Elk Valley Water Quality Plan
Technical Advisory Committee – Meeting #4 Notes - FINAL

February 4-6, 2014 – Vancouver, BC

Meeting Objectives

- Provide an update on the Elk Valley Water Quality Plan (the "Plan" or EVWQP).
- Review and agree to the "technical advice" received during and after TAC Meeting 3.
- Review further details on the mitigation measures and their incorporation into the water quality planning model.
- Review and discuss preliminary results from the water quality planning model.
- Review and discuss the approach for incorporating tributaries.
- Review and discuss the estimation of ecological effects for a range of water quality concentrations.
- Review and discuss the approach for calcite management, including (i) developing narrative objectives, (ii) assessing impacts, and (iii) identifying and evaluating management scenarios.
- Confirm the TAC workplan and next steps (for Meetings 5 to 7).

Meeting Summary

- **TAC Documentation:** The TAC advice tables and meeting notes from TAC Meeting #3 were finalized.
- **TAC Work Plan:** The TAC discussed Teck's overview of proposed work packages for TAC Meetings 5-7. The TAC provided feedback on the content and timing of work packages related to effects matrices, management scenarios, human health, and Lake Koocanusa.
- **Ecological Effects Assessments:** The TAC reviewed and discussed Teck's methodology for assessing the ecological effects of selenium, cadmium, nitrate and sulphate.
- **Mitigation Measures:** The TAC discussed the rationale for including or excluding certain mitigation measures within the management scenarios and the Water Quality Planning (WQP) Model.
- **Management Scenarios (approach to development):** A presentation was made on Teck's approach for developing and modelling management scenarios. Teck explained that they are only considering mitigation measures that they know could be effective at reducing water quality concentrations of the constituents of concern. These mitigation measures include active water treatment (AWT), clean water diversion (CWD), and geomembrane covers.
- **Management Scenarios (preliminary results):** The TAC reviewed and discussed the emerging patterns from preliminary modelling of management scenarios. A number of questions were raised in relation to how loadings would change with management scenarios, the influence and validity of various modelling assumptions, and how geomembrane covers should be carried forward in the analysis using longer modelling time frames that can demonstrate their benefits.
- **Tributaries:** The TAC reviewed and discussed Teck's approach for considering tributaries to the Elk and Fording Rivers during the development of the Plan and managing effects in tributaries during Plan implementation. Key discussion points were the management units for tributaries, the availability of data for tributaries, and the extent of the effects assessment for tributaries during the development of the Plan. The TAC recommended that any trade-offs between tributaries need to be made explicit in the development of the Plan and in the Plan itself.
- **Calcite:** The TAC reviewed and discussed Teck's approach to assessing the impacts of calcite formation. The TAC discussed that Teck has very limited information to determine the effects of calcite. The TAC

acknowledged the challenges with setting targets as outlined in the Order given this lack of baseline information. In light of this information, the TAC member for the Ministry of Environment stated that they will seek direction from the Order Manager[1] with respect to setting calcite targets.

- **Adaptive Management:** The TAC highlighted the importance of adaptive management as a core element of the Plan given the uncertainties and data gaps. The TAC recommended an adaptive management framework be developed, which should include the explicit treatment of uncertainty, and identification of triggers and targets associated with follow-up actions. Teck confirmed that adaptive management will be an important part of the Plan.
- **TAC Advice:** The TAC's specific technical advice on the topics discussed at TAC Meeting 4 is summarized in two separate appendices[2] to this Meeting Summary, which will be posted on the public website on April 10, 2014.

Meeting Participants

At least one representative from each TAC member agency was present. The nine TAC members represent:

- Teck;
- the Ministry of Environment (BC);
- the Ministry of Energy and Mines (BC);
- the Environmental Assessment Office (BC);
- the Government of Canada represented by Environment Canada;
- the US Federal Government represented by US Geological Survey;
- Montana State Government represented by Department of Environmental Quality;
- the Ktunaxa Nation Council;
- an independent third-party qualified professional scientist.

Presentations and Discussions

Selenium Ecological Effects Assessment Methodology

Teck made their second presentation to the TAC on their overall assessment methodology for developing matrices of potential effects of aqueous selenium concentrations. The selenium effects matrices will estimate the effects of selenium bioaccumulation in fish, birds, amphibians, and invertebrates, which are species that are

[1] The "Order Manager" is the Statutory Decision Maker (SDM) for the *Environmental Management Act,* which is the provincial legislation under which the Ministerial Order for the Elk Valley Water Quality Plan was enacted. The Order Manager advises Teck and the TAC on any scope or process questions that arise during the development of the Plan.
[2] *Appendix A – TAC Technical Advice Received at TAC Meeting 4* **and** *Appendix B – TAC "Technical Advice" Received After TAC Meeting 4.*

sensitive to selenium.

The TAC discussed the two main steps for developing a selenium effects matrix:

- Using toxicity studies reported in the literature and BC water quality guidelines to define the sensitivity of aquatic species to a range of selenium concentrations in their tissue; and,
- Using sampling data collected from the Elk Valley to develop selenium bioaccumulation models that estimate the selenium tissue concentration of a species for a given selenium water quality concentration.

The TAC discussion centered on the bioaccumulation models. Teck presented a multi-step bioaccumulation modelling approach, which is a series of regression models describing the successive uptake and transfer of selenium through the aquatic ecosystem food chain. Below is a list of the regression models that make up the multi-step bioaccumulation modelling approach:

- Step 1: Aqueous selenium to Periphyton (algae) in Lentic (slow moving water) areas
- Step 1: Aqueous selenium to Periphyton (algae) in Lotic (fast moving water) areas
- Step 2: Periphyton to Invertebrates
- Step 3: Invertebrates to Westslope Cutthroat Trout Egg Clutches
- Step 3: Invertebrates to Red-winged Blackbird Egg Clutches
- Step 3: Invertebrates to Amphibian Eggs

The TAC discussed the merits of the multi-step bioaccumulation modelling approach over the one-step bioaccumulation modelling approach. The one-step approach estimates the direct relationship between selenium water quality concentrations and tissue concentrations in fish, birds, amphibians and invertebrates. For example, the one-step approach does not try to estimate selenium bioaccumulation from water to periphyton.

A key discussion point at the TAC meeting was the water to periphyton step because this is the step where the highest magnitude of selenium bioaccumulation in tissue occurs. This step also has the highest variability in sampling data between a given selenium water quality concentration and the selenium tissue concentration in periphyton. The TAC made some suggestions for further analysis on the water to periphyton step as well as the invertebrate to amphibian step. Several TAC members stated that it is important for Teck to provide a detailed summary of uncertainties associated with the modelling.

Another key discussion point at the TAC meeting was the methodology for assessing the exposure of fish to selenium across three aquatic habitats – lotic mainstem of the Fording and Elk Rivers, lentic areas along these mainstems and tributaries to the mainstems. The methodology Teck presented is to first estimate effects assuming that fish spend all of their time in just one of these habitats. The integrated potential effect to fish across a reach (sub-area) is calculated as an average of the potential effect in each habitat, weighted by the area of that habitat present in a reach. Teck stated that there is limited data to confirm that this method accurately represents the exposure of fish to selenium across a reach, which is why they are currently undertaking a fish telemetry study to obtain data on the habitat use of Westslope Cutthroat Trout in the Upper Fording River. The TAC stated that it is important to present both of the effects separately for these three habitats as well as the estimate of the integrated effect on a population across the habitats.

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Cadmium Ecological Effects Assessment Methodology

Teck made their second presentation to the TAC on their overall assessment methodology for developing matrices of potential effects of aqueous cadmium concentrations.

The toxicity of cadmium to aquatic organisms is dependent on the concentration of other substances in the water. These substances are called "Toxicity Modifying Factors (TMFs)" and they can affect the ability of cadmium to bind with biotic ligand[3] (e.g. gill surface). For instance, higher concentrations of substances associated with hard water can reduce the binding of Cd to the gill surface, causing a reduction in the bioavailability[4] and toxicity of the metal to an aquatic organism.

At the meeting, Teck presented on the two methods that can be used to estimate the toxicity of cadmium given the presence of different levels of toxicity modifying factors: (1) the hardness equation and (2) the Biotic Ligand Model (BLM). The main difference between these approaches is that the hardness equation only considers how cadmium bioavailability varies with the concentration of one toxicity modifying factor (water hardness), and the BLM considers how cadmium bioavailability varies in the presence of a fuller set of toxicity modifying factors (e.g. hardness, pH, dissolved organic carbon).

The TAC discussed the advantages and disadvantages of these two methods. In particular, some TAC members inquired whether adequate data is available to inform and validate the BLM approach. It was agreed that both methods would be used in assessing effects of cadmium.

Nitrate and Sulphate Ecological Effects Assessment Methodology

Teck gave a presentation on their nitrate and sulphate ecological effects assessment methodology. The methodology for estimating the effects of these substances is to measure the associations between exposure of organisms to these substances and the response of organisms through controlled laboratory toxicity testing. To obtain data on the exposure-response relationship for nitrate and sulphate, Teck has completed a review of the literature with results from relevant toxicity tests and has conducted their own toxicity testing using site water from the Fording River and Elk River.

Fish, invertebrates, and amphibians have been identified as sensitive organisms for nitrate and sulphate and therefore exposure-response benchmarks have been estimated for these organisms. The Elk Valley also supports a diverse assemblage of birds and mammals, many of which use streams as sources of drinking water. However, because uptake of nitrate and sulphate occurs primarily through direct contact with water, organisms that are exposed through dietary uptake are less sensitive than organisms that live within nitrate- or sulphate-containing waters. On this basis, wildlife were not identified by Teck as sensitive receptors for nitrate or sulphate.

The TAC discussed the protocols for the site-specific toxicity testing conducted by Teck and the screening process

[3] In this context, a "biotic ligand" is a molecule on an organism that can bond to a metal atom, such as cadmium.
[4] The term "bioavailability" refers to changes in the toxicity of a metal to aquatic organisms that result from changes in the composition of the exposure water. These bioavailability effects may be caused by factors that affect the chemical speciation of the metal (such as organic matter), or they may result from factors that inhibit the interaction of metal ions with biological surfaces (such as elevated calcium, which is associated with harder water).

for determining the relevance of toxicity studies reported in the literature. The TAC also discussed that direct toxicity effects are not the only pathway of effects for elevated concentrations of nitrate, and that eutrophication[5] can also be a risk, especially if future developments in the watershed (may or may not be mining related) lead to additional phosphorus in the aquatic environment.

Management Scenarios

Management scenarios are the different combinations of mitigation measures that can be applied to reduce the concentrations of selenium, cadmium, nitrate and sulphate in the water discharged from waste rock piles.

The TAC reviewed the set of mitigation measures considered within the Plan and asked for more information on why some mitigation measures were not being considered. Most of the discussion centered on why the placement of geomembrane covers on certain waste rock piles were not considered feasible mitigation measures. Based on this feedback, Teck will be providing the TAC with more rationale on why geomembrane covers are considered potentially feasible for some waste rock piles and not for others.

The TAC reviewed and discussed the approach for developing management scenarios and the emerging patterns from preliminary water quality modelling of management scenarios. Three preliminary management scenarios were modeled: (1) active water treatment (AWT), (2) AWT + clean water diversion (CWD), and (3) AWT + CWD + geomembrane covers.

The TAC was generally comfortable with Teck's approach to developing management scenarios. Their main feedback was to present a sufficiently long time-frame for modelling of management scenarios so that the long-term benefits of geomembrane covers could be estimated. The TAC also asked for further validation of some modelling assumptions related to the effectiveness of mitigation measures.

Tributaries

Teck gave a presentation on their approach for considering tributaries to the Fording River and the Elk River during the development of the Plan and managing effects in tributaries during Plan implementation. Teck explained that their approach for tributaries during Plan development includes three components:

1. Assessing current conditions in tributaries through a Synthesis Report of the data collected in the Regional Aquatic Effects Monitoring Program (AEMP);
2. Estimating future conditions in tributaries; and,
3. Assessing potential integrated effects in tributaries and mainstem Fording and Elk rivers for the purposes of setting targets at Order Stations.

The TAC discussed the available data for tributaries and the methodology used in the AEMP for determining effects in tributaries. The TAC agreed that the Plan needs to highlight the uncertainties that remain, qualify the

[5] Eutrophication refers to the process by which a body of water becomes enriched in dissolved nutients (e.g. nitrogen and phosphorus) that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

targets with respect to these uncertainties and develop an adaptive management framework to address the uncertainties. A TAC member also remarked that ultimately the Plan may require tradeoffs in the watershed between tributaries and asked that these trade-offs are clear in the documentation of the Plan.

Calcite

Teck gave a presentation on their approach for assessing the impacts of calcite precipitation in the Elk Valley. The presentation included background on the chemical processes involved in calcite precipitation in Elk Valley streams, an overview of current efforts to measure the extent of calcite precipitation in the Elk Valley, Teck's plan for assessing the potential impact of calcite through regional and local Aquatic Effects Monitoring Programs, the management options to control calcite precipitation, and a draft narrative objective for calcite.

The TAC discussed that Teck has very limited information to determine the effects of calcite. The TAC agreed that if calcite effects cannot be quantified at this point then a long-term target cannot be set. However, it was mentioned that since there is information on the spatial extent and magnitude of calcite formation and the concept of the Order was to stabilize and decrease, then setting a medium-term target should be possible. In light of this information, the TAC member for the Ministry of Environment stated that she will seek direction from the Order Manager with respect to setting calcite targets.

Adaptive Management Framework / Plan Implementation

At several points during the meeting, the TAC expressed a need for the Plan to include periodic review and an adaptive management approach to confirm that targets are protective of the aquatic ecosystem and to revise targets if necessary. The TAC agreed that TAC discussions of uncertainties will inform their advice on the adaptive management approach and will help to prioritize additional work to confirm or modify targets. Teck confirmed that they plan to have periodic updates of the effects assessments and that the Plan will include an adaptive management framework. A TAC Member stated that successful adaptive management frameworks provide specific triggers, feedback loops and actions, as well as linkages to future regulatory processes.