# Environmental Effects Monitoring at Twenty-Seven Pulp and Paper Mills in Ontario

## A Program Overview

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## TABLE OF CONTENTS

pulp + paper effluent regulations

## PREFACE

The Environmental Effects Monitoring Program (EEM) is designed to assess the adequacy of the PPER for protecting fish, fish habitat and the use of fishery resources. Adequacy is assessed on the basis of:

- the magnitude of effects, if any, in receiving environments related to mills
- the spatial extent of effects, if any, in receiving environments related to mills

For the purposes of EEM, effects may include, but are not limited to, 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.

This report provides a general overview of the implementation of the EEM program in Ontario. Subsequent reports will consolidate and discuss the interpretive results from the field work.

## PROGRAM OBJECTIVE

To protect fish and fish habitat, the amended **Pulp and Paper Effluent Regulations** (**PPER**) of the federal Fisheries Act (1992) prescribe limits for discharge of Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) in effluent and acute lethality of effluent to rainbow trout. The adequacy of the 1992 **PPER** for protection of fish and fish habitat is to be assessed by undertaking aquatic Environmental Effects Monitoring (EEM) studies at all locations where effluent is discharged to the aquatic receiving environment from a pulp and paper mill or an off-site treatment facility.

Beginning in 1992, all Canadian mills regulated under the amended **PPER** were required to conduct EEM studies at regular intervals in accordance with Sections 28 to 35 of the **PPER**, the generic requirements document referenced in the **PPER** and the specific requirements outlined in Annex I to the **PPER** (Tables 1 and 2).

The EEM program is a sequential series of monitoring and interpretation cycles, wherein the requirements of each cycle are dependent on the findings of the previous cycle. Currently all Canadian mills are engaged in the first cycle of the EEM program. Under the **PPER**, all mills must submit their interpretive reports from the first cycle EEM studies on or before 01 April, 1996.

## PROGRAM REQUIREMENTS

The EEM Program requirements apply to twenty-seven regulated pulp and paper mills in Ontario (Figure 1).

Table 1 outlines the requirements for pre-design information which had to be provided prior to undertaking the first EEM cycle while Table 2 outlines the information requirements for the first cycle. The components of the program are:

- An adult fish survey where specified sample sizes of two sentinel fish species must be collected for measurement of various features described in Annex 1.
- A benthic invertebrate survey
- Supporting receiving environment measurements of water and sediment quality associated with fish an benthic invertebrate surveys.
- For mills with chlorine bleaching, dioxin/furan analysis of composite fish tissue samples.
- Fish tainting evaluation at mills where there were documented records of tainting

in fish.

- Tracers to substantiate exposure of biota to mill effluent.
- Sublethal toxicity testing of effluent

## PROGRAM ADMINISTRATION

The **PPER** required each mill to submit a Pre-Design and First Cycle Study Design Report to the office of the Regional Authorization Officer (RAO) for review and authorization, before commencement of field studies. In Ontario Region, the RAO is the Regional Director of the Environmental Protection Branch - Ontario Region, Environment Canada.

Each report was reviewed by a sub-technical advisory panel (sub-TAP), formed to advise the RAO during the authorization process. Each sub-TAP was composed of staff from Environment Canada, Fisheries and Oceans Canada, and from local offices of the Ontario Ministry of Environment and Energy and the Ontario Ministry of Natural Resources. The provincial assistance was provided subject to a co-operative arrangement between the Federal government and the province of Ontario, where the above named ministries received Federal funding for their review of EEM study designs and field observation of some mill studies.

The reviews were coordinated and administered by the RAO's staff. The legislated review period is 180 days from the date the report arrives in the RAO's office. Nearly all reviews in Ontario were completed within that timeframe, and sub-TAP comments and action items were sent back to the mills. In many cases, meetings between a mill, their consultant, and the sub-TAP were held to further discuss the comments and action items. When the comments and action items had been addressed to the satisfaction of all concerned, the study design was accepted, and the mill was authorized, in writing, to proceed with field studies.

TABLE 1: Pre-Design Requirements For EEM (From Annex 1)

| INFORMATION/ VARIABLES |
|---|
| Description of Study Area (Receiving Environment)[a]<br><br>Delineation of Zone of Effluent Mixing<br>Resource Inventory<br>Habitat Inventory and Classification<br>Historical Receiving Environment Data<br><br>Effluent Quality[b]<br><br>pH<br>Flow<br>Conductivity<br>Biochemical Oxygen Demand (BOD)<br>Total Suspended Solids (TSS)<br>96-h Rainbow Trout Lethality<br>48-h Daphnia Magna Lethality<br>Chlorinated Dioxin and Furan Congeners[c]<br><br>Mill History and Operations[d] |
| [a] To be updated as required, prior to each EEM Cycle.<br>[b] Requirements under the Pulp and Paper Effluent Regulations, Fisheries Act (1992) except where otherwise indicated.<br>[c] Requirements for Regulations respecting the Release of Polychlorinated Dibenzo-para-Dioxins and Polychlorinated Dibenzofurans from Pulp and Paper Mills (Canadian Environmental Protection Act).<br>[d] Mills are required to report on mill history and operations data as specified in the Pulp and Paper Effluent Regulations, Fisheries Act (1992) and Regulations respecting the Release of Polychlorinated Dibenzo-para-Dioxins and Polychlorinated Dibenzofurans from Pulp and Paper Mills (Canadian Environmental Protection Act). Recommendations on additional data which will assist in interpretation of EEM results are given in Environment Canada (1992a). |

Table 2: Monitoring Requirements For The First Cycle Of EEM And Associated Minimum Level Of Sampling Effort (Adapted from Annex 1)

| VARIABLES | Minimum Number of Areas* | Minimum Number of Sampling Units per Area |
|---|---|---|
| **Effects on Fish**: Adult Fish Survey | 2 | 20[a] |
| **Effects on Fish Habitat**: Invertebrate Community Survey | | |
| No historical data - extensive survey | 12[b] | 2[c] |
| Historical data available - intensive survey | 4[d] | 3 |
| **Effects on Use of Fisheries Resources:** | | |
| Tissue Analyses: Chlorinated dioxin and furan congeners[e] | 2 | 1[f] |
| Tainting Evaluation[g] | | |
| - Reference site | 1 | 20[h] |
| - Exposure site | 1 | 12 |
| **Supportive Receiving Environment Measurements:** | | |
| Physical and Chemical Analyses associated with Fish and Invertebrate Surveys: | | |
| Water Column: Dissolved Oxygen, Temperature, pH, salinity (marine), conductivity (freshwater) | At all sampling sites | |
| Sediment: Particle size, TOC | At all benthic invertebrate sampling sites where substrate type permits | |
| Tracer(s) to substantiate exposure of fish to the liquid phase of the effluent in the receiving environment for fish survey, or to solids related to mill discharges for invertebrate community survey | As required | |
| **Effluent Measurements:**[i] | Frequency | |
| Fish early life stage development test | Quarterly | |
| Invertebrate reproduction test | Quarterly | |
| Plant toxicity test | Quarterly | |
| Chemical tracer | As required | |

* Including reference area

a Number of fish for each sex of each of two species

b Number of stations in extensive survey

c Number of field replicates per station in extensive survey

d Number of areas to be sampled per dominant habitat class

e For mills employing chlorine bleaching. Where monitoring programs for dioxin in fish are in place, they shall take precedence

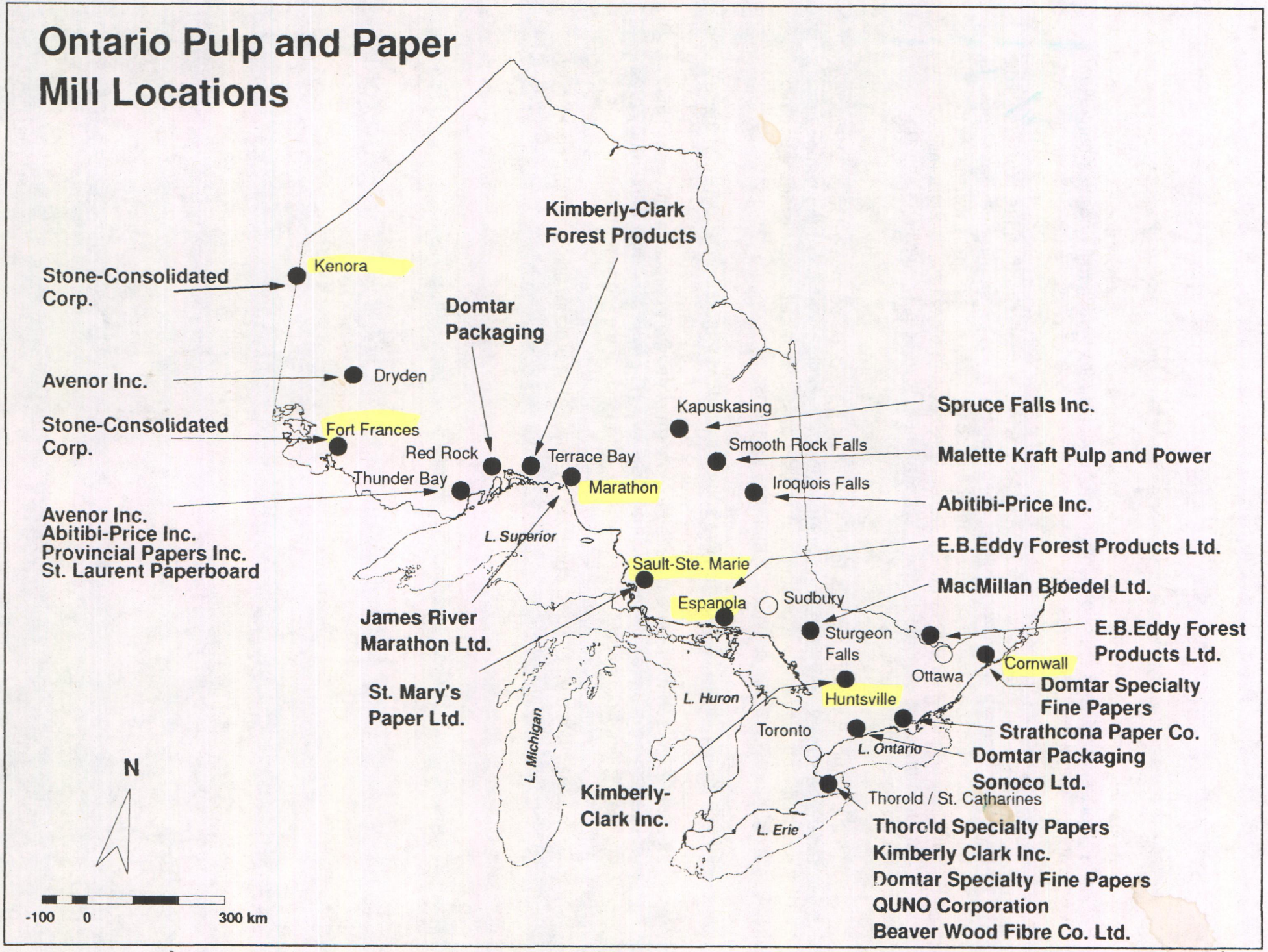
f Composite of edible portion of 10 fish

g If tainting has been identified as a concern during the resource inventory or by historical information.

h More fish are required at reference site due to need for 8 known and 12 hidden control samples

i In addition to those effluent quality requirements listed in Table 1. Additional samples may be required initially as part of the delineation of the zone of effluent mixing

# Ontario Pulp and Paper Mill Locations



## PROGRESS TO DATE

First cycle EEM field work has been completed at all 27 sites in Ontario.
Table 3 summarizes anecdotal information received from each mill and their consultant, about each mill's field study.

Fish species selected as sentinel fish include white sucker, shorthead redhorse sucker, silver redhorse sucker, carp, walleye, yellow perch, goldeye, smallmouth bass, rock bass, pumpkinseed, spottail shiner and blacknose dace. Not all mills were able to capture adequate numbers of two species, as specified by Annex 1. Eight mills captured only one sentinel species. One mill had no success collecting fish in the receiving environment.

To meet Annex 1 requirements for the benthic invertebrate survey, 18 mills conducted extensive surveys and nine conducted intensive benthic surveys. Authorization to proceed with an intensive benthic survey was based on acceptable historical benthic invertebrate data being available for these locations.

Fifteen mills analyzed fish composite samples for dioxin/furan isomers. Ten of these mills also used the dioxin measurement as a tracer to confirm fish exposure to the mill effluent. Eighteen mills were required to confirm exposure to process effluent. This requirement was based on the fact that there was no physical barrier in the study area preventing fish from migrating between the reference and exposure areas.

Twenty-two field studies were observed by sub-TAP members using standardized checklists (Appendix 1).

Table 3: Pulp and Paper Environmental Effects Monitoring - Ontario Mills

| MILL | PLUME DELINEATION | SENTINEL SPECIES | BENTHIC SURVEY TYPE | DIOXIN FURAN ANALYSIS | TAINTING STUDY | WATER TRACER | FISH TRACER |
|---|---|---|---|---|---|---|---|
| Abitibi -Price - Iroquois Falls | RWT + Modelling | Walleye, Goldeye | Extensive | No | No | No | No |
| Abitibi-Price - Fort William | Modelling + Cond. | Spottail shiner | Extensive | No | No | Cond. | DHA |
| Avenor - Dryden | Modelling + Flow Records | White sucker, Walleye | Intensive | Yes | No | Cond. | Dioxin |
| Avenor - Thunder Bay | Modelling + Cond. | White sucker | Intensive | Yes | No | Cond. | Dioxin |
| BeaverWood Fibre Co. - Thorold | RWT + Modelling | Pumpkinseed, Carp | Extensive | No | No | No | No |
| Domtar Packaging - Red Rock | RWT | White sucker, Longnose sucker | Extensive | Yes | No | Cond. | Dioxin |
| Domtar Packaging Trenton | RWT | Redhorse sucker, Carp | Intensive | No | No | RWT | No |
| Domtar Specialty Fine Papers - Cornwall | RWT | White sucker, Yellow perch | Intensive | Yes | No | RWT | Dioxin |
| Domtar Specialty Fine Papers - St. Catharines | RWT + Modelling | Redhorse sucker | Extensive | Yes | No | Ca, Mg | DHA |
| E.B. Eddy Forest Products Espanola | RWT | White sucker, Walleye | Intensive | Yes | No | Cond. | Dioxin |
| E.B. Eddy Forest Products Ottawa | RWT | White sucker | Intensive | Yes | No | RWT | No |
| James River- Marathon | RWT + Modelling | Longnose sucker | Extensive | Yes | No | | Dioxin |
| Kimberly-Clark- Huntsville | Modelling + Cond | None | Intensive | No | No | Cond, Mg. Ca | No |
| Kimberly-Clark - St. Catharines | RWT + Modelling | Redhorse sucker | Extensive | Yes | No | Ca, Mg | DHA |
| Kimberly-Clark - Terrace Bay | RWT | White sucker, Longnose sucker | Intensive | Yes | No | No | Dioxin |
| Malette Kraft - Smooth Rock Falls | RWT | White sucker | Extensive | Yes | No | No | Dioxin |
| MacMillan Bloedel - Sturgeon Falls | Modelling | White sucker, Rock bass | Extensive | No | No | No | No |
| Provincial Papers - Thunder Bay | Modelling + Cond. | White sucker, Spottail shiner | Extensive | No | No | Al, Cond. | DHA, RFA |
| QUNO - Thorold | RWT + Modelling | Redhorse sucker | Extensive | Yes | No | Ca, Mg | DHA |
| Stone Consolidated - Fort Frances | RWT | White sucker, walleye | Extensive | Yes | No | Cond. | Dioxin |
| Stone Consolidated - Kenora | RWT | White sucker | Extensive | No | No | pH, Cond., Temp | RFA |
| St. Mary's Paper - Sault Ste Marie | Modelling + Cond. | White sucker, Yellow perch | Extensive | No | No | Cond. | RFA. Zn, Mn |
| Spruce Falls - Kapuskasing | Modelling + Cond. | White sucker, Walleye | Intensive | Yes | No | Cond., Na, Mg | Dioxin |
| Sonoco - Trenton | Modelling + RFA | Redhorse sucker | Extensive | No | No | RFA | No |
| Strathcona Paper Compony - Napanee | Modelling + Cond. | Rock bass, Smallmouth bass | Extensive | No | No | No | No |
| Thunder Bay Packaging - Thunder Bay | Modelling | Spottalil shiner, Blacknose dace | Extensive | No | No | No | No |
| Thorold Specialty Papers - Thorold | RWT + Modelling | Redhorse sucker | Extensive | Yes | No | Ca, Mg | DHA |

## CURRENT ACTIVITIES

The National EEM Team is currently establishing a nationally consistent process for evaluating the Cycle 1 interpretive reports. Ontario Region staff participate on the Team, and are providing input to the development of the evaluation criteria.

Many technical issues and problems have arisen during implementation of Cycle 1 and mechanisms are being sought to resolve these before Cycle 2 commences. Some of these issues include: lack of suitable chemical tracers to confirm effluent exposure, plume delineation methods for certain receiving environments, availability of recommended sentinel fish species, lack of suitable reference areas, difficulty with egg size measurements, and high incidental catches of important sport fish.

Environment Canada, Fisheries and Oceans Canada, and the Canadian Pulp and Paper Association are currently working together as technical teams to resolve some of these issues. Ontario Region staff participate on some of these technical committees.

## FUTURE ACTIVITIES

On April 1, 1996, twenty-six Cycle 1 interpretive reports will be received by this office. One interpretive report, for a new mill, will be submitted at a later date. These interpretive reports will be evaluated by Ontario Region staff, using the evaluation criteria which are currently under development.

Cycle 2 EEM will commence on April 1, 1996. Each of the twenty-seven mills' Cycle 2 requirements will be partially based on their Cycle 1 data and interpretive report. These requirements will be defined through discussion between the RAO, her/his staff, and each mill, as soon as possible within the three year period from April 1996 to April 1999, so that each mill will have time to prepare the Cycle 2 study design and receive authorization from the RAO before commencing field studies. Cycle 2 interpretive reports are expected to be submitted on or before April 1, 1999.

## REFERENCES

1. Environment Canada and Department of Fisheries and Oceans. 1992. Aquatic Environmental Effects Monitoring Requirements. Annex 1 Aquatic environmental effects monitoring requirements at pulp and paper mills and off-site treatment facilities regulated under the Pulp and Paper Effluent Regulations of the Fisheries Act May 20, 1992. 23(+iii)pp.

## APPENDIX 1

Field Observation Checklist - Ontario Region

**Environmental Effects Monitoring Field Observation Checklist**

**Mill Name:**
**Observation Date:**
**Observation Team:**

| GENERAL SAMPLING Checklist Items | Yes | No | Additional observations |
|---|---|---|---|
| Is mill under normal operation? | | | |
| Are comprehensive field records being kept? | | | |
| Are sampling locations being verified with GPS or navigational charts? | | | |
| Are Standard Operating Procedures (SOP's) Protocols available for quick reference? | | | |
| Is there Accurate, durable labelling of samples and containers? | | | |
| Are chain of custody records being kept? | | | |
| Are samples being handled in accordance with SOP's? | | | |
| Storage in accordance with SOP's? | | | |
| Lake or River conditions typical? | | | |



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**Environmental Effects Monitoring Field Observation Checklist**

**Mill Name:** **Observation Date:**

| BENTHIC INVERTEBRATE SURVEY Checklist Items | Yes | No | Additional Observations |
|---|---|---|---|
| Reference locations suitable? | | | |
| Type of substrate sampling: Artificial Natural | | | |
| For artificial sampling note type of sampler, residence time in study area and compliance with approved study design | | | |
| For natural substrates note sampling method and equipment and if in accordance with study design. | | | |
| Water quality measurement instruments calibrated. Record calibration dates. | | | |
| Water quality measurements taken i.e. pH, temperature, conductivity, dissolved oxygen | | | |
| Samples collected at each site for determination of particle size and TOC | | | |
| Check sieve mesh sizes | | | |
| Sample preservation? | | | |
| Subsampling and preservation for tracer analysis? | | | |



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**Environmental Effects Monitoring Field Observation Checklist**

**Mill Name:** **Observation Date:**

| ADULT FISH SURVEY Checklist Items | Yes | No | Additional Observations |
|---|---|---|---|
| Scientific Collector's Permit? | | | |
| Species, numbers, location, fishing method and timing in accordance with permit and study design? | | | |
| Suitable reference location | | | |
| Water quality measurements taken at sampling sites? | | | |
| Are fish taxonomic keys available for quick reference? | | | |
| Note numbers of males, females of sentinel species collected. | | | |
| Are fish being processed immediately? | | | |
| Adequate preservation on ice or dry ice if there is going to be significant delay in processing? | | | |
| Careful handling of live non-incidental catches if they are being returned to the lake or river | | | |
| Dead incidental catches being disposed as determined by the area office of the Ministry of Natural Resources? | | | |
| Fish balances calibrated to allow accurate weight determination | | | |
| Appropriate handling, subsampling and preservation of tissues for tracer analysis and dioxin/furan where applicable | | | |
| Compliance with the Reasonable Level of Fishing Effort Authorized by the Regional authorization officer. | | | |



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