AQUATIC ENVIRONMENTAL EFFECTS

MONITORING REQUIREMENTS

Environment Canada

Department of Fisheries and Oceans

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1.0 INTRODUCTION

1.1 Background

Industrial sectors and/or sites regulated under the Fisheries Act are required to undertake Environmental Effects Monitoring (EEM) as an integral part of their responsibilities under the regulations.

The application of regulations based on uniform effluent standards alone may not, in all cases, provide protection of the receiving environment. Furthermore, short-term tests of effluent toxicity do not accurately predict the effects of persistent chemicals that bioaccumulate, the cumulative effects on fish of lifetime effluent exposure, or the influence of environmental conditions on effluent toxicity. The overall adequacy of effluent regulations therefore is assessed by monitoring for environmental effects at each receiving water site.

Many Canadian industrial sites have conducted effects monitoring in the past in response to government priorities and emerging environmental issues. In order to achieve national uniformity in these studies, an Environmental Effects Monitoring (EEM) requirement shall be included in future regulations dealing with effluent discharges to fish habitat.

1.2 EEM Regulatory Requirement

Beginning in 1992, all new effluent regulations will require the regulated sites to conduct EEM.

1.3 EEM Objectives

The objective of the Environmental Effects Monitoring program is to assess the adequacy of national regulations for protecting fish, fish habitat and the use of fisheries resources. Adequacy is assessed on the basis of:

- the magnitude of site-related effects, if any, in receiving environments; and
- the spatial extent of site-related effects, if any, taking into account the presence of other potential sources of effects.

Successive cycles of EEM allows the assessment of:

- temporal changes in the degree and/or spatial extent of any site-related effects on fish, fish habitat and the use of fisheries resources.

On a national basis, EEM data will be examined, relative to effluent compliance data, to determine the adequacy of the regulations in protecting fish, fish habitat, and the use of fisheries resources.

For the purposes of the EEM program, the following definitions apply:

- "effect" - a significant difference measured in an environmental variable between a receiving area and a reference area; examples of effects on fish and fish habitat include changes in the health of fish, distortion of fish population structure or the life cycle of fish, deterioration of habitat essential for growth and sustenance of fish, or accumulation of substances in fish to levels prejudicial to human health and/or the marketability of fish. The statistical significance required to measure an effect will be determined on a site-specific basis; furthermore, statistical significance does not necessarily imply a failure to protect fish, fish habitat or the use of fisheries resources;

- "environment" - is the sum of the physical, chemical and biological conditions upon which fish depend to live;

- "fish" - includes shellfish, crustaceans, marine animals, and the eggs, spawn, spat and juvenile stages of fish, shellfish, crustaceans, and marine animals (Fisheries Act, Chap F-14, sec.2);

- "fish habitat" - means spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes (Fisheries Act, Chap F-14 sec.34(1));

- "fisheries resources" - means fish stocks or populations that sustain Canadian commercial, recreational or native fisheries;

- "monitoring" is a sequence of measurements over space and time, for the purpose of characterizing environmental conditions;

- "reference area" - is an area with zero exposure to effluents or deposits from the site under study, but otherwise comparable to an exposure area, and if possible on the same waterbody capturing any effects of inputs to the study area from upstream or other sources.

1.4 General Program Requirements

The EEM program requirements ensure consistency in data collection, analysis, and interpretation. The program also addresses site-specific concerns in a meaningful way. This is accomplished through:

- common objectives;

- a specific set of sampling variables which may include "core" and "site-specific" elements; core elements are those variables which apply to the entire industrial sector while site-specific elements are those which apply to select components of a sector based on defined selection criteria;

- recognized performance standards and associated quality assurance requirements;
- common design principles; and
- guidance on data interpretation.

Monitoring variables to be included in the EEM program are selected based on the following criteria:

- relevance to the detection/quantification of adverse effects, or likely adverse effects, on fish, fish habitat or fisheries;
- availability to the commercial sector of well-established methodology, having appropriate levels of sensitivity, accuracy, and precision; and
- amenability to consistent scientific evaluation and interpretation with a high degree of confidence.

During the first cycle of EEM, emphasis will be placed on good quality assurance (QA) and quality control (QC) practices and standardized, specific performance criteria as outlined in the relevant Annex. Each regulated site is responsible for ensuring that data meet the performance criteria and are properly documented. Additional quality assurance (QA) procedures, such as on-site sampling and data audits, will be conducted on a random basis.

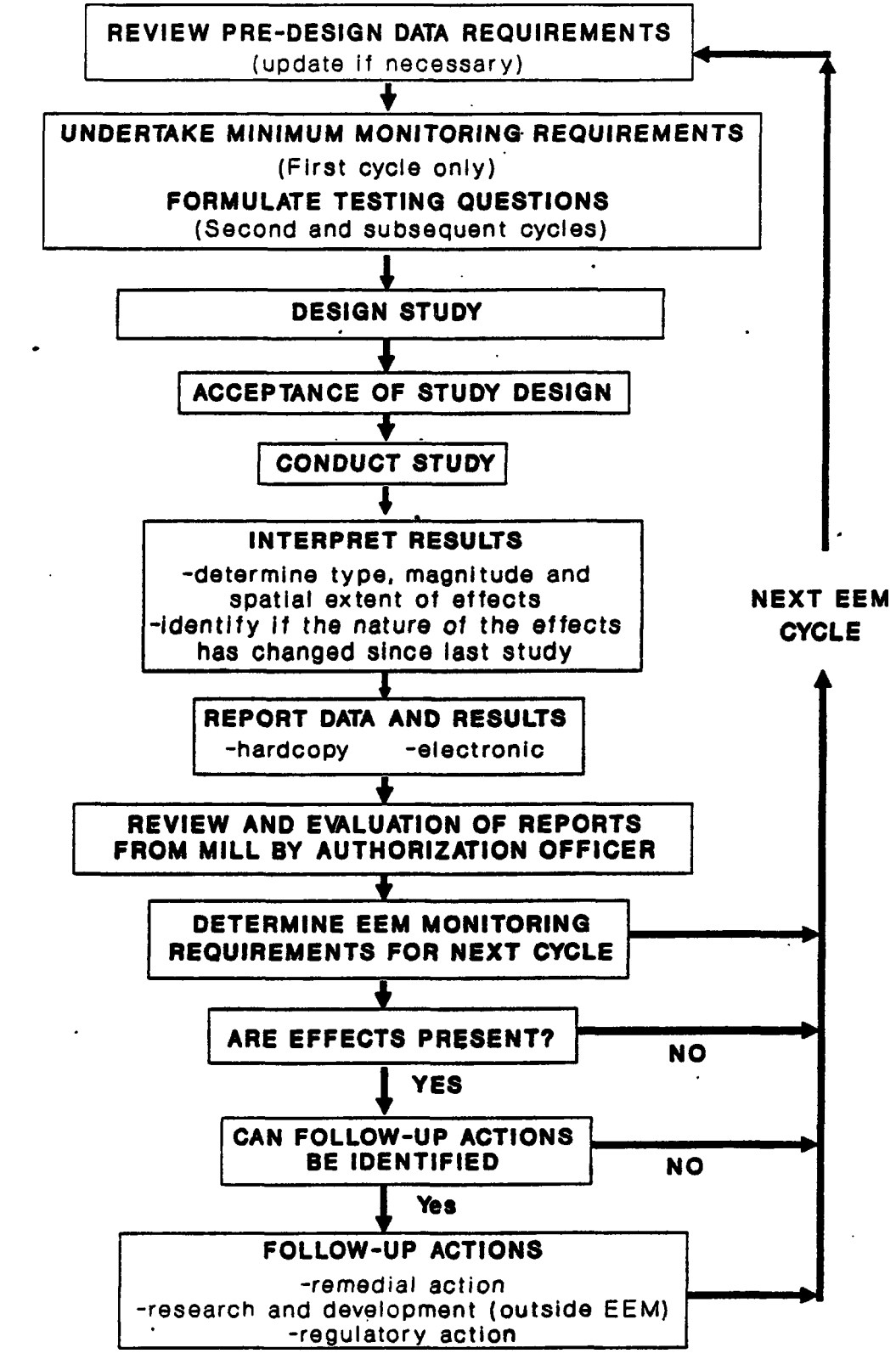
2.0 EEM REQUIREMENTS

2.1 Overview

Aquatic environmental effects monitoring is a sequential series of monitoring and interpretation cycles. Each cycle consists of a sequence of tasks and decision points, as outlined in the accompanying figure, which are applicable to all sectors and/or sites to which Fisheries Act regulations apply. An EEM program is evolutionary in that the requirements of subsequent EEM cycles will be determined following an evaluation of the results of previous cycles. The following principles are to serve as a guide in its evolution. The program must:

1) be scientifically defensible;
2) be cost-effective;
3) be flexible so that new or improved monitoring techniques can be incorporated;
4) be able to build on the findings of relevant research programs;
5) be manageable with respect to its requirements and timeframes;
6) generate interpretable results;
7) use a weight of evidence approach to interpret results with respect to effects; and,
8) provide defined decision points.

SEQUENCE OF EVENTS INVOLVED IN EEM STUDIES



Annexes to this document outline the requirements for specific regulated sectors or sites. Each shall refer to the relevant Annex in conducting a monitoring program. Regulated sectors and sites may follow the recommended principles and methodologies outlined in the technical guidance manuals issued from time to time by the government.

It is recognized that the requirement to undertake an EEM program may be associated with new regulatory requirements for effluent treatment. Consequently, there may be a transition period associated with installation of new control technologies; this will be considered in defining the requirements for the first cycle and in interpreting the results of that cycle.

2.2 Pre-Design Data Requirements

The pre-design requirements are set out in the relevant Annex for each regulated sector or site and may include both core measurements and measurements of other variables, triggered by site-specific conditions. These requirements are necessary to:

1) delineate the spatial extent of the study area, including the zone of effluent mixing and representative reference areas;
2) provide confirmation at the time of field sampling that the samples collected are representative of these areas;
3) provide a description of habitat type at a level of resolution sufficient to allow siting of invertebrate and sediment sampling stations;
4) document any potentially confounding or influencing factors that may have to be considered in the study design and/or interpretation of results;
5) provide a knowledge of the relative abundance of fish in the study area sufficient to allow the selection of a minimum of two sentinel fish species; and,
6) describe the quality and use of fisheries resources in the receiving environment to assist in the setting of statistical criteria in the second EEM cycle.

The pre-design phase must be completed prior to submission of the EEM study design. After the first cycle of EEM, the pre-design information requirements do not need to be repeated as long as the operations of the industrial site, or receiving environment conditions, have not changed substantially since the previous EEM cycle.

The acceptability of historical data will be determined based on the principles, methodology, and quality assurance standards presented in the Annex.

2.3 EEM Study Design

EEM design involves the formulation of testable questions, the selection of variables to be sampled and determination of sampling locations (including reference areas), the determination of the number of samples required for each variable, and the timing of sample collection.

Each EEM program shall be designed to answer the following questions for each effect of interest:

- does the effect occur?
- what is the magnitude of the effect?
- how far does the effect extend?
- has the magnitude or extent of the effect changed since the last EEM cycle?

These questions reflect the EEM objectives presented in Section 1.0. Each of these questions will not necessarily be addressed in each EEM cycle. The first cycle of EEM will be used both to establish a baseline against which data from future cycles can be compared, and to provide a preliminary assessment of whether effects, if any, are evident in the receiving environment. Successive cycles of EEM will allow the assessment of temporal changes in the magnitude and/or spatial extent of any site-related effects on fish, fish habitat and the use of fisheries resources.

2.3.1 Variable Selection

All sites will monitor variables as set out in the relevant Annex. Some variables may be designated as core and must be monitored at all regulated sites. Additional variables may be triggered by factors in current or historical site operations and existing receiving environment conditions.

2.3.2 Sampling Design

In recognition that some sites will not have sufficient historical data to support statistical sampling design for the first cycle of EEM, a minimum level of effort is specified in the relevant Annex. This will apply to the first EEM cycle at all industrial sites except for those which have historical data judged to be of acceptable quality and relevant to current site operations and receiving environment conditions. In such cases, a lower level of effort for the first EEM program can be used if:

- data are provided for each variable sufficient to meet the minimum level of effort; this may occur through the use of historical data alone, or by using historical data augmented with new data; or
- a lower level of effort will permit statistically valid testing of the questions posed.

This minimum level of effort shall also apply to EEM studies at all pre-operational sites.

After the first cycle of EEM, all subsequent studies shall be statistically designed as outlined in the relevant Annex. Receiving environment data from previous EEM cycles will provide knowledge of measurement (single point) and spatial variability for each relevant variable. The level of sampling effort (i.e., numbers of samples) will be a consequence of the level of statistical resolution used in the sampling design. The level of statistical resolution will be defined on a site-specific basis, consistent with the sampling design requirements outlined in the relevant Annex, in consultation between the regulated site and the Authorization Officer prior to approval of EEM design. Detailed instructions for sampling design will be outlined in the relevant Annex.

2.4 Conducting the EEM

The EEM program consists of field sampling and laboratory analyses. Field collections may involve more than one field sampling campaign throughout the year, depending on the nature of the receiving environment. Laboratory analyses and field measurements shall be conducted in accordance with criteria specified in the relevant Annex. Reference to the Technical Guidance Manual can be made for recommended sampling methods.

2.5 Data Interpretation

Data interpretation involves the identification and quantification of any measured environmental effects and an evaluation of their extent and significance with respect to fish, fish habitat and the use of fisheries resources. This is accomplished through evaluation of data quality and comparison of physical, chemical and biological data from the area of effluent exposure to reference areas and/or environmental quality objectives or criteria. General guidance on data interpretation will be provided.

2.6 Data Reporting

Copies of a final report shall be submitted in a prescribed format. The data shall be used as a basis for recommendations in support of the objectives of the program.

2.7 EEM Requirements at Pre-Operational Sites

New industrial sites within the regulated sector are required to complete the EEM requirements of the first cycle prior to the start-up of operations. Since no effluent will be discharged at the time of the pre-operation EEM, delineation of the zone of effluent mixing should be estimated or predicted based on design criteria. Characterization of effluent will not be required. The level of sampling effort must follow the requirements specified for the first cycle of EEM in the relevant Annex.