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Science-Based Solutions
Solutions fondées sur la science

Development of this series of factsheets was coordinated by the National Guidelines and Standards Office of Environment Canada to consolidate information on the variety of existing approaches to the assessment of sediment quality in Canada and to highlight sediment assessment programs developed by Environment Canada. Additional factsheets will be added to the series as new sediment assessment tools or programs are developed to highlight significant work across the Federal government.

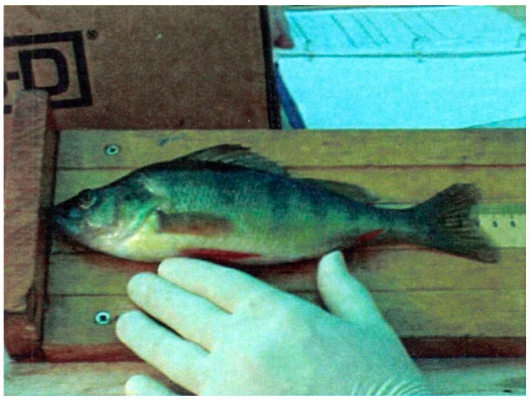
SEDIMENT ASSESSMENT SERIES

Environmental Effects Monitoring (EEM): Metal Mining and Pulp and Paper Mill Effluent Regulations

Factsheet 5

Program Description

Sediments are an integral component of aquatic ecosystems. They provide habitat and food resources to benthic organisms, and can act as both a sink for and source of contaminants that enter aquatic systems from point sources, such as metal mine or pulp and paper mill effluent. Bioavailable contaminants in sediments can enter aquatic food webs, thereby affecting the quality of the habitat. Consequently, the assessment of sediment quality is a key component of an effective Environmental Effects Monitoring (EEM) program.



Managed and coordinated by Environment Canada, the EEM program is a scientific tool used to determine if industrial effluent adversely affects fish health, fish habitat and the human use of fisheries resources. The Canadian pulp and paper industry is currently required to conduct EEM under the *Pulp and Paper Effluent Regulations* (PPER) under the *Fisheries Act*. The *Metal Mining Effluent Regulations* (MMER) require that all Canadian metal mines conduct EEM, as part of the mine's authority to deposit effluent, under the *Fisheries Act*.

The EEM program is structured in a sequence of monitoring and interpretation phases or cycles that are carried out every two to six years, depending upon the monitoring results of the previous cycle. For example, mines that are causing effects in both fish and benthic invertebrates will be required to complete their monitoring every two years. A study design is submitted by each regulated facility to Environment Canada, outlining their site-specific monitoring program prior to conducting EEM. A summary of the field work and an interpretation of the results are submitted to Environment Canada in the form of an "interpretative report" by individual mills and mines at the end of each EEM cycle.

What's Inside

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Conducting a benthic invertebrate community survey is a requirement of the EEM program. Benthic communities are assessed to determine if there are effects on fish habitat, since the pollution prevention provisions of the *Fisheries Act* are intended to protect fish, fish habitat and the use of fisheries resources. Whole sediment chemistry (compared to Canadian Sediment Quality Guidelines) and whole sediment toxicity testing are recommended as part of EEM for metal mining and pulp and paper mills. If effects are found in the receiving environment, these tools may be used to aid in the interpretation of the biological monitoring results, and possibly in the determination of the cause of effects found in fish or benthic invertebrates.

Metal Mining Effluent Regulations

Approach Used

Prior to the development of the EEM program as a requirement in the MMER, the Aquatic Effects Technology Evaluation (AETE), under Natural Resources Canada, reviewed and evaluated technologies for the assessment of mining-related impacts in the aquatic environment. The intention of the program was to evaluate and identify cost-effective technologies in order to apply sound scientific principles to the EEM program. The results of this initiative, along with recommendations from a multi-stakeholder AQUAMIN (Assessment of Aquatic Effects of Mining) working group, formed the basis for the assessment tools and program requirements of the metal mining EEM program.

The EEM program is based on a tiered monitoring approach (Initial, Periodic and Focussed Monitoring and Investigation of Cause) with the requirements of each monitoring phase dependent upon the results of the previous monitoring (see box below). Initial Monitoring is the first EEM study that a mine conducts upon being subject to the MMER and is completed within three years (see box below). The frequency of the second and subsequent EEM studies is dependent upon previous results. Generally, a mine will complete EEM studies every three years. However, if after two consecutive EEM studies a mine finds no effects in fish and the benthic invertebrate community, the mine can reduce its monitoring frequency to every six years. Alternatively, if after two consecutive EEM studies a mine has effects in either fish or the benthic invertebrates, the frequency of its EEM studies is increased to every two years, and the mine must also determine the magnitude, geographic extent and cause of those effects.

EEM Monitoring Tiers

Initial Monitoring:
- determine if the mine effluent has had an effect on fish and benthic invertebrates in the exposure area nearest to the effluent discharge

Periodic Monitoring:
- confirm results
- detect changes in receiving environment
- generate long term trend data

Focussed Monitoring:
- determine the cause, magnitude, and extent of effects

As part of each EEM benthic invertebrate survey, mines are required to collect sediment samples for analysis of particle size distribution and total organic carbon. When mines move into a Focussed Monitoring program, it is recommended that each sediment sample also undergo a chemical analysis, to determine if there are habitat differences, and to potentially aid in the determination of cause. Whole sediment bioassays may also be recommended if the mine effluent is having effects on the benthic invertebrate community.

The Sediment Quality Triad approach (e.g., Chapman 1986, 1990, 1996), or elements of it, may also be used during Focussed Monitoring and Investigation of Cause to aid in the interpretation of results. The triad integrates sediment chemistry, toxicity and benthic community data in a weight-of-evidence approach, rendering the analysis and interpretation more powerful than if each component were interpreted individually.

Initial Monitoring — Benthic Community Descriptors

Required Effect Endpoints	Total invertebrate density Taxon richness Simpson's diversity index Bray-Curtis index
Supporting Endpoints	Evenness Taxon (Family): density, proportion, presence/absence

The "*Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring*" (Environment Canada 2002) provides guidance on conducting a scientifically defensible EEM study, including detailed descriptions of the recommended sediment assessment methods.

Strengths and Limitations

The EEM program benefits from assessing the effects of mining effluent on natural assemblages of organisms. This approach has the advantage of being flexible and can be tailored to site-specific conditions. When necessary the causes of effects can be addressed using tools, such as specific sediment assessment techniques designed to meet the objectives of a Focussed Monitoring or an Investigation of Cause phase of the EEM program. This effects-based approach facilitates decision making based on known environmental effects.

The principal limitation of this approach is time. Initial Monitoring results are received by Environment Canada three years after program start-up. Within the tiered monitoring approach, mines can confirm effects before moving into Focussed Monitoring or Investigation of Cause. To balance the time frame necessary for conducting biological monitoring, the EEM program includes requirements that mines conduct quarterly effluent and water quality monitoring, as well as sub-lethal toxicity testing twice a year, in addition to the more frequent compliance monitoring that is required under the MMER.

Outcome

The EEM program for metal mining is designed to generate detailed environmental effects-based data on over 100 mine sites across Canada to ensure the health of aquatic systems and the continued use of the associated fisheries resources. The use of a variety of sediment assessment tools is critical in this process. This information will be useful in assessing the effectiveness of environmental protection measures that are in place, including the MMER. In addition, an Environment Canada policy document will outline the steps to be taken, outside of EEM, when effects have been identified, and the causes of these effects are known. This policy document is the basis for using EEM results in the decision-making process for environmental protection and management.

Pulp and Paper Mill Effluent Regulations — Regional Implementation

Program Description

Regional implementation of the National EEM Program for pulp and paper mills is coordinated by Environment Canada staff in five regions of Canada. In April 2000, 126 pulp and paper mills across Canada conducted EEM studies.

Approach Used

Environment Canada's Regional Directors of Environmental Protection have the role of the Authorization Officer (AO) in the implementation of EEM. The AO is responsible for forming Technical Advisory Panels (TAPs) or Local Monitoring Committees (LMCs). Membership of the TAPs/LMCs consists of mill staff and their consultants, and representatives from federal and provincial environment departments and agencies. The AO is the chair of these committees.

The TAPs/LMCs meet to review, discuss and implement EEM requirements on a site-specific basis. Provincial representation makes the TAPs/LMCs an ideal forum to discuss any additional monitoring requirements associated with the mills' provincial discharge permits. The role of the TAPs/LMCs is to make recommendations to the AO on the adequacy of study designs, such as the level of resolution, location of sampling stations and quality assurance/quality control practices. As well, these committees will review interpretative reports and advise the AO on the quality of data, the validity of conclusions and the frequency of subsequent monitoring.

Strengths and Limitations

The TAPs/LMCs are also useful arenas for the exchange of information on other environmental studies or research occurring within the watershed. This allows for cooperation and coordination of scientific resources.

The major challenge identified to date concerns tailoring the national monitoring requirements into meaningful, site-specific sampling designs while at the same time maintaining national and regional consistency. Receiving available information and environment characteristics may influence the level of

effort required at each mill site to meet EEM requirements. The importance of "confounding factors" (e.g., other discharges) and the selection of appropriate exposure and reference areas also pose challenges to specific program design.

Outcome

Notwithstanding these challenges, the EEM program provides a framework to review the state of the environment and mill history at each site, and design focussed monitoring programs which meet the nationally consistent requirements associated with the regulations.

WANT MORE INFORMATION?

Website: www.ec.gc.ca/eem

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