LINKING ENVIRONMENTAL ASSESSMENT TO ENVIRONMENTAL REGULATION THROUGH ADAPTIVE MANAGEMENT

Kathleen I Racher,*† Neil Hutchinson,‡ Don Hart,§ Brian Fraser,§ Bev Clark,‡ Ryan Fequet,† Patty Ewaschuk,† and Mark Cliffe-Phillips†
†*Wek'èezhìi Land and Water Board, Yellowknife, NWT, Canada*
‡*Hutchinson Environmental Sciences Ltd., Bracebridge, ON, Canada*
§*Ecometrix Incorporated, Mississauga, ON, Canada*
**racherk@wlwb.ca*
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The Wek'èezhìi Land and Water Board (WLWB), the regulator for 2 large diamond mines in Canada's Northwest Territories, has noted that there does not appear to be any standard method for applying the principles of adaptive management, as described in the academic literature, to developments such as operating mines. The WLWB has attempted to address this issue through the development of a draft document, entitled ''Guidelines for Adaptive Management—a Response Framework for Aquatic Effects Monitoring'' which, if approved, will apply to all mines under WLWB jurisdiction. These guidelines define a transparent and consistent method for responding adaptively to project-related environmental changes measured through environmental monitoring programs. The WLWB is unaware of similar requirements and/or guidance in other jurisdictions and therefore offers a summary of the guidelines to generate further discussion and comment.

The WLWB seeks to prescribe, in regulatory permits, the principles of adaptive management by requiring proponents to develop a Response Framework specific to their project and its particular environmental setting. The Response Framework assumes that the best management actions need not be defined a priori but will be determined in response to specific changes documented by environmental monitoring programs. It provides the means to respond to all reasonable monitoring outcomes, without the need to develop specific management responses to all possible outcomes before they occur. The Response Framework is therefore a systematic approach to responding to the results of an environmental monitoring program.

The Framework requires proponents to take appropriate actions upon reaching predefined levels of environmental change (or effect). These action levels are, in turn, set such that significant adverse impacts never occur. It is therefore critical that the Response Framework contains a quantitative or qualitative definition of what ''significant adverse impacts'' would be for a project in a given environment. The WLWB uses the term ''significance threshold'' to describe the threshold where an environmental change would be considered significantly adverse. Knowledge of this threshold from the environmental assessment (EA) allows the regulator to react appropriately to environmental change measured after the project has moved into the regulatory phase.

To ensure that the significance threshold is never reached, the Response Framework involves 3 action levels (low, moderate, and high) corresponding to increasing levels of environmental change (Table 1). Each action level is associated with a corresponding management response. Note that the Low Action Level is pre-emptive in nature and is meant to be set by the proponent in advance of actually measuring an environmental change. The others are set within the Response Framework, in response to systematic review of monitoring results. The EA process contributes to the development of a Response Framework by documenting the predictions of environmental change that are considered significant. With a clear definition from the EA of changes to be avoided, the Response Framework can set action levels and mitigation responses designed to ensure that such changes do not occur. However, it has been noted that the EA process does not always provide a clear description of what a significant adverse effect (i.e., the significance threshold) would be for the project. It is possible that the EA determination proceeds to a reasonable and defensible conclusion of no significant adverse effect without a clear understanding of what changes would be significantly adverse. In this case all we can know is that the EA predictions can potentially fall anywhere between baseline conditions and the significance threshold. This should not normally pose a problem—the project proceeds, changes remain within predictions, and stakeholders remain confident in the outcome of the EA process.

The lack of a predefined threshold for a significant adverse effect becomes a problem, however, if environmental changes exceed predictions, or if changes occur that were not predicted. Does this mean that the project now has a significant adverse effect, or does it simply reflect the uncertainty inherent in predictions? Regulators must decide what is the appropriate management response to observed project-related environmental changes. For example, if an EA prediction is exceeded during operation of a mine, should the regulator suspend the permit, require the implementation of costly mitigation measures or simply

Table 1. Relationship between Monitoring Results, Action Levels, and Management Actions

Environmental monitoring result	Action level exceeded	Management actions
Trend away from background but below benchmark concentrations No biological effect measured	Low	• Investigate trend and implications • Identify potential mitigation options • Set Moderate and High Action Levels
Benchmark exceedance or biological effect is imminent or has been measured in the area where effects were predicted in the EA	Moderate	• Implement mitigations to stop or slow trend
Benchmark exceedances or biological effects are measured that are above EA predictions but below significance threshold	High	• Implement mitigations to reverse trend • Environmental remediation may be necessary

order further monitoring? The appropriate response depends on how closely the observed environmental change approaches a significance threshold. Environmental measurements that reach the threshold would constitute a significant adverse effect, while measurements below the threshold would not, even if they were not predicted in the EA.

If significance is not explicitly defined during the EA, the Response Framework would be the vehicle for setting significance thresholds during the regulatory phase of a project. The Framework envisions the proponent recommending significance thresholds based on project-specific details, including information from the EA. The WLWB would then seek stakeholder input on the proposed thresholds before a Response Framework document is approved.

Setting the significance threshold, during either the EA or the regulatory phase of a project, can be a difficult process. For example, many stakeholders are reluctant to define a limit of acceptable change because they fear that it will become a ‘‘pollute up to’’ limit or an excuse not to take any mitigative action until the limit is reached. The Response Framework would require, however, that action be taken well below the significance threshold and thus maintain the intent of pollution prevention. Furthermore, although it will be challenging to predefine significance thresholds (and associated action levels) for a project, the alternative is having the debate only after some environmental changes or effects have already been measured. In the latter case, unnecessary delays in implementing appropriate management response actions may occur, hindering our ability to minimize project-related effects in a timely and effective way. Finally, although the WLWB already has the ability to assess monitoring results on an on-going basis and decide what action to take, the establishment of a Response Framework—with a well-defined significance threshold and action levels—makes the process more transparent and consistent for all parties.

[Note that the guidelines are in draft form and have not been approved by the WLWB. Please contact K. Racher - racherk@wlwb.ca - if you wish to receive a copy].

LINKING INCINERATION TO DIOXINS AND FURANS IN LAKEBED SEDIMENTS (OR, THE CASE OF THE MISSING WATER LICENSE CONDITION)

Anne Wilson,*† Dave Fox,† Gary Poole,‡ and Ron Bujold†
†*Environment Canada, Yellowknife, Northwest Territories, Canada*
‡*Environmental Science and Technology Centre, Ottawa, Ontario, Canada*
**anne.wilson@ec.gc.ca*
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Remote mining developments in Canada’s North typically have camp accommodations housing from 200 to 1100 persons and use incinerators to dispose of camp waste. Air emissions from waste incinerators account for a significant portion of dioxins and furans entering the environment (Su and Christensen 1997; CCME 2001a). Operators are encouraged to meet the Canadian Council of Ministers of the Environment Canada-Wide Standards for Dioxins and Furans (CCME 2001b), using appropriate technology and diligent operation to minimize harmful emissions. However, air emissions in the Northwest Territories and Nunavut fall into a regulatory gap, unregulated by land use permits and water licenses. Regulators issuing water licenses to large-scale mining developments have been reluctant to include license conditions, which are seen to fall outside direct water-related aspects.

To draw the link between compounds deposited on land and lake surfaces from incinerator stacks, and their transport to and potential accumulation in aquatic systems, Environment Canada conducted a limited sediment sampling program for dioxins and furans in the vicinity of the Ekati Diamond Mine camp incinerators. Activity at the Ekati mine site began in the early 1990 s with an exploration camp and progressed to completion of the mine camp by 1998. Waste incineration has been practiced throughout this period and continues today. The mine camp and incinerators are situated on the north shore of Kodiak Lake, which has a drainage area of 28.7 km^2.

Sediment cores were collected 7–9 April 2008 from Kodiak Lake and Counts Lake (a reference site) using a Glew sediment corer. Kodiak Lake samples were collected from 2 sites, designated K1 and K2. K1 samples were taken from near the deepest basin of the lake (7175581E and 518243N), from holes that were between 2 and 3 m apart, with water depths of 9.8 to 10.5 m. K2 was located in an area with a small 6-m deep basin (7175851E and 518231N). Reference samples were taken from water depths of 10.5 to 11.0 m in Counts Lake (7169852E and 533690N). Five replicates were collected from each site. Sampling and sample handling followed protocols specified by the Environmental Science and Technology Centre (ESTC) laboratory to ensure that contamination of the samples did not occur. Cores were frozen and shipped with dry ice to the ESTC for slicing and analysis of the top layers for dioxins and furans. Freezing of the cores resulted in ‘‘mounding’’ of the sample within the tube, which precluded precise slicing of the sample. Instead, approximately the first 5 cm (1.0 g dry weight) of each core was separated manually, with the visually distinct top layer scraped off for analysis. The second visually discrete layer (0.75 to 1.25 cm) was removed and stored separately. The underlying third and fourth slices were each 1 cm in thickness. The ESTC provided analytical results for 17 polychlorinated dibenzo-*p*-dioxin (PCDD) and polychlorinated dibenzofuran (PCDF) congeners, with detection limits of 0.3 to 0.9 pg/g dry weight. Toxic equivalencies (TEQs) were calculated using toxic equivalency factors for fish (CCME 2001a).

What We Found

Figure 1 shows the mean TEQs for each depth layer at each site. Table 1 provides mean total TCDD and TCDF concentrations for each sampling site. Total PCDD and PCDF concentrations in surficial sediments were generally an order of magnitude higher at the exposure site than at the reference site. Surficial sediment TEQs of total PCDDs and PCDFs exceeded the Canadian Sediment Quality Guidelines (CCME 2001a) at both Kodiak Lake stations. These compounds are chemically stable, persist in lake sediments, and are expected to continue to accumulate as long as there are ongoing inputs from combustion sources. Snowfall can influence accumulation and subsequent transport of hydrophobic, low volatility