The Technical Advisory Committee (TAC) for the Elk Valley Water Quality Plan (the "Plan") held their 2nd meeting on October 29-30, 2012. This document is a record of the technical advice received at this meeting.

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 #2.

The focus of TAC Meeting #2 was a review of Work Package #2a, which includes an overview of the approach being taken to assess potential ecological effects to aquatic ecosystems and species from a range of water quality concentrations for selenium, cadmium, sulphate and nitrate. Almost all of the technical advice recorded in this table is related to Work Package #2a. At the meeting, the TAC also briefly discussed and provided advice on Work Package # 7, which outlined Teck's approach for the protection of human health. Work Package #7 is scheduled to be presented and discussed at TAC Meeting 4 (planned for February 2014).

Summary Table

Category	#	Description of "Technical Advice" from Mtg 2	Rationale
Work Package 2a *Methods for Ecological Effects Assessment* – **Overall Approach**	**2-1**	Recommend the explicit documentation of uncertainties (limitations of the current data) in order to assist in the interpretation of results and address key data gaps for the monitoring program.	The ecological effects matrices will be developed based on the existing data from toxicity testing and site monitoring. Due to gaps in the existing data, some assumptions will have to be made to develop the ecological effects matrices.
	2-2	Recommend that the effects matrixes being developed for selenium, sulphate, nitrate and cadmium reflect the full range of water quality present in the watershed.	For the effects matrixes to be the most relevant and useful to understanding potential effects that could occur at the 7 target locations and in the broader watershed, the analysis should reflect the full range of concentrations that are present for the parameters of concern.
	2-3	Where available and appropriate, use existing aquatic effects monitoring data from the Elk Valley to evaluate the toxicity testing approach and inform the development of ecological effects matrices for selenium, cadmium, sulphate and nitrate.	Toxicity testing using a limited suite of indicators and/or resident species may not reflect effects on sensitivity species associated with long-term exposure.
Work Package 2a *Methods for Ecological Effects Assessment* – **Selenium Work**	**2-4**	A site-specific ecosystem-scale model of selenium (Presser and Luoma, 2010, or equivalent) and associated selenium mass balance model is needed for Lake Koocanusa to assess current and future assimilative capacity of the reservoir and cumulative effects. Development of the model(s) should be done using water, sediment, and biological data from Lake Koocanusa and appropriate inflow/outflow sites. We suggest that	Site-specific water-quality targets for selenium are being developed for the protection of aquatic life in the Elk and Fording Rivers; however, cumulative impacts are not being considered for Lake Koocanusa either north or south of the international boundary. Furthermore, appropriate data have not been collected to determine if Lake Koocanusa is functioning as a selenium sink.

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Plan		this be a cooperative data collection and modeling effort between Teck Coal, the Ministry of the Environment (MOE), and U.S. state and federal agencies. At a minimum, the most sensitive species/food chain should be characterized so that threshold water quality criterion can be established. The calibrated (and confirmed) model should be used to determine egg and tissue concentrations under different loading scenarios and develop future adaptive management scenarios, as appropriate, in particular, those related to both increases and reductions of selenium in the watershed. Given the complexity of this advice, a longer timeline for assessment and implementation is likely needed to allow sufficient time to adequately address these concerns for Lake Koocanusa.	Hence, the current approach is inconsistent with the rigor used elsewhere in the watershed and the conventional wisdom that reservoirs are often the most sensitive receiving-water. Given that (1) selected water-column and fish-tissue data collected by the State of Montana in Lake Koocanusa in 2013 indicate elevated selenium levels, and (2) water samples from Lake Koocanusa are already exceeding the alert levels noted in the 2012 Draft BC Selenium Guidelines (2012), neither the State of Montana nor federal (US) regulators can adequately assess the ecosystem impacts of current (2013) and future selenium loads within Lake Koocanusa until a scientifically defensible cumulative effects assessment is initiated. The Order requires Teck to complete such an analysis (Schedule C, section B.3) and we believe this is a critical requirement of the Order. Once the assessment is complete, we can understand what level of protection, if any, is needed so that allowable loadings from the U.S. and Canada can be established.
	2-5	Recommend assessing potential ecological effects in Lake Koocanusa given the site specific nature of selenium effects	Ecological effects in lentic habitats can occur at lower exposure levels than in lotic habitats. Therefore, it is essential to evaluate effects in Lake Koocanusa where loadings of selenium are ultimately deposited.
	2-6	Recommend that the algal-water concentration rations (K_d values) derived from estimated exposure data (i.e., water chemistry data based on monthly sampling results averaged over some period of time) should be validated using the results of a site-specific investigation that involves deployment of plate samplers at multiple locations in the Elk/Fording/Lake Koocanusa system and intensive evaluation of exposure to selenium. The exposure assessment should be conducted by collecting water samples on a weekly basis for analysis of selenium and mine-related conventional variables (e.g., alkalinity) and by conducting continuous monitoring of mine-related conventional variables (i.e., using continuous monitoring probes). This work should be conducted in the late summer and early spring to determine if K_ds vary on a seasonal basis, which could	Synoptically-collected water chemistry and algal tissue-chemistry data appear to be insufficient to support the derivation of reliable algal-water concentration ratios (Kd values). These ratios are of fundamental importance to the overall bioaccumulation modeling for selenium.

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		substantially affect the results of bioaccumulation modeling.	
	2-6a	**Description of Related Alternate (or Addn) Advice:** Both the MT Govt. and U.S. Govt. generally support this advice, but also recommend that a more robust approach be taken towards the determination of K_d (and other trophic transfer factors) for lentic waters, in particular, for Lake Koocanusa. Specifically, we recommended that a Quality Assurance Project Plan (QAPP) and Sampling and Analysis Plan (SAP) be developed to direct these activities so that the bioaccumulation modeling work outlined in advice item #2-4 can be appropriately implemented. Important supporting information that should be considered in this SAP includes: (1) distribution and seasonal changes in selenium species in the lentic water column; (2) particle surface composition (algal, sediment); (3) water/particle residence time and recycling potential; and (4) seasonal changes of redox conditions in the water column, particularly at the sediment/water interface.	
	2-6b	**Description of Related Alternate (or Addn) Advice:** Environment Canada supports controlled field assessment of K_d, with artificial substrates and seasonal sampling to assess variability.	
	2-7	In terms of calculating a weighted exposure between both lentic and lotic habitats (for species that reside in both habitats like Westslope Cutthroat Trout), need to conduct a sensitivity assessment to assess the impacts of assumptions in the weighting methodology on the ecological effects matrices. This should include conducting and sharing the results of the sensitivity analyses for lentic and lotic areas separately.	Exposure of WCT to dietary Se will likely be higher in lentic than lotic environments. However, both the fraction of the population and the relative amount of time spent in the two environments is uncertain. Consequently, some assumptions will be required to estimate exposure. Understanding the impacts of these assumptions on the resulting ecological effects matrices is important. Also, by conducting the exposure assessment for the two environments independently, it will be possible to define the range of exposure scenarios. The results can then be weighted in various ways to conduct the overall assessment.
	2-8	Whenever available, the effects on ecological receptors under current and relevant historic conditions (i.e., where exposures may have been similar to some future exposure scenario) should be evaluated using measured data	Such an assessment provides an independent basis for evaluating effects on aquatic organisms and wildlife species, beyond the

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		on the concentrations of selenium in invertebrates, fish, amphibians, and birds. These data should also be used to validate the bioaccumulation model used in the ecological effects assessment for selenium.	modeling approach that is proposed by Teck.
Work Package 2a *Methods for Ecological Effects Assessment* – **Nitrate/Sulphate Work Plan**	**2-9**	For the results of the nitrate/sulphate work plan, recommend a comparison of the stoichiometry (or ratio of ions) between test water and site water and provide an analysis of the uncertainty for any differences in the stoichiometry.	Aqueous concentrations of certain parameters in Elk Valley waters are dictated by specific water-rock interactions (dissolution / oxidation / reduction) that occur in the natural system. Toxicity testing conducted using solutions created using salts to produce a range of concentrations may lead to ionic ratios that differ from the natural system. The artificial cation-anion ratios created by using salts in lab testing may lead to unintended/unidentified artifacts in data that may contribute to overall uncertainty in the test data.
	2-9a	**Description of Related Alternate (or Addn) Advice:** Environment Canada supports extra control of ionic constituents in toxicity testing waters.	
	2-10	Recommend that additional toxicity testing be conducted using sensitive species and longer term exposures (see technical advice *#B2-12 in Appendix B – Received within 7 days after TAC Meeting 2* for more information). If this work is not completed, then an approach needs to be developed for translating empirically derived toxicity thresholds (based on the results of toxicity tests) to estimate toxicity thresholds for communities in the Elk/Fording watershed.	It is not clear that the selected toxicity tests for evaluating the effects on aquatic organisms associated with exposure to nitrate or sulphate are the most sensitive and/or relevant (i.e., mayflies were not tested; amphipods were tested in 14-d exposures only; biomass and reproduction were not evaluated; amphibians were not tested). Therefore, the results of such toxicity tests cannot be used directly to identify toxicity thresholds for aquatic organisms relative to nitrate or sulphate.
	2-11	We recommend that the ecological effects assessment for dissolved nitrate (NO_3) include the effect of NO_3 loading to Lake Koocanusa from coal mining activities, in particular, whether this load (in accompaniment with additional dissolved phosphorus loadings) would cause harmful eutrophication effects or additional accumulation of selenium in biota in the reservoir. It is recommended that loading models (e.g., LOADEST or physically based watershed models) be used to simulate historical and current phosphate and nitrate loadings from the Kootenay, Elk, and other rivers, and that the receiving water response in Lake Koocanusa be	Lake Koocanusa appears to currently (2013) be a phosphorus (P) limited system, however, dissolved nitrate (NO_3) concentrations in Lake Koocanusa at the international boundary are high (and increasing) presumably due to the increased loading in the Elk and Fording River from blasting operations associated with coal mining. In fact, NO_3 currently exceed levels saturating for phytoplankton growth [see Thoman and Mueller (1987) or Chapra (1997)]. Hence some investigation of the importance of the control of P needs to be made to ensure no shifts in lake trophic

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		evaluated with respect to impact(s) to ecosystem function. The CE-QUAL-W2 model developed by the U.S. Army Corps of Engineers may be of help in addressing the receiving water component (in particular eutrophication effects); although at present, only the temperature component of the model has been calibrated. Realistic future loading scenarios should then be evaluated which address levels of phosphorus needed to minimize eutrophication effects and characterize the flux of selenium to the sediments under such conditions (from phytoplankton settling). The proposed work plan, including modeling methods, should be reviewed by U.S. and Montana government representatives prior to implementation and should then be tied back to the work described in item 2-4 to evaluate potential effects on selenium bioaccumulation.	state occur (i.e., eutrophication) which may enhance the removal of selenium from the water column, change or increase bioavailability through hypoxia, and subsequently impact the bioaccumulation of selenium. Presumably, future increases in loadings of soluble P (e.g., POTWs, agriculture, logging, phosphate mining, wildfires, etc.) have potential to significantly degrade water quality and ecosystem function by accelerating eutrophication and changing the rate of selenium accumulation in the base of the food chain. In addition, some thought should be given about how increasing NO_3 loading may alter the assimilative capacity of the reservoir and reservoir outflow (Kootenai River) with respect to N (i.e., referring to ongoing numeric nutrient criteria work in the U.S.).
	2-12	Evaluate the potential adverse effects on mammals associated with exposure to nitrate via drinking water. Use a range of concentrations representative of current concentrations in the Elk Valley watershed.	The current concentration levels of nitrogen in the surface water of the Elk Valley watershed may be too low to cause effects on mammals that use the surface water as a source of drinking water. However, this is an issue that members of the public have voiced concerns over and thus the Plan should explicitly demonstrate that mammals are not currently experiencing effects from this pathway.
	2-13	Benthic invertebrate community structure data should be used as an independent line of evidence for evaluating the potential effects of mine-related discharges. In this respect, multivariate analysis (or similar methods) should be used to evaluate potential effects on benthic invertebrates relative to exposure to chemicals of potential concern (COPCs) and habitat characteristics; and the analysis should include evaluating the toxicity of sediments within the study area on benthic invertebrates.	Toxicity test results are useful for assessing potential effects on aquatic organisms. However, such data may not be relevant to all species or exposure periods the benthic community integrates.
	2-13a	**Description of Related Alternate (or Addn) Advice:** 1. Environment Canada supports analysis of benthic macro-invertebrate community structure	
	2-13b	2. Pore-water chemistry, surface water chemistry, and invertebrate tissue chemistry (from field studies and/or laboratory bioaccumulation	Toxicity and benthic invertebrate community structure represent only two of multiple lines of evidence that can and should be used

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		tests) should also be carried out to evaluate effects on benthic invertebrates.	to assess effects.
	2-14	The interactive effects of mixtures of COPCs and calcite formation needs to be evaluated in the tributaries and in the Elk/Fording mainstem habitats.	Calcite deposits have the potential to reduce the productivity of tributary habitats and/or influence the reproductive success of fish species. Such effects could be exacerbated by exposure of aquatic organisms to COPCs.
Work Package 2a *Methods for Ecological Effects Assessment –* **Cadmium Work Plan**	**2-15**	Recommend that the cadmium Biotic Ligand Model (BLM) being developed for use in the Elk/Fording watershed be validated using site-specific chronic toxicity test data. And the TAC should be provided with an opportunity to review the design of the toxicity testing program that is developed to generate the requisite site specific toxicity data.	No site-specific toxicity tests have been conducted or have been proposed to support the development of toxicity thresholds or relationships for cadmium. Rather, the proposed approach is dependent on development of concentration-response relationships based on hardness normalization and/or biotic ligand modeling (BLM). Hardness normalization has been used to derive numerical water quality guidelines for cadmium by the CCME and BC MOE. However, BLM has not been used to derive water quality guidelines or water quality criteria for cadmium in Canada or the United States.
	2-16	When assessing the ecological effects of cadmium through the Biotic Ligand Model or other methods, consider the temporal nature of cadmium exposure and toxicity modifying factors in the natural system.	In the natural system, the concentration of cadmium and factors that modify the toxicity of cadmium vary throughout the year, mostly because of variable flow conditions. Other related points raised in relation to this discussion included a) taking into account changes in water chemistry as a result of water treatment at sites, b) consideration of TMFs given co-precipitation of carbonates, c) consideration of conducting a serio test as a means of validation approach.
	2-16a	**Description of Related Alternate (or Addn) Advice:** Environment Canada states that it is important to be looking at any factors relating to Cd toxicity	
	2-17	Recommend the evaluation of the ecological effects of cadmium under current conditions must consider maximum exposures as well as average exposures to these substances.	In conducting such assessments, it is important to recognize that the results of monthly water sampling represent the average concentration of the COPC for that month. Average COPC concentrations must be determined based on the results of five water samples collected within a 30-d period.
Work Package #7	**2-18**	Recommend that a Human Health Assessment be conducted that includes	The current proposed approach of Work Package #7 appears to

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Protection of Human Health		consideration of a surface water pathway and the full range of water quality present in the watershed.	focus on fish consumption and on groundwater pathways (and possibly surface to groundwater pathways). It further proposes that management actions will be identified to maintain protection of human health. However, it is noted that water quality guidelines exist for drinking water for selenium (500 mg/l), sulphate (10 ug/l) and nitrate + nitrite (10 mg/l) and some areas of the Elk Valley watershed are above these concentrations. Thus it is recommended that a similar effects analysis (matrices) should be developed for drinking water quality for the full range of water quality present in the watershed, and that this should be applied to both surface water and groundwater evaluations. This assessment step should be done before management actions are identified (i.e. a similar approach to aquatic health assessment). Having water quality that is suitable for drinking water speaks to values for both current and potential future users of drinking water in the watershed. Also the current proposed approach may not be reflective of stakeholder values that have been previously expressed for a healthy watershed that is fishable, drinkable and swimmable.
	2-18a	**Description of Related Alternate (or Addn) Advice:** Environment Canada supports an assessment of drinking water quality	