects for Mountain Whitefish (MWF) exceeds 32 µg/g dw selenium (Se) in the eggs; however, there is a lot of uncertainty associated with this conclusion because the study did not include a control group.</p> <p>To address this uncertainty, we recommend that this study be repeated in the future with appropriate controls or, alternatively, a laboratory feeding (with a control group) could be conducted.</p>	<p>In this study the effect of Se on survival and fertilization rates was very difficult to determine because:</p> <ul style="list-style-type: none"> ○ Fungal contamination killed a portion of eggs in 2010; however, without a control group, there was no mechanism to determine which deaths were due to the fungus and which (if any) were due to Se. ○ Collection of unripe eggs in 2011 resulted in much lower fertilization rates; however, without a control group, it is difficult to state with certainty the effect is due to egg maturity and not Se.
Review of Updated Appendix D (Se Report) (received May 14)	6B -2	<p>Priority for Plan Submission:</p> <p>We recommend a more consistent application of the decision criteria be applied to the literature.</p>	<p>There are inconsistencies in the application of the decision criteria related to including or excluding literature in the development of Se benchmarks.</p> <ul style="list-style-type: none"> ○ some studies that re-analyzed data from other studies were considered primary (Adams et al. (2003)), whereas, other papers were excluded (Skorupa and Ohlendorf (1991), Heinz (1996), US DOI (1998), Skorupa (1999), Seiler et al. (2003), Wayland et al. (2007), Beckon et al. (2008), and Ohlendorf and Heinz (2011)). ○ DeForest and Adams (2011) was excluded but DeForest et al (1999) was considered primary.

Summary Table

Category	#	Description of “Technical Advice” from Mtg	Rationale
Review of Updated Appendix D (Se Report) (received May 14)	6B -3	<p>Priority for Plan Submission:</p> <p>We recommend that rationale be provided for the % moisture used by Golder to convert ovary wet weight to dry weight (e.g. Bryson et al. (1985) - 80-81% moisture; Hermanutz et al. (1992) – 85% moisture).</p>	<p>In several instances Golder has chosen high % moisture content to convert ovary wet weight to dry weight (e.g. Bryson et al. (1985) - 80-81% moisture; Hermanutz et al. (1992) – 85% moisture). The USEPA (2004) adopted 76% as the moisture content in bluegill egg/ovary which was an average of those used by Gillespie and Baumann (1986) and Nakamoto and Hassler (1992), to convert egg/ovary bluegill data reported by Hermanutz et al. (1996).</p>
Ecological Effects Assessment – Lake Koocanusa - Selenium	6B - 4	<p>It is recommended that the science and rationale for the proposed selenium target in Lake Koocanusa be further elaborated on in the Elk Valley Water Quality Plan (EVWQP). Specifically, it should be discussed how the 2 µg/L water column target will result in compliance with the B.C. or ovary fish tissue guideline. The linkage between these two numbers has not yet been defined. In particular, Draft Chapter 7, Section 7.2.2.2 states “Because bioaccumulation rates and toxicity vary widely, the BC Ministry of Environment (MOE) recommends site specific assessments of selenium bioaccumulation and toxicity.” Why has this approach not been taken for Lake Koocanusa?</p>	<p>Existing data shows that at least one fish species (mean of longnose sucker) in Lake Koocanusa currently exceeds the B.C. fish tissue selenium of 4 µg/g dw (U.S. data) at an average lake concentration of 1.13 µg/L. It is likely that with increasing concentrations up to 2 µg/L (as shown in TAC meeting 6), the fish tissue concentrations (and ovaries) will also continue to increase. It is unclear why one would conclude that 2 µg/L will be protective in a stratified potentially poorly oxygenated system, without additional scientific basis (i.e., site-specific assessment such as recommended by MOE). Further explanation should be provided in the EVWQP as to why such an approach was taken for the entire Elk Valley, but not for Lake Koocanusa.</p>
Ecological Effects Assessment – Lake Koocanusa - Nitrate	6B - 5	<p>Recommend adding language in the Plan to acknowledge the potential for eutrophication impacts, monitor for impacts, and set targets to protect from impacts.</p>	<p>There is no discussion in the draft plan of potential eutrophication issues related to elevated nitrogen (and potentially phosphorus) and how this can enhance bioaccumulation through increased primary productivity and perhaps reduced oxygen content at the sediment-water interface of stratified systems. Furthermore, the nitrate target of 3 mg/L is an order of magnitude higher than the Montana Department of Environmental Quality considers adequate to protect streams from eutrophication related impacts, and may become troubling for existing NPDES permit holders.</p>

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Targets – Lake Koocanusa - Selenium	6B -6	Teck needs to explain how a selenium target of 2 µg/L in Lake Koocanusa is compliant with the Order requirement to, “immediately begin to stabilize water quality concentrations of selenium, cadmium, nitrate, and sulphate, and the rate of formation of calcite in the designated area”.	Average existing selenium concentrations in Lake Koocanusa are approximately 1.13 µg/L. The selenium target set in the Order is 2 µg/L. Information presented at the TAC 6 meeting indicates that the 2 µg/L target is a “pollute up to” level. In other words, Teck is not required to “stabilize and reduce” concentrations in Lake Koocanusa, but rather can increase concentrations up to 2 µg/L. The U.S. and MT Governments do not agree with this approach, and suggest instead that Teck set an interim “hold the line” selenium target in the lake until further scientific evidence can be developed to define appropriate selenium targets that are protective of aquatic life and birds throughout the watershed including Lake Koocanusa (such as is done throughout the rest of the Elk Valley).
Targets – Lake Koocanusa - Selenium	6B -7	It should be documented in EVWQP, at a minimum in both the executive summary as well as Chapter 2, that there has not been scientific consensus amongst members of the TAC about the proposed target for Lake Koocanusa (2 µg/L Se).	The draft chapters in the plan do not adequately capture the lack of TAC consensus regarding the Lake Koocanusa selenium and nitrate targets. The draft Plan suggests that there was TAC agreement on this topic; however, this is not factually based. Note that other TAC disagreements (Section 7.2.2.3) are mentioned in the draft plan, and this too should be adequately documented.
Water Quality Planning Model	6B -8	<p>Please provide additional information in the EVWQP regarding model bias and its impacts to predicted concentrations in Lake Koocanusa. In particular, it is unclear whether the model bias correction factor was based on all years simulated in the model for Order Station ER5, or only the bias for a certain period of record. It is most representative to use the average monthly bias calculated over the entire simulation period.</p> <p>Additionally, it is important to differentiate between concentration bias, and loading bias, which are flow dependent. For example, the model has virtually no concentration bias during the period of highest loading (May-September, relative bias ~1), whereas during low loading but higher concentration (winter months), the model is</p>	Draft Chapter 7 (Targets) states that the selenium watershed model has a positive bias (i.e., over-predicts concentrations) in the Elk River and subsequently Lake Koocanusa by ~ 1 µg/L. Teck has performed a monthly bias correction to make the predictions from the model more realistic. While it is always preferred to calibrate the model to minimize bias (to the extent possible), it appears as if this was not possible in this instance. As a consequence, further discussion should be included about the net cause of the bias (i.e., was it related to poor flow representation during the winter period, inadequacies in estimation of monthly geochemical terms in the model, etc.) and if there are any foreseeable problems with the use of a bias

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
		highly biased (bias ~1.5). A narrative description on how these interactions influence the Lake Koocanusa mixing calculation, and associated water-quality, should be included.	correction factor in the future (as opposed to recalibration of the model or better representation of its processes).
Water Quality Planning Model	6B -9	Please provide a detailed explanation of how the Lake Koocanusa selenium and nitrate concentrations were generated in the modeling (i.e., methods). We would also like a time series of modeled loads, flows, and concentrations under both the (1) unmitigated and (2) proposed future clean water diversion and active water treatment scenarios, ensuring that all future mine expansions are in fact included in the modeling results. Also, please explicitly state the assumptions used in the active water treatment and diversion scenario so that load reductions can be verified (i.e., how much mass or potential mass are each of these practices removing from the system). The following results should be provided: monthly flows, loadings, and concentration at the Elk River mouth (ER5), along with whatever other assumptions were made about the state of the reservoir or inflows to it, and associated reductions from management options.	It is unclear how Teck is generating the modeled selenium and nitrate concentrations in Lake Koocanusa. To comment on the scientific validity of the approach, the TAC should be provided with this information. At a minimum, methods and assumptions used in this approach need to be described. Furthermore, it would be useful to have a time-series of the modeling results so that we can verify them against our own model estimates. Lastly, it must be described how Teck is accounting for the loads from the Kootenay River and how the mixing calculations are being completed. For example, what assumptions are being made about the inflow concentration, seasonal variability, etc.?
Implementation Plan	6B -10	Teck needs to describe in the Plan how the modeled increasing trends in nitrate and selenium (which are predicted to occur for several years going forward), and modeled exceedances of the proposed Order Station targets, are compliant with the Order.	Draft Chapter 7 (Targets), and presentations distributed by Teck, show that modeled selenium and nitrate concentrations will continue to increase over the next 1-5 years (prior to new treatment plants coming online) at several stations in the Elk Valley and Lake Koocanusa. Sometimes, these predicted increases result in concentrations exceeding proposed targets at Order stations in the Elk Valley. This is contrary to the order which states that Teck must “immediately begin to stabilize water quality concentrations of selenium, cadmium, nitrate, and sulphate, and the rate of formation of calcite in the designated area”. Also, this is in direct violation of the currently proposed targets (where modeled results show this to be the case).

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Implementation Plan	6B -11	Similar to the information on water treatment, the Initial Implementation Plan should include more information on the timing and volumes of water that will be diverted and managed.	All aspects of the mitigation that form the basis of the initial implementation plan need to be fully described (not just water treatment).
Implementation Plan	6B -12	The WQP should make specific reference to water quality (main stems and tributaries) and mitigation associated with future mining areas (e.g. CMO2 and EVO Baldy Ridge).	To support future regulatory decision making in the watershed, the WQP should include information on future mining areas and/or include discussion on how these will be assessed.
Management Scenarios	6B -13	If additional mining or water management scenarios have been added to the EVWQP since the beginning of the planning process, these should be fully described (e.g. EVO pit dewatering).	Transparency of all scenario inputs to the EVWQP is important and will provide clarity for the implementation phase.

Monitoring, Synthesis Report, Mixture Toxicity Testing

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Monitoring	6B -14	Include a section that discusses other monitoring that is ongoing or will be undertaken in the valley that will be utilized to inform adaptive management and future updates to the EVWQP.	The monitoring chapter is focussed on monitoring for ecotoxicology, aquatic effects, human health and groundwater. A section should be added that includes the other types of monitoring that is/will be ongoing in the watershed (e.g. water quality and hydrology monitoring to update geochemical source term development and refinement of water quality planning tool, calcite monitoring, reclamation monitoring, etc.)
Monitoring (Draft Chapter 9) General	6B -15	Priority for Plan Submission: Recommend that hypotheses/questions are identified and related to measurement endpoints.	Measurement end-points need to be linked to hypotheses/questions so that the efficacy of the endpoint can be evaluated.
Monitoring (Draft Chapter 9) Calcite	6B -16	Priority for Plan Submission: Recommend that the calcite monitoring program describe how new areas that have been affected by calcite deposition will be detected.	Need a method to determine if the area impacted by calcite deposition is increasing.
Monitoring (Draft Chapter 9) Lake Kookanusa	6B -17	Priority for Plan Implementation: MOE recommends adding continued sampling of Lake Kookanusa to the Regional Aquatic Effects Monitoring Program (RAEMP) for at least 3 consecutive years.	A longer period of baseline data is necessary to evaluate current conditions.
Monitoring (Draft Chapter 9) Periphyton	6B -18	Priority for Plan Implementation: MOE recommends that periphyton monitoring be conducted during peak biomass, as opposed to the end of season.	Unless monthly biomass measurements have been assessed and it was found that September is the time of peak biomass, I would infer that it is more likely to be in early- to mid-August in the Elk River watershed.
Monitoring (Draft Chapter 9) Sediment	6B -19	Priority for Plan Implementation: MOE recommends that the sediment monitoring program includes a long-term evaluation of mine-related contaminant trends throughout the Elk River watershed.	Historic sediment data from the Elk Valley is sparse, and insufficient data (i.e., one year of good quality data) are currently available to evaluate trends. Sediment sampling should be focussed on collecting data to evaluate trends rather than only focussing on areas with demonstrated toxicity and contaminants > Sediment Quality Guidelines (SQGs).

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Draft Aquatic Environment Synthesis Report 2014	6B -20	The Water Quality Index (WQI) index, as implemented in the assessment should be re-named to distinguish this application as an unintended variant of the Canadian Council of Ministers of the Environment (CCME) version.	Several comments: 1) The use of site-specific guidelines intended for application in the CCME WQI are background levels for variables which there is either 1) no existing guideline or where 2) the background levels exceed an existing approved guideline. 2) The benchmark values used in the assessment are neither “background” nor protective of sensitive water uses. Since the most sensitive water use in the upper Fording River is apparently not aquatic life, then other uses, such as drinking should be used as the benchmark. 3) CCME guidance suggests a minimum of 10 variables in the index calculation, while only the 4 order variables were included in the Teck version of the index.
Draft Aquatic Environment Synthesis Report 2014 General Advice	6B -21	Priority for Plan Submission: Recommend that the report include all available data to achieve its stated objectives. Sub-recommendations include: <ul style="list-style-type: none">• Evaluate long-term data to evaluate trends in Constituents of Interest (Cols) over time; and• Include data and interpretation related to 2013 periphyton and fish community studies, amphibian and bird surveys, which is not included in the draft report.	One of the key questions of the AEMP was “How are conditions changing over time?” However, the Synthesis Report provides no information with respect to long term trends for Cols. The report should rely on all data as much as possible to illustrate the changes that have taken place over the past two decades. The assessment should include trends of parameters over the entire period of record, even if they are below guidelines, and include parameters which may not have guidelines (e.g., hardness). In addition, results presented for sediment, periphyton and fish population studies are incomplete and there are no data presented related to amphibian and bird surveys.
Draft Aquatic Environment Synthesis Report 2014 General Advice	6B -22	Priority for Plan Submission: Recommend that Teck conducts a review of the report to ensure that all statements are supported by evidence and that all summary statistics are correct.	Many of the statements made in the report do not reference data in support of the statement. For example, on page 2-12, the report suggests that calcite formations incorporate trace elements such as Cd and Se. The report needs to provide clarity to statements like this and support them with sufficient evidence. Also data tables need to be reviewed for errors. For example, tables A2-1, A2-2, and A2-3 show many 95 th percentile values greater than the maximum value reported for the data set.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Draft Aquatic Environment Synthesis Report 2014 Overall Comment – Sampling Design Descriptions	6B -23	Priority for Plan Submission: Recommend that sampling design descriptions associated with the data presented for water, sediment, and biota be included in the report. This should include study objectives, sampling and analytical methods, # of sites, # of replicates from each site, parameters assessed. This information is key to understanding and interpreting study results.	<p>There are limited details provided, which make the interpretation difficult. For example:</p> <ul style="list-style-type: none"> • Details are needed to evaluate the 2011 and 2013 sediment studies, including objectives, methodology, etc. The studies evaluated in this section used different methods and sampled sediments in different habitats (i.e., lotic vs. lentic sediments), which might make it difficult to compare data. • Clarification is required on the extensive annual monitoring completed between 1999 and 2013 and how methodology, sites, etc. compared with RAEMP. It is not clear when full tissue metals assessment and community composition were assessed.
Draft Aquatic Environment Synthesis Report 2014 Overall Comment – Reference Data	6B -24	Priority for Plan Submission: Recommend providing data for all reference stations so suitability of each station can be evaluated.	<p>Section 3.1.2.3 describes the pooling of reference data from 8 sites across all management units. The data are presented in box and whisker plots with no differentiation between sites within the plot. It is possible that the sites are quite different from one another making the pooling of data inappropriate.</p> <p>Also, reference sites should be located up gradient from all coal mining operations but it is difficult to evaluate this based on the scale of map given in the report and the lack of data. For example, FR_UFR1 and FR_KC4 appear to be within the bounds of the Fording River Operation (Map 3.1-2); LC_DC1 appears to be downstream from the Line Creek Operation and LC_GRCK as tributaries that reach into the Line Creek Operation (Map 3.1-3); and although difficult to tell from the map it appears that GH_BR_F and GH_Wolf are both on streams that have tributaries that reach into the Fording River Operations (Map 3.1-4).</p>
Draft Aquatic Environment Synthesis Report 2014 Overall Comment – Figures	6B -25	Priority for Plan Submission: Recommend that the report includes figures showing contaminant levels in water, sediment and biological tissues to support discussion of spatial and temporal trends. Figures should include error bars, and relevant guidelines and thresholds, where appropriate.	Graphical depiction of data will facilitate interpretation of current conditions, and spatial/temporal trends. The existing approach provides a very high level overview of Cols, but results in omission of key information.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Draft Aquatic Environment Synthesis Report 2014 S 1.2	6B -26	Priority for Plan Submission: Recommend that the report summarize best available data in a conclusion section to answer the key questions posed in section 1.2.	In the introduction, six key questions are listed as the main drivers behind the RAEMP program. However, there is no discussion or summary that brings together the multiple lines of evidence to begin to answer these questions. As with all technical or scientific studies, a conclusion/summary section is necessary that will revisit the initial questions and provide answers where possible supported by the data, and if the questions cannot be addressed, then a modification of the methodology or sampling design should be recommended.
Draft Aquatic Environment Synthesis Report 2014 Section 2.3.2.2	6B -27	Priority for Plan Submission: Recommend that clarification be provided with respect to data availability for zooplankton in the reservoir.	It would appear that data is not available from “the past 10 years”, but rather 1997 – 2007.
Draft Aquatic Environment Synthesis Report 2014 Section 3.1	6B -28	Priority for Plan Submission: Recommend that evidence used to determine the status of Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), Total Suspended Solids (TSS), and turbidity be included in the document.	It is unclear why TOC, DOC, TSS, and turbidity were excluded from the assessment.
Synthesis Report S 3.1.2.4	6B -29	Priority for Plan Submission: Recommend that Teck provide an explanation as to why the Cols identified by Minnow and PLA (2012) were not also identified in this report.	From the information provided it is difficult to tell whether or not it is just a difference in methodologies or if conditions have changed.
Draft Aquatic Environment Synthesis Report 2014 Section 3.1.5	6B -30	Priority for Plan Submission: There is insufficient data for meaningful interpretation of water quality information provided for MU 6. MOE recommends conducting a complete review and analysis on seasonal datasets for multiple years (if available). MOE also recommends all future sampling in Lake Koocanusa to be conducted at least monthly during the ice-free season.	Limited 2013 data is included in this document (and the appendices). As a result, a complete review of seasonal water quality data cannot be conducted at this time. Furthermore, the summary and conclusions made in this document with regards to Lake Koocanusa water quality have not been substantiated.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Draft Aquatic Environment Synthesis Report 2014 Section 3.1.5	6B -31	Priority for Plan Submission: MOE recommends evaluating nitrogen (especially Total Nitrogen (TN) and Nitrate (NO ₃)) as a potential Col in regards to nutrient enrichment, along with phosphorus (an identified Constituent of Potential Concern) in Management Unit (MU) 6.	Changes in nitrogen may lead to community composition changes in algal communities within Lake Koocanusa. Shifts from P-limitation to N-limitation (or co-limitation), can alter cyanobacteria populations and species composition, which in turn could lead to other changes in trophic structure within a lake. Also, while elevated levels (e.g., >500 µg/L) of total nitrogen can be associated with eutrophication, the inorganic forms (e.g., nitrate) are more likely to be taken up directly by algae and should generally, be of more concern. While nitrate is considered a primary Col in other MUs, it is not included within Lake Koocanusa. This is an accurate assessment as far as toxicity is concerned, however, nitrate as a nutrient source and a constituent that may lead to eutrophication is not evaluated.
Draft Aquatic Environment Synthesis Report 2014 Section 3.2 & Appendix B	6B -32	Priority for Plan Submission: Recommend that sediment results be presented based on individual station location (in addition to MU) and the sampling date (i.e., 2011 vs. 2013) should be clear. Data from individual stations should be compared to appropriate SQGs.	Compiling all data based on MU over-simplifies the assessment and makes it difficult to determine spatial trends effects of the individual mines and discharges.
Draft Aquatic Environment Synthesis Report 2014 Section 3.2.2.4	6B -33	Priority for Plan Submission: Recommend that additional discussion on study limitations of sediment toxicity studies is provided.	As noted by MOE in comments provided to Teck Apr 30/14, the sample size for sediment toxicity testing was too small (i.e., 3 receiving environment sites and 1 settling pond) to make definitive conclusions regarding sediment toxicity.
Draft Aquatic Environment Synthesis Report 2014 S 3.3	6B -34	Priority for Plan Submission: Recommend reporting spatial distribution of calcite index results.	Table 3.2-12 summarizes the kilometres of stream bed affected by calcite deposition. However, to evaluate the potential impacts and cumulative effects associated with calcite deposition, information is needed on spatial distribution of impacts relative to mining operations.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Draft Aquatic Environment Synthesis Report 2014 Section 3.4.2	6B -35	Priority for Plan Implementation: MOE recommends the continued assessment of the feasibility of monitoring periphyton communities, to complement other ongoing biomonitoring activities following a weight of evidence approach.	<p>Section 3.4.2 primarily focuses on the inter-laboratory comparison of taxonomy and enumeration for split samples. It is unclear why this component was even conducted in the first place, and is something that can be overcome by choosing an appropriate set of standardized field and laboratory methods. There are several examples from the US, Europe, New Zealand, that have been successfully used in a variety of biomonitoring studies. A recent Canadian approach that could be adapted easily for use in BC is the Algal Bioassessment Protocol (ABP) by the Ontario Ministry of Environment (OMOE 2011). The ABP was designed to complement other water monitoring programs already in place in Ontario, such as the Provincial Water Quality Monitoring Network, the Ontario Stream Assessment Protocol and the Ontario Benthos Biomonitoring Network. The ABP identified that high resolution taxonomic identification of diatom communities was the optimal approach to periphyton biomonitoring. It also provides standardized methods for sample collection, lab prep, counting and identification, and data analysis</p> <p>A well designed, multi- assemblage biomonitoring program can provide valuable information on the risks to, and impacts on biological communities and overall stream health (Carlisle et al. 2008). Periphyton is at the base of the food chain, and their exclusion from a sampling program would be inappropriate. As a result, it is important to continue monitoring the biological community (periphyton) that is most sensitive to nutrient enrichment and responds the quickest to such changes (Stevenson et al., 2010).</p> <p><u>References:</u></p> <p>Carlisle, D. M., Hawkins, C. P., Meador, M. R., Potapova, M., and Falcone, J. (2008). Biological assessments of Appalachian streams based on predictive models for fish, macroinvertebrate, and diatom assemblages. <i>Journal of North American Benthological Society</i>, 27, 16–37.</p> <p>Stevenson, R.J., PAN, Y and Van Dam, H. 2010. Assessing environmental conditions in rivers and streams with diatoms. In: The Diatoms: Applications for the Environmental and Earth Sciences, 2nd Edition, eds.</p>

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
			John P. Smol and Eugene F. Stoermer. Cambridge University Press. 686 pgs. OMOE (Ontario Ministry of the Environment Environmental Monitoring and Reporting Branch). 2011. An Algal Bioassessment Protocol for use in Ontario Rivers. Last revision date: December 2011.
Draft Aquatic Environment Synthesis Report 2014 Section 3.4-3.8	6B -36	Priority for Plan Submission: Recommend that the screening evaluation for identifying Constituents of Potential Concern (COPCs) for tissue samples be fully described and relevant references including those to approaches adopted by other jurisdictions should be included.	Methodology and assumptions built into the screening evaluation need to be fully transparent so that the results can be interpreted. For example, it is unclear whether comparing the 95% Upper Confidence Limit (UCL) of the mean to benthic invertebrate and fish Toxicological Reference Values (TRVs) will adequately identify all areas that are at risk due to mining related constituents.
Draft Aquatic Environment Synthesis Report 2014 Section 3.6.1.2	6B -37	Priority for Plan Submission: Recommend that screening for fish include any Cols identified in sediments or lower trophic levels, as water is not the only exposure pathway for fish.	COPCs only included constituents identified in the surface water evaluation.
Environment Synthesis Report 2014 Section 4	6B -38	Priority for Plan Submission: Recommend that a detailed methodology with rationale for all assumptions be given for each column presented in the MU evaluation report cards (Tables E1-E5).	It is not clear how the data in each column is calculated. A detailed methodology is needed to interpret the results.
Environment Synthesis Report 2014 Section 4	6B -39	Priority for Plan Submission: Recommend that a list of rules are presented that describe how the “overall ranking” column is calculated, if this overall ranking is included in the report.	Currently there is no discussion given on how the multiple lines of evidence are evaluated to identify an overall ranking.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Environment Synthesis Report 2014 Section 4	6B -40	Priority for Plan Submission: Recommend that the classification of calcite index values into good, fair and poor is suspended until additional research is conducted to determine the impacts of calcite on benthic populations.	The current classification is not based on scientific evidence. Further study is needed.
Draft Aquatic Environment Synthesis Report 2014 Section 4.8	6B -41	Priority for Plan Implementation: MOE recommends completing a comprehensive multi-trophic level biological monitoring program on Lake Koocanusa to complement the water quality sampling.	As with the Elk River watershed, a weight of evidence approach is prudent to determine any potential impacts of mining activities on biological communities within downstream environments such as Lake Koocanusa.
Draft Aquatic Environment Synthesis Report 2014 Section 4.8	6B -42	Priority for Plan Submission: Recommend that data used for the evaluation of Lake Koocanusa (MU6) be referenced and clarification provided for zooplankton and fish data.	Section 4.8 seems to be missing data for burbot, which contained the highest measured concentration of Se in fish, which will skew these findings. The source for zooplankton data (Section 4.9.3), along with site locations, should be clarified.
Draft Aquatic Environment Synthesis Report 2014 Appendix C	6B -43	Priority for Plan Implementation: Attachment A : Periphyton concentrations from within the Elk Valley, BC – Selenium MOE recommends adding periphyton tissue selenium as a COPC, and conducting further analyses. MOE also recommends considering adding a component to analyze diatom frustule deformities.	While there is no referenced TRV for selenium in periphyton tissue, further evaluation of the bioaccumulation of selenium in algal tissue is warranted. Visually, the data plots indicate that there may be statistically significant differences (note that significance is not indicated on the plots), between reference sites and those in MU 1, 2 and 3. Considering periphyton is at the base of the food chain, this apparent increase in tissue selenium is concerning. Furthermore, metal contamination has been shown to contribute to diatom frustule (external layer made of silica [cell walls]) deformities, and an examination of the proportional abundance of these deformities has the potential to be used as a measure of metal contamination (e.g., Falasco et al., 2009; Duong et al., 2010). Although these references do not specifically test for effects of high selenium concentrations, they do indicate the potential for the bioaccumulation of selenium to affect diatom growth and morphology. References:

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
			<p>Falasco, E, Bona, F, Ginepro, M, Hlúbková, D, Hoffmann, L and Ector, L. 2009. Morphological abnormalities of diatom silica walls in relation to heavy metal contamination and artificial growth conditions. Water SA 35(5): 595-606.</p> <p>Duong, TT., Morin, S., Coste, M., Herlory, O., Feurte-Mazel, A. and Boudou, A. 2010. Experimental toxicity and bioaccumulation of cadmium in freshwater periphytic diatoms in relation with biofilm maturity. Science of The Total Environment, vol. 408, p. 552-562.</p>
Draft Aquatic Environment Synthesis Report 2014 Appendix C	6B -44	Priority for Plan Submission: Recommend describing the data that was used to calculate the Exposure Point Concentration (EPC) for each component (sample locations, dates, species, etc.)	Currently it is not clear what data are used to determine the EPC.
Draft Aquatic Environment Synthesis Report 2014 Appendix D	6B -45	Priority for Plan Submission: Recommend the use of approved Water Quality Guidelines (WQGs) in the calculation of Water Quality Index (WQI) values.	WQI values should not be calculated using benchmark values given that the validity of these benchmarks has not yet been confirmed. Using these may lead to inaccurate index values. For example, following standard approaches, the WQG of 2 µg/L would be applied to all waterbodies. In this assessment values of 19 µg/L is applied in MU1 and 52 µg/L is used in MUs 2 – 5. Also, cadmium and zinc should be included in the WQI using hardness based guidelines.
Draft Aquatic Environment Synthesis Report 2014 Appendix D	6B -46	Priority for Plan Submission: Recommend using the low SQG as the threshold for calculating the SeQG.	The low SQG are “safe levels of substance that will protect aquatic life”. A “good” ranking under the SeQG means that, “conditions rarely depart from natural or desirable levels”. Using the low SeQG is consistent with the CCME definitions.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Review of: Phase 1 Mixture Toxicity Testing and Phase 2 Site-specific Toxicity Testing	6B -47	<p>Priority for Plan Implementation: Amphibians were not considered in the mixture toxicity study</p> <p>We recommend that amphibians be included in future toxicity work.</p>	Amphibians are known to occur in the area of interest. The authors of the report suggest that the three test species that were considered (i.e., <i>Ceriodaphnia dubia</i> , <i>Hyalella azteca</i> , and <i>Oncorhynchus mykiss</i>) were more sensitive than amphibians precluding the latter's inclusion in the study. However, toxicant mixtures represent a complex exposure medium which may or may not result in species-specific responses. At least some evidence should be available to demonstrate that results from the three chosen test species will still be protective for amphibians.
Review of: Phase 1 Mixture Toxicity Testing and Phase 2 Site-specific Toxicity Testing	6B -48	<p>Priority for Plan Submission: Recommend that Fig. 1 in the mixture toxicity study provide some statistical support for the apparent modifying influence of Ca and Cl.</p>	This data is necessary to interpret the results.
Review of: Phase 1 Mixture Toxicity Testing and Phase 2 Site-specific Toxicity Testing	6B -49	<p>Priority for Plan Submission: In the Site-Specific Toxicity Data Report (Nautilus Environmental 2014), where river waters were spiked with either SO₄ or NO₄, only raw data were provided for the nitrate toxicity tests. We recommend an analysis of effects based on data presented.</p>	Tables 13 and 14 demonstrate reproduction impairment in <i>C. dubia</i> with increasing NO ₄ concentrations. However, no attempt is made to establish the NO ₄ concentration that induces the effect.
Review of: Phase 1 Mixture Toxicity Testing and Phase 2 Site-specific Toxicity Testing	6B -50	<p>Priority for Plan Implementation: In the site-specific toxicity data report, the authors chose to test rainbow trout using a non-standard method (Lazorchak and Smith, 2007). We recommend this study be repeated using a standard protocol for a long-term test on rainbow trout.</p>	In using this protocol, no discernible effect of nitrate was observed. However, it is uncertain if that's because there's no effect of nitrate or the protocol used was simply not sensitive enough to detect an effect.

Calcite, Human Health & Groundwater

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Calcite Management Plan (Draft Chapter 5)	6B -51	<p>Priority for Plan Implementation:</p> <p>Recommend that Teck looks at ecological value of all reaches showing $CI > 0.50$ and manage based on this information.</p>	Stream reaches showing calcite indices (CI) over 2.0 may not necessarily be the most valuable reaches to focus on for management. Until more is known, it may be more beneficial to the Elk Valley aquatic populations to focus treatment on stream reaches with high (or high potential) ecological value, rather than simply starting with all of the most highly affected stream reaches.
Calcite Management Plan (Draft Chapter 5)	6B -52	<p>Priority for Plan Submission:</p> <p>Recommend clarifying how “receiving environment” was determined, in terms of eliminating stream reaches from potential management in Figure 9. (E.g. Smith Pond Outlet)</p>	While historically “receiving environment” has often been defined as locations below sedimentation ponds, this may not always be appropriate for parameters other than TSS, including calcite. Discussion of an initial dilution zone for calcite precipitation may be valuable to clarify how an impacted tributary may interact with the main stem and how this will be managed.
Calcite Management Plan (Draft Chapter 5)	6B -53	<p>Priority for Plan Submission:</p> <p>Recommend providing a summary of data collected on the reference streams.</p>	Teck has stated that all reference streams show $CI < 0.50$ – to support this statement a table clearly summarizing reference stream reaches and CI values is needed.
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -54	<p>Priority for Plan Implementation:</p> <p>Recommend that further information be compiled, related to but not limited to, the identification and characterization of:</p> <ul style="list-style-type: none"> - Aquifers - Hydraulic gradients - Recharge areas <p>Geologic structures such as faults</p>	There is limited information on the groundwater resources and hydrogeology of the Elk Valley area. This makes it difficult to actively manage and protect groundwater resources in the Valley.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -55	Priority for Plan Submission: Recommend identifying uncertainties associated with estimates and predictions used in groundwater assessment.	Many aspects of hydrogeologic parameters estimates, conceptual/numerical model predictions, and impact predictions may be significantly affected by unexpected hydrogeologic or geologic conditions or insufficiently conservative parameters used in the analyses. For example: Unexpected high groundwater or surface water flow volumes during freshet, which may cause pulses in contaminants and may affect the receiving environment more than expected, <ul style="list-style-type: none">• Lowered or increased groundwater levels at distances significantly greater than indicated by the models, which for example could be the result of sustained groundwater pumping at certain times of the year,• Groundwater quality degradation at significantly greater distances and at greater concentrations than predicted, which may affect down-gradient groundwater users and discharge areas, and Detection of contaminated groundwater at unexpected locations, which may affect down-gradient groundwater users and discharge areas
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -56	Priority for Plan Submission: Recommend that comparisons in Table HH2 be clarified to clearly indicate whether sampling results are compared to guideline values expressed in total or dissolved concentrations. It would also be helpful to show the number of data samples	Clarifying the comparisons to guidelines and providing information on the size of the dataset serves to improve understanding of the monitoring results and subsequent assessment.
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -57	Priority for Plan Submission : Recommend that rationale be provided for carrying forward constituents that are not compared to guidelines	Several parameters (phenanthrene, inorganics) are carried forward for analysis without basis. These parameters are later eliminated from analysis for lack of guideline values.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -58	Priority for Plan Implementation : Recommend that the groundwater parameter suite include major drinking water quality parameters (metals and organics), similar to the parameter suite for surface water monitoring for wells on public supplies.	The groundwater monitoring parameter suite is limited to 10 inorganic constituents, many with no guideline value. Because groundwater is primarily used for drinking water, the parameter suite is not adequate to evaluate the potability of the source water and potential human health risks. For example, arsenic is a groundwater constituent of concern that was found to exceed guidelines in surface waters, but is absent from the groundwater suite. At a minimum, the report should discuss the rationale for groundwater parameter suite.
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -59	Priority for Plan Submission: Recommend that all relevant details and rationale of the groundwater quality monitoring study be provided in the report or through reference to other reports.	There is no information about the goals and design of the groundwater quality monitoring study, including sampling protocols and QA/QC.
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -60	Priority for Plan Submission: Recommend that an appraisal of the limitations of the groundwater monitoring study be provided in terms of implications on the human health assessment.	There is no discussion or assessment of the monitoring program in terms of its adequacy to characterize groundwater quality for human health assessment? Without this information it is difficult to assess the validity of the monitoring data.

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -61	<p>Priority for Plan Implementation:</p> <p>Recommend that a more comprehensive description and assessment of potential migration pathways for constituents of concern between mine activities and the groundwater (GW) supply aquifers be included. This should include a description of regional groundwater flow patterns and recharge areas, groundwater interactions with surface waters (SW), the effects of groundwater withdrawals on the SW/GW interactions, and the mobility of mine related constituents. Once all potential pathways are identified, the assessment should clearly explain why or why not each of these pathways can potentially affect human health of existing and future groundwater users. Recommend presenting this information in the form of a conceptual model to allow for an assessment of combined risks to groundwater.</p>	<p>Section 1.6 describes potential migration pathways for mine related constituents to reach GW supplies. However, much of the discussion focuses on the Elk River Valley floodplain, where there could be losing stream conditions down gradient from river meanders. Other potential pathways were not discussed. For example:</p> <ul style="list-style-type: none"> the location of potential groundwater recharge areas down gradient from mine influenced activities, groundwater recharge areas along stream channels in upland areas, along alluvial fans, and grade breaks; water wells in the flood plain can potentially induce infiltration from the river into the aquifer depending on their location, pumping rate and depth; and Cumulative pumping from the surficial aquifer can potentially change the nature of SW/GW interactions from gaining to losing stream conditions. <p>None of these potential pathways were discussed.</p>
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Groundwater	6B -62	<p>Priority for Plan Submission:</p> <p>Recommend that the conclusion that groundwater will be protected through protection of surface water quality be substantiated through the inclusion of relevant data and evidence.</p>	<p>The conclusion that GW will be protected through protection of surface water quality does not appear to be fully supported by the evidence reviewed in this section of the report. There is no indication that there has been a comprehensive characterization of the GW flow system, including identification of recharge areas in the upland areas, and a comprehensive source analysis of mine and non-mine sources. Without such knowledge it is not accurate to dismiss other potential migration pathways within and outside of the floodplain area.</p>
Assessment of Protection of Human Health and Groundwater (Draft Chapter 6) Human Health	6B -63	<p>Priority for Plan Submission :</p> <p>The Plan needs to clearly identify where, when, and the magnitude of exceedances of generic health-based guidelines for short and long-term targets. Please note these are MOE or Health Canada guidelines and not the risk-based guidelines provided by Environ (referred to as pathway specific benchmarks)</p>	<p>Decisions related to the protection of public health require specific information about where guidelines may be exceeded. This allows public health agencies to identify risks and determine actions as appropriate. The MOE uses generic health-based guidelines as the benchmark for ensuring public health protection. If these guidelines are exceeded, the authority lies with Medical Health Officers to determine what action, monitoring or investigations are necessary.</p>

Adaptive Management

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Adaptive Management – (Draft Chapter 10) Objectives	6B -64	<p>Priority for Plan Submission:</p> <p>The Adaptive Management (AM) Framework will be very important in implementing the EVWQP. It is recommended that the framework clearly links to the overarching (Order) objectives (and a lower tier of more specific objectives), monitoring specific to the EVWQP, the Regional Aquatic Effects Monitoring Plan, and the critical uncertainties that are associated with the current EVWQP implementation plan. It should also link to the impact hypotheses that are to be tested in the monitoring program during the implementation of the Plan.</p>	<p>Advice was provided as to the main items that should be included in the AM framework. Examples of similar frameworks that should be used to guide the development of the AM are included below.</p> <p>The BCHydro Water Use Plans https://www.bchydro.com/about/sustainability/conservation/water_use_planning.html provide an approach to adaptive management (often without explicit reference). They identify clear objectives and adaptive approaches for meeting the objectives. Also further studies are identified to help reduce uncertainties. For example the Bridge River Water Use Plan – https://www.bchydro.com/about/sustainability/conservation/water_use_planning/lower_mainland/bridge_river.html.</p> <p>Western Forest Strategy – Adaptive Management Summary – http://www.for.gov.bc.ca/hfd/library/FIA/2010/LBIP_6903009.pdf</p> <p>BC Ministry of Forest Lands and Natural Resource Operations Adaptive Management Initiatives – http://www.for.gov.bc.ca/HFP/amhome/index.htm</p> <p>References</p> <p>Gregory, R., Ohlson, D., and J. Arvai. Deconstructing Adaptive Management: Criteria for Applications to Environmental Management. <i>Ecological Applications</i>, 16(6), 2006, pp 2411-2425 [http://www.ncbi.nlm.nih.gov/pubmed/17205914]</p> <p>https://circle.ubc.ca/bitstream/id/21174/18%20Love%20Paper.pdf</p> <p>http://www.fs.fed.us/pnw/pubs/pnw_gtr654.pdf</p> <p>ftp://ftp.for.gov.bc.ca/HFP/external/publish/Web/AMHOME/SUMMARY_Amsumms.htm</p>

Summary Table			
Category	#	Description of “Technical Advice” from Mtg	Rationale
Adaptive Management – (Draft Chapter 10) Links to Monitoring	6B -65	<p>Priority for Plan Submission:</p> <p>It is recommended that further details be given that will clarify how the adaptive management plan will be linked to ongoing monitoring. Sub-recommendations include:</p> <ul style="list-style-type: none"> • more consideration be given to how frequent monitoring results should be evaluated; and • the adaptive management approach integrates with cumulative effects assessment monitoring. 	<p>It is unclear in Chapter 10 whether the frequency of evaluating the monitoring results is appropriate for all monitoring and whether this would enable effective adaptive management. If impact hypotheses are added, different monitoring and evaluation frequencies may need to be considered (i.e., different monitoring programs treated differently but appropriately for what is being monitored). Also, adaptive management is very much about protection of populations and the cumulative effects impact to these populations. This is a key monitoring component.</p>
Implementation and Adaptive Management (Draft Chapter 10) Uncertainty and Research	6B -66	<p>Priority for Plan Submission:</p> <p>It is recommended that the Adaptive Management plan identify uncertainties related to the development of targets and to any gaps in the science and information used to develop these targets. It is further recommended that priority research necessary to fill these gaps is identified</p>	<p>The concept of uncertainty is not identified as a key issue. As the water quality targets themselves are uncertain, any uncertainties or risks should be addressed in the adaptive management approach. Uncertainties identified are focused on treatment technology and source control R&D. There is nothing about additional research on gaps in science, looking at uncertainty, etc.</p>
Adaptive Management – Diagrams	6B -67	<p>Priority for Plan Submission:</p> <p>It is recommended that the adaptive management diagrams represent a feedback loop.</p>	<p>The AM process is ongoing and cyclical. Once decisions are made and adaptation is implemented, the process of monitoring, evaluation, decision and adaptation begin again.</p>
Adaptive Management Targets	6B -68	<p>Priority for Plan Submission:</p> <p>Recommend linking the adaptive management plan to the monitoring plan to assess the frequency of the adaptive management cycle for review/calibration given the frequency of monitoring and anticipated detection of trends.</p>	<p>Targets are based on models that need to be tested and verified. A clear description of the adaptive management cycle and monitoring.</p>