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FISHERIES-RELATED INFORMATION REQUIREMENTS FOR PIPELINE WATER CROSSINGS

by

Gareth A. Goodchild[1] and Serge Metikosh

Fisheries and Habitat Management
Central and Arctic Region
Department of Fisheries and Oceans
P.O. Box 5050
Burlington, Ontario
L7R 4A6

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[1]Aquatic Ecosystems Branch, Ministry of Natural Resources. Peterborough, Ontario K9J 8M5

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ABSTRACT

Goodchild, Gareth A. and Serge Metikosh. 1994. Fisheries-related information requirements for pipeline water crossings. Can. Manuscr. Rep. Fish. Aquat. Sci. 2235: 17 p.

This report contains the results of a Department of Fisheries and Oceans and Ministry of Natural Resources workshop held in 1992 at North Bay to determine the minimum information needed to assess the impact of pipeline water crossings on fish and fish habitat. The report addresses activities associated with crossings, related impacts, and information requirements for developing effective mitigation and compensation strategies.

The information requirements discussed in the report include: 1) Erosion and sedimentation potential of right of way soil including substrate particle composition; 2) A photograph or video of pre-construction site conditions, and mapping of basic fish habitat inventory data and physical conditions; 3) Detailed habitat assessment within the impact zone; and 4) Presence or absence of cold and warm water fish species based on historical and anecdotal data (on a watershed basis) for construction timing windows.

RÉSUMÉ

Goodchild, Gareth A. and Serge Metikosh. 1994. Fisheries-related information requirements for pipeline water crossings. Can. Manuscr. Rep. Fish. Aquat. Sci. 2235: 17 p.

Ce rapport présente les résultats d'un atelier qui a eu lieu en 1992 à North Bay, conduit par le Ministère des Pêches et Océans et le Ministère des Ressources Naturelles, organisé pour qu'on détermine les exigences minimales de renseignements afin d'évaluer l'impact des projets de franchissement de gazoducs sur l'habitat du poisson et le plan des pêches. Le rapport tient compte des activités associées aux franchissements, des impacts associés avec ces activités et indique quels renseignements sont nécessaires pour préparer des mesures d'atténuation ou de correction.

Les besoins en renseignements discutés dans le rapport sont les suivants: 1) Les risques d'érosion et de sédimentation du sol de l'emprise et la composition granulométrique du substrat; 2) Une photo ou un vidéo du terrain dans l'état qu'il se trouve au lieu étudié, et cartographie des habitats principaux du poisson et des conditions physiques; 3) Une évaluation détaillée de la zone impactée; et 4) La présence ou l'absence de poissons (d'eau chaude, d'eau froide), déterminée à partir de relevés historiques ou de rapports anecdotiques (à l'échelle du bassin hydrographique en vue de l'échéancement des travaux.

ACKNOWLEDGEMENTS

The authors wish to thank all participants in the "Information Requirements for Pipeline Water Crossings" workshop. The authors wish to thank staff of the Department of Fisheries and Oceans Habitat Management Branch for additional assistance in preparing this manuscript for publication. The authors also extend thanks to those who, through the review of various drafts, helped bring this manuscript to completion.

PREFACE

There has been a continuing need to discuss and more clearly define fisheries information requirements of MNR and DFO when reviewing pipeline water crossing proposals. The terms of reference for consultants, the approach and parameters of fisheries assessments and the content of fisheries documents needs to be clarified to enable OMNR District and DFO Fisheries and Habitat Management staff to make necessary decisions regarding proposed pipeline water crossings. Frequently in the past, there has been difficulty deciding whether or not compensation was required or whether appropriate construction and mitigation techniques were to be used. Often much of the information provided was not used in the decision making process.

A decision was made that a workshop would help to alleviate these problems by developing guidelines for the preparation and documentation of fisheries assessments that are submitted to MNR and DFO for review. A one and a half day workshop was organized and held in North Bay on September 29 and 30, 1993. The results of the workshop are contained in this report.

It must be stressed that there are many ways of carrying out fisheries assessments. The assessment methodology described in this report is only one method. However, this methodology was agreed to by both MNR and DFO and if information submitted is collected and presented according to the suggested guidelines then it will be found acceptable for pre-approval purposes.

1.0 INTRODUCTION

The workshop objective was to determine what the minimum information requirements were for approval of pipeline water crossings. It was noted however, that there were a few realities that had to be taken into account. These were stated as "givens":

GIVEN:
- pipelines will be built regardless
- the route selection is generally fixed (looping/twinning of existing lines)
- timing of construction is generally inflexible (notwithstanding cold water stream crossings)

THEN:
- Information collected should focus on mitigation and compensation so that water related construction activities shall not result in the loss of productive capacity of fish habitat.

The suggested approach for initiating workshop discussions was based on the VEC concept (Valued Ecosystem component). In this approach, which has been used successfully in other workshops, a conceptual model is developed that links impacts from specific project activities to selected ecosystem components such as fish and fish habitat. In the case of pipeline water crossings these equated to:

- considering the activities associated with pipeline water crossings;
- determining the impact of the activities and their pathways;
- determining how and where to mitigate the impacts; and
- determining information required to develop effective mitigation and/or compensation.

The framework for this model is illustrated in Figure 1.

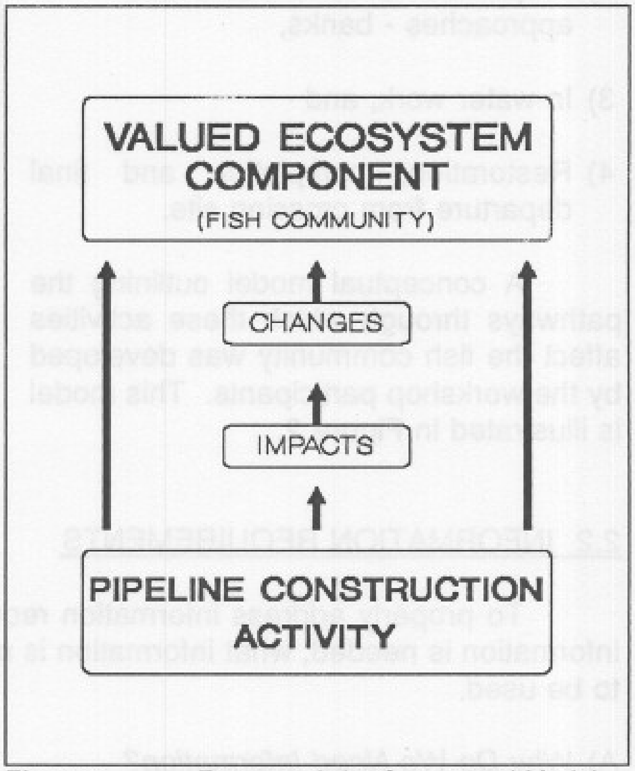

Figure 1 Framework for Conceptual Model

2.0 PIPELINE ACTIVITIES AND INFORMATION NEEDS

2.1 Pipeline Activities Which May Affect Fish Habitat

To fully assess which information requirements are needed, it is necessary to first review the specific activities involved with constructing pipeline water crossings and then understand the pathways through which each activity affects the fish community.

Four general categories of water crossing construction activities were identified by the group:

1) Right of way (ROW) preparation,

2) Preparation of stream and lake approaches - banks,

3) In-water work, and

4) Restoration, completion and final departure from crossing site.

A conceptual model outlining the pathways through which these activities affect the fish community was developed by the workshop participants. This model is illustrated in Figure 2.

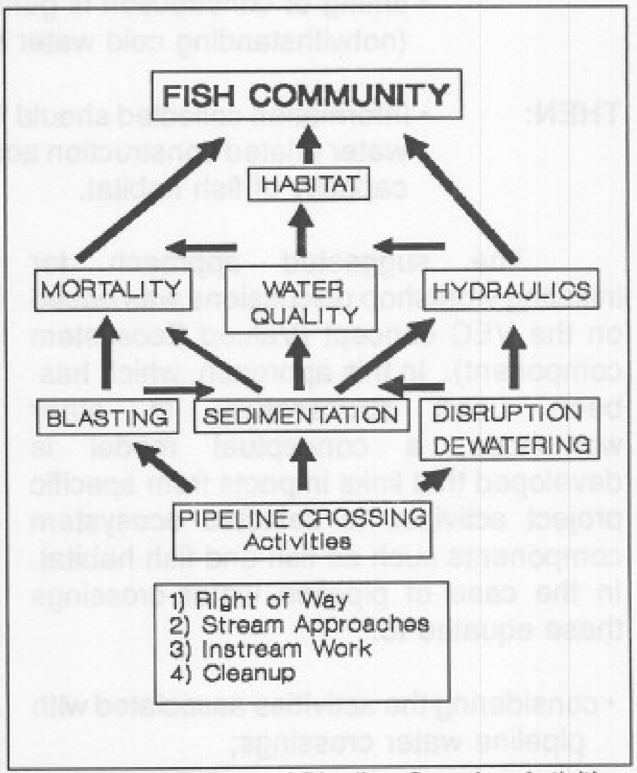

Figure 2 Effects of Pipeline Crossing Activities.

2.2 INFORMATION REQUIREMENTS

To properly address information requirements it is important to understand why information is needed, what information is needed, and how this information is intended to be used.

A) *Why Do We Need Information?*

1)Evaluate risk to the resource from activities during the mitigative review and to optimize mitigative tactics.

2) Determine need for compensation.

3)Develop mitigation/compensation plans.

4) Assess adequacy of mitigation.

B) *What Information Do We Need?*

1) A snapshot (photograph or video) of the existing conditions at the study site/impacted area including maps of basic fish habitat inventory and physical conditions in sufficient detail to develop mitigation/compensation plans should harmful alteration take place.

2) Fish species inventory for construction timing windows.

3) Erosion and sedimentation potential of ROW (taking into consideration the physical site conditions) soils as well as stream/lake substrate particle composition for evaluating risk in mitigative review.

4) Detailed habitat assessment wishing the impact zone.

C) *How Will We Use This Information?*

Mitigation should focus on the engineering solution that is based on the best achievable technology necessary to maintain the physical and functional integrity of the aquatic system. Information should also focus on requirements for compensation (rebuilding) and mitigation. This blended review will require a closer working relationship between the biological and engineering staff. Figure 3 highlights this typical mitigative review process.

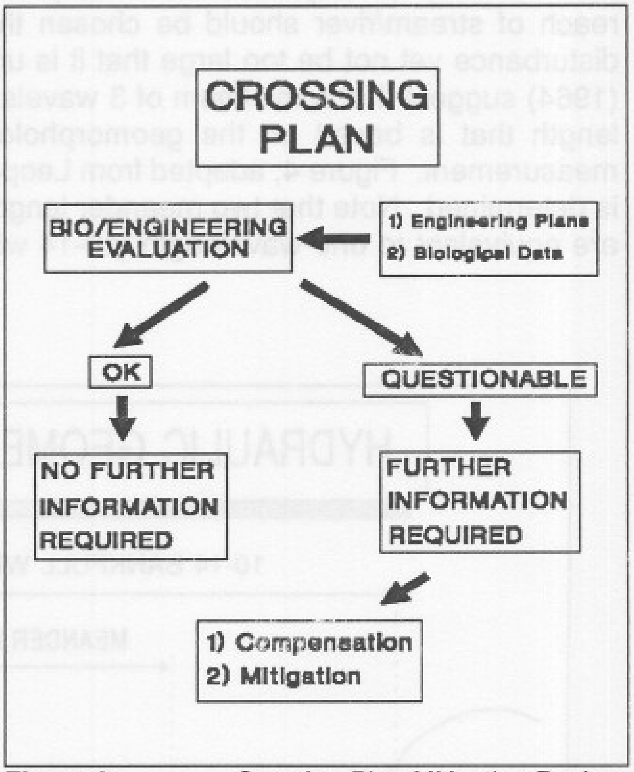

Figure 3 Crossing Plan Mitigative Review.

3.0 DETERMINING THE STUDY SITE

In the past, there has been a lack of consistency in delineating the boundaries of study sites. Often, it has been unclear how large an area should be looked at or what detail of information should be collected during fisheries and habitat assessments. As a result of this lack of consistency from one project to the next, the pipeline industry has encountered problems when contracting out assessment work. After completion of the field studies, regulatory government agencies would point out deficiencies in the information collected, and additional contracting would be required after the field season had ended. It was concluded that standard study areas should be delineated that would suffice for most situations. The approach taken was to break down the assessment areas into two areas: 1) the study site at the location of the water crossing and 2) the zone of impact from the construction site.

3.1 Stream Crossing Sites

In order to fully understand the processes at the site of the pipeline crossing, a reach of stream/river should be chosen that is large enough to represent the site of disturbance yet not be too large that it is unmanageable or superfluous. Leopold et al. (1964) suggest that a minimum of 3 wavelengths (2 above, 1 below) is a representative length that is based on the geomorphology of the system rather than an arbitrary measurement. Figure 4, adapted from Leopold et al. 1964 illustrates how the study reach is determined. Note that two meander lengths (meander length is defined as 5-7 widths) are equivalent to one wavelength (10-14 widths).

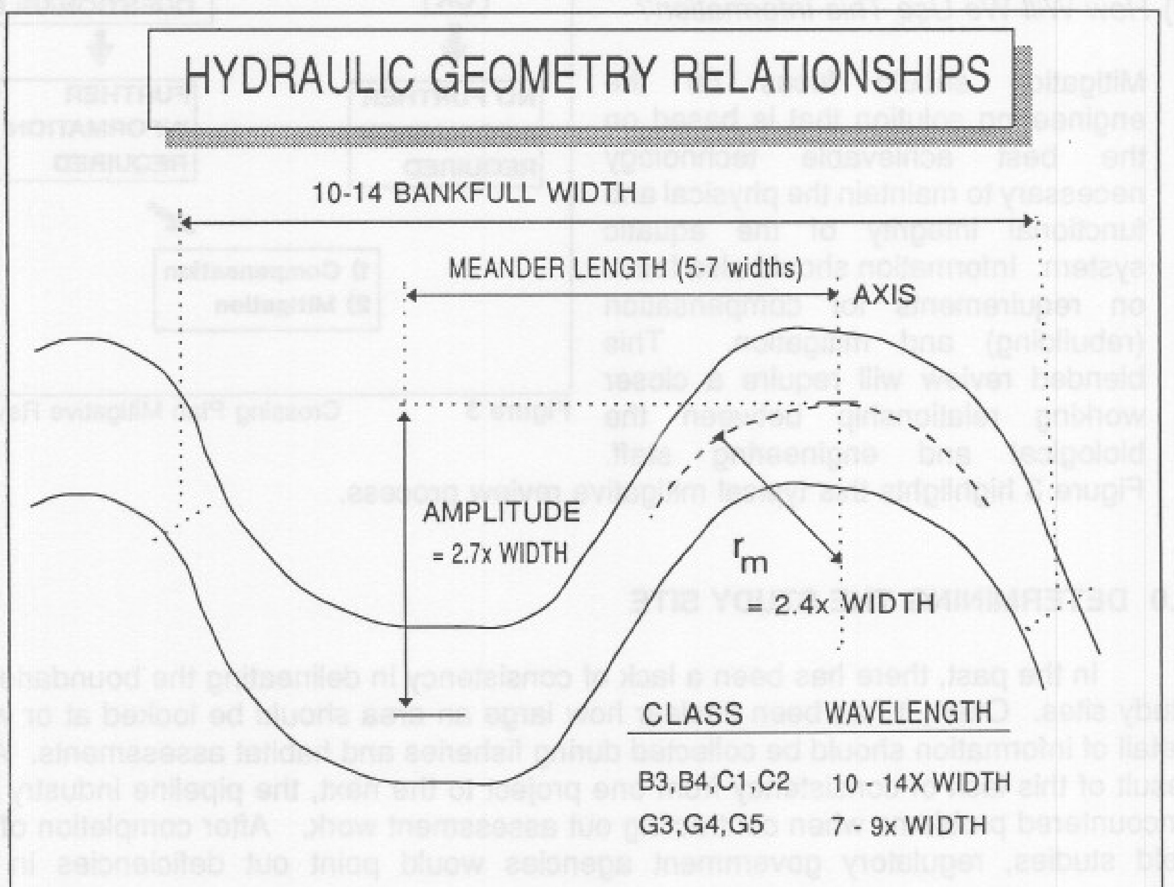

Figure 4 Hydraulic Geometry Relationships.[adapted from [1]Leopold et al. (1964) by J.G. Imhof] (Stream classes described in Appendix B)

In many cases for small creeks and streams, the length of this reach will be too short to effectively categorize the locale. In these cases a minimum of 100 metres above and below the ROW will be used to determine the study site boundaries. Extending the study zone upstream of the ROW is necessary to accurately determine pre-construction conditions should the site be atypical (highly modified or degraded) due to previous activities or disturbances. All the necessary calculations for the site boundaries such as meander length, amplitude, width etc, can normally be determined from air photos, prior to field visits.

3.2 Lake Crossing Sites

Detailed requirements for lake crossing sites were not discussed at the workshop and will need to be determined at a later date. However, in the case of lake crossings, it is believed that the study site should not need to be much larger than the planned corridor route across the channel. Other factors such as whether the pipe is trenched or laid on the substrate will likely dictate the study area size. Habitat determinations may also dictate the need to expand the site if important habitat structure such as a spawning shoal, sensitive substrate or toxic sediment is detected.

3.3 Zones of Impact

In addition to assessments at the pipeline crossing sites described above, it is also necessary to determine the zones of impact. These zones are described as areas where 90% of the discharged sediment will be deposited. In the case of lotic systems this is calculated under hypothetical Q_2 conditions (2 year flood standard). In lakes, channels and other lentic systems, the zone of impact can be calculated by a plume dispersal model such as the Rand Model (Gore & Storrie Limited, 1991) based on particle size of material, currents, shoreline processes and duration. Assessment locales are summarized in Table 1.

Table No. 1	ASSESSMENT LOCALES	
	STREAMS	**LAKES**
SITE LOCATION	Minimum of 100 metres upstream and down of ROW or 3 wave lengths (2 above and 1 below) which ever is greatest.	Immediate vicinity of pipe corridor.
ZONE OF IMPACT	Downstream of ROW to a distance that accounts for deposition of 90% of sediment (eroded material) under Q_2 conditions.	Determined by plume dispersal model based on particle size of material, currents, shoreline processes and duration.

4.0 HABITAT ASSESSMENT

As mentioned in Section 2, it is necessary to accurately record detailed habitat information so that the risk to the resource can be evaluated, mitigation/compensation plans can be developed and the site of disturbance can be returned as closely as possible to its original state. Sections 4.1, 4.2 and 4.3 discuss the sampling strategy that the group felt would collect the minimum amount of information required to satisfy these requirements.

4.1 Substrate Sampling

It was generally agreed that the greatest risk to both streams and lakes during pipeline construction at water crossings is from the resuspension and deposition of sediment onto the substrate. Sedimentation can be introduced from both bank erosion in the ROW and from the under water disturbance of substrate in the pipeline construction zone. The reason or cause of sediment introduction can be from any number of events. Routine construction such as in-stream trenching during a "wet crossing" or unchecked ROW erosion during a storm event are common scenarios where sediment can enter the water course. Regardless of the reason, most detrimental impacts associated with pipeline water crossings result from sediment deposition off the ROW and into the impact zone. The effects of turbidity and sediment on aquatic organisms are well recorded in the literature as discussed at length by Newcombe and MacDonald (1991). Additionally, Ward (1992) details the particular problems for fish from increased sediment loads. Sediment is considered a deleterious substance under the federal Fisheries Act.

In the past, most water crossing assessments have not adequately addressed this problem of sedimentation and the inherent risk factor associated with it. It was felt therefore that a methodology for determining risk was required for assessing each crossing and in particular, to address the risk of:

1) Introduction of sediment from ROW soil erosion.

2) Introduction of sediment from instream disturbances of substrate at the site of the pipe crossing.

Calculating the risk of introduced sediment is discussed in Section 5.2. Initially however, sediment and soil sampling must be undertaken. In most cases this will involve a two-part procedure.

The initial sampling will require quantitative (composite) samples (usually core) from 4 metre depths (depth of pipe) or depth of refusal that will determine the mean sediment composition from:

1) The ROW soils on banks and approach slopes adjacent to the crossing site.

2) The submerged substrate to be excavated when burying the pipe.

This initial sampling will dictate the condition of the substrate and soils (percentage particle size) that are likely to be discharged during construction and storm events. Also, it will enable the establishment of the impact zone boundaries as described in section 3.3.

Once the impact zone has been established, a second sampling process will be carried out to further evaluate the condition of the substrate in deposition zones such as settling pools and riffle areas as illustrated in Figure 5. A minimum of 3 core samples taken in transects across the sensitive areas and to a depth of 15 cm or expected normal depth of penetration will enable a mean composition by particle size of substrate to be calculated. Categories of particle sizes for the composite samples are presented in Table 2. Sensitive areas include zones of likely deposition and/or specific habitat types such as spawning areas and feeding sites. Substrate/habitat data can then be mapped and recorded for each zone. Secondary sampling information will be used for:

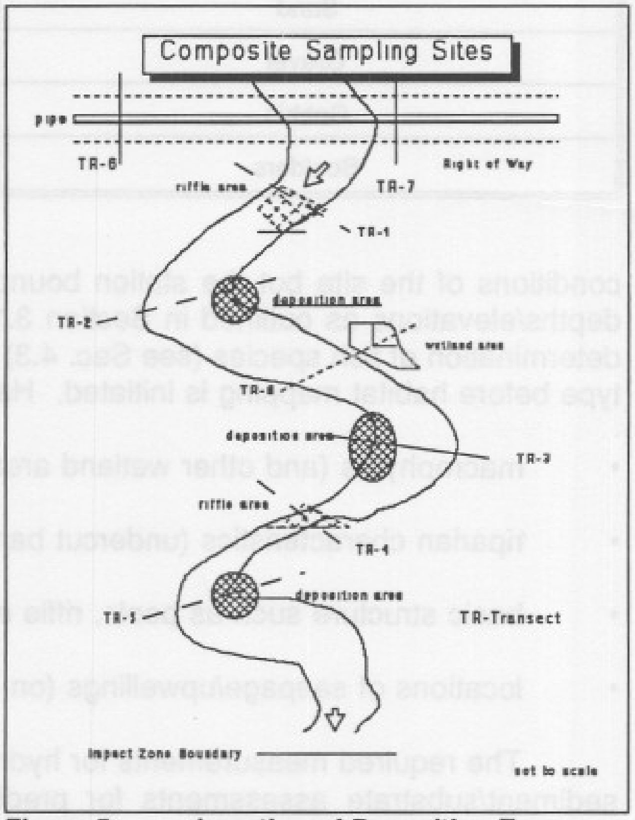

Figure 5 Location of Deposition Zones.

1) The determination of risk to existing sites due to sedimentation of substrate.

2) The preparation of mitigation plans as a result of risk determination and also to prepare plans for site rebuilding to pre-construction conditions in the event of a large sediment discharge.

3) The preparation of compensation plans if required.

4.2 Physical and Geomorphological Habitat Variables

The physical and geomorphological variables collected as a part of the detailed habitat assessment will vary somewhat with the scope of the water crossing and the

Table No. 2 MEAN PARTICLE SIZE FOR CONSOLIDATED SAMPLES (after Culbertson 1977)	
MATERIAL	**SIZE (mm)**
Clay	0.002-0.004
Silt	0.004-0.062
Sand	0.062-2
Gravel	2-64
Cobble	64-256
Boulders	256 - 400

conditions of the site but the station boundaries will be based on bankfull widths and depths/elevations as outlined in Section 3.1. Initially however, water temperature and determination of fish species (see Sec. 4.3) should be determined to classify the stream type before habitat mapping is initiated. Habitat mapping should show the locations of:

- macrophytes (and other wetland areas)
- riparian characteristics (undercut banks, vegetation, trees, etc.)
- basic structure such as pools, riffle areas, dams, etc.
- locations of seepage/upwellings (on cold water streams)

The required measurements for hydraulic parameters are collected as part of the sediment/substrate assessments for predicting the impact zone. Along with these measurements such as radius of curvature, meander length, amplitude etc., other associated parameters such as valley widths and slopes etc. will be determined for completion of the sediment control plans as described by Adamson and Harris (1992).

4.3 Fisheries Inventory

Too often in the past, unnecessary detail has been collected when documenting the fish species present in the vicinity of pipeline water crossings. It was the general conclusion that since the best construction practices should always be used to provide equal protection to <u>all</u> fish species then species information was really only needed to determine:

1) whether fish/fish habitat was actually present.

2) construction timing windows based on species life cycle requirements.

Therefore, qualitative (presence/absence) fish species data are the only requirements necessary at each crossing site. This information is usually available from OMNR historical/anecdotal records.

In the absence of reliable information, surrogate data from adjacent waterbodies in the same watershed are acceptable. Only in the case where absolutely no information is available should field inventory surveys be necessary or required. It should be noted however, that in the case where OMNR staff have classified a stream community on the basis of anecdotal information and the proponent disagrees with the OMNR assessment, the onus is on the proponent to provide data that support their position. Additionally, this assessment would not be satisfied by a point in time fisheries inventory but would require a more detailed study spanning several seasons. Table 3 summarizes the detailed habitat assessment required at the study sites.

5.0 DATA INTERPRETATION

In order to achieve the best mitigative solution it is necessary to first interpret the information provided by the field sampling program. This will involve first looking at the habitat conditions that are in the impact zone, and then assessing the risk to the habitat from sedimentation. The general approach to be taken is illustrated in Figure 6.

5.1 Biological Evaluation of Risk

The evaluation of the risk factor involves assessing the fish and detailed habitat at the site of the pipeline corridor and also in the zone of impact. The evaluation is to assess the relative risk of the pipeline activities to the existing fish habitat conditions and to use this information to choose the most appropriate mitigative strategy.

Along with the evaluation of risk, a habitat inventory is required in order to document existing conditions so that the water course can be returned to pre-disturbance conditions in the event of habitat damage due to construction or weather events. This will also facilitate the preparation of mitigation/compensation plans.

5.2 Sedimentation Risk Evaluation

In order to assess the relative risk potential to substrate from discharged ROW soils and instream sediments, a particle size distribution chart was devised to quantify the size difference between the discharge particles and the receiving stream substrate. For example, estimated volumes of excavated material will have to be determined based on

Table No. 3 DETAILED HABITAT ASSESSMENT

	STREAMS	LAKES
SUBSTRATE	1) Consolidated sampling of ROW soil in run off zone and substrate at construction site to 4m for particle size analysis. 2) Consolidated sampling of substrate in deposition zones to 15 cm for particle size analysis. 3) Map substrate data for each morphological deposition zone.	1) Consolidated sampling of substrate for plume model calculations. 2) Consolidated sampling of ROW soils in approach zones. 3) Map substrate data for littoral zone sediment composition. 4) Identification of any downwind shoals which could influence sedimentation.
MACRO-PHYTES	1) Map floating, emergent, submerged vegetation. 2) Map flood plain marshes, other wetland areas.	Map littoral habitats including floating, emergent and submergent vegetation, including potential spawning sites.
STRUCTURE	Pools/riffles, beaver dams etc.	Distance to nearest settleable basin
GROUND WATER	Map upwellings, seepage from banks (visual observations) for coldwater streams	Map upwelling areas and possible spawning sites.
FISH SPECIES	Qualitative presence/absence of fish species (cold/warm water). Historical/anecdotal MNR information on a watershed basis.	As per stream requirements.
TEMP	Differentiate cold/warm water stream	Differentiate cold/warm water lakes

in-stream trench dimensions and consolidated core samples (for mean particle size determination). By using the mean sediment particle sizes collected (composite sediment samples), the ratios of particle size can be compared based on D_{50} and D_{84} percentages of particles. Figure 7 illustrates this comparison.

In the example above, the relative risk potential of sedimentation to the stream substrate is made by comparing on-bank soil composition and stream substrate composition. In this case the nature of the eroded material which would be deposited in the stream is much finer than the receiving substrate (i.e. D_{50} or the mean particle size diameter of the bank soil is approximately 0.75 mm whereas the mean particle size of the receiving substrate is 15 mm). This poses a potential risk as smaller soil particles tend to clog the interstitial spaces of coarser substrate material. If on the other hand, the two curves were similar or even interchanges, then the risk factor would be much lower or perhaps negligible. A similar risk analysis can be carried out for substrate sediment from the construction site being deposited downstream to deposition areas of the impact zone. (D_{84} represents the maximum size of particles that will be transported under Q_2 conditions).

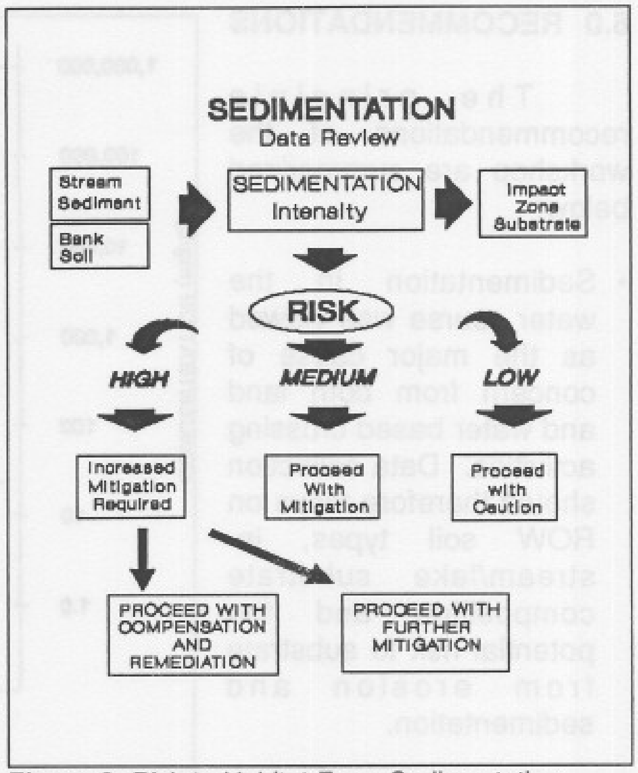

Figure 6 Risk to Habitat From Sedimentation

In addition, along with the risk of particle size difference to the receiving substrate, it is also necessary to take into account the duration that sediment will be released. Severity of impact from sediment is a function of both concentration and duration. Figure 8 [from Newcombe (1986) in Ward (1992)] illustrates the effects and expectedoutcomes of episodes of discharged sediment based on an assumed frequency of one sedimentation episode per year.

The two diagonal lines that separate zones 2, 3 and 4 are truncated to discourage extrapolation of the trends when a sedimentation episode is extremely brief with high concentrations of inert sediments or when it is long-term with extremely low concentrations.

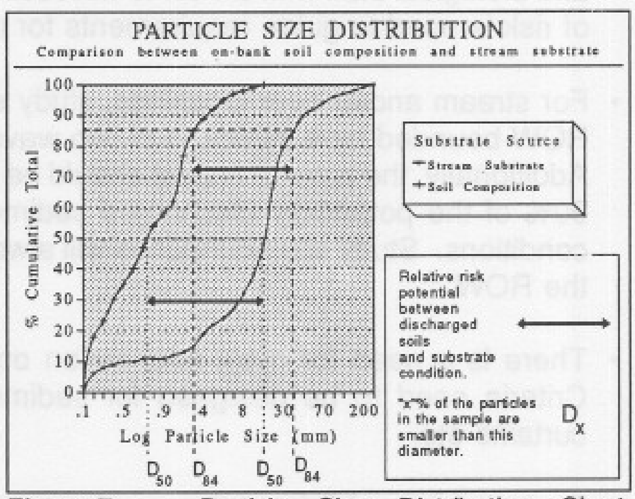

Figure 7 Particle Size Distribution Chart. [adapted from [2]Leopold et al. (1964) by J.G. Imhof]

Along with assessing the particle size of sediments, it will also be necessary to assess the slope stabilities and some geotechnical aspects to achieve a better understanding of risk potential. This includes parameters such as flood plain width, slope angles, ground water flow, and evidence of seepage.

6.0 RECOMMENDATIONS

The principle recommendations of the workshop are summarized below:

- Sedimentation in the water course was viewed as the major cause of concern from both land and water based crossing activities. Data collection should therefore focus on ROW soil types, in-stream/lake substrate composition and the potential risk to substrate from erosion and sedimentation.

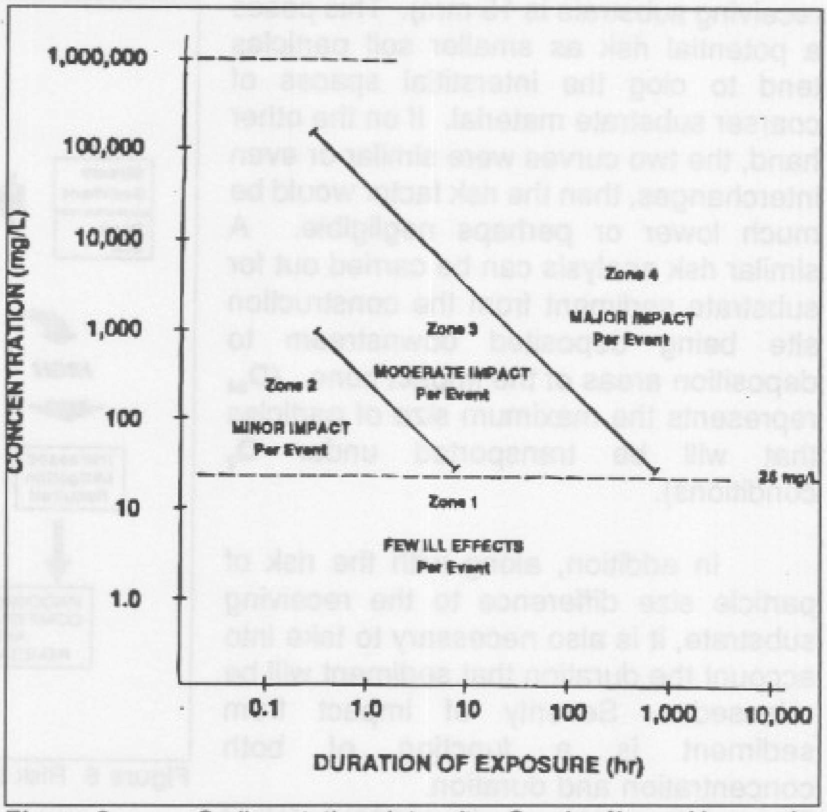

Figure 8 Sedimentation Intensity Graph. [from Newcombe (1986) in Ward (1992)].

- The review of pipeline water crossing proposals should be conducted jointly by both engineering and biological staff with a view to assessing the risk to fish and fish habitat. Evaluation of risk is used to guide requirements for additional mitigation and/or compensation.

- For stream and/or river crossings, study sites should include the area of the crossing ROW bounded by a minimum of two wavelengths above the crossing and one below. Additionally, the zone of impact should be determined by the distance downstream that 90% of the potentially discharged sediment will be deposited under hypothetical Q_2 conditions. Study site boundaries will always be a minimum of 100 m above and below the ROW.

- There is a need for more information on the effects of pipeline crossings on lakes. Criteria need to be designed for sediment effects, plume models, deep water silt curtains etc.

- Basic (minimum) information needs consist of:

    1) Erosion and sedimentation potential of right of way soil as well as substrate particle composition for evaluation sedimentation risk in mitigative review

2) A snapshot (video) of the existing conditions at the study site including mapping of basic fish habitat inventory and physical conditions to develop mitigation/compensation plans.

3) Detailed habitat assessment within the impact zone to include substrate, macrophyte and structure mapping as well as stream temperatures and sites of ground water upwelling or seepage. For lakes, substrate/sediment quality are to be included as well as littoral habitat mapping within the expected influence of the plume.

4) Presence/absence of fish species (cold/warm water) based on historical/anecdotal MNR data (on a watershed basis) for construction timing windows.

7.0 FUTURE REQUIREMENTS

Due to the brevity of the workshop, discussions were limited to the objectives stated at the onset of the proceedings. However, several items were identified as being issues that need to be addressed.

- Minimum sedimentation standards should be set. What constitutes acceptable levels and what is considered in violation of the *Fisheries Act*? This conundrum has apparently started to be pursued by DFO Pacific Region.

- Monitoring, both during construction and for some time after construction has finished is required to ensure that regulations and mitigation and compensation plans are followed.

- More effectiveness studies are needed to check and evaluate mitigation techniques.

- National Standards for pipeline construction techniques and habitat protection/assessment studies should be pursued.

- After adoption by TCPL and other pipeline companies, bring other industries/agencies in line with workshop recommendations.

- Effective communication plans/protocol are needed to inform agency and industry of final requirements of guidelines.

APPENDIX "A"

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APPENDIX "B"

MAJOR STREAM TYPES

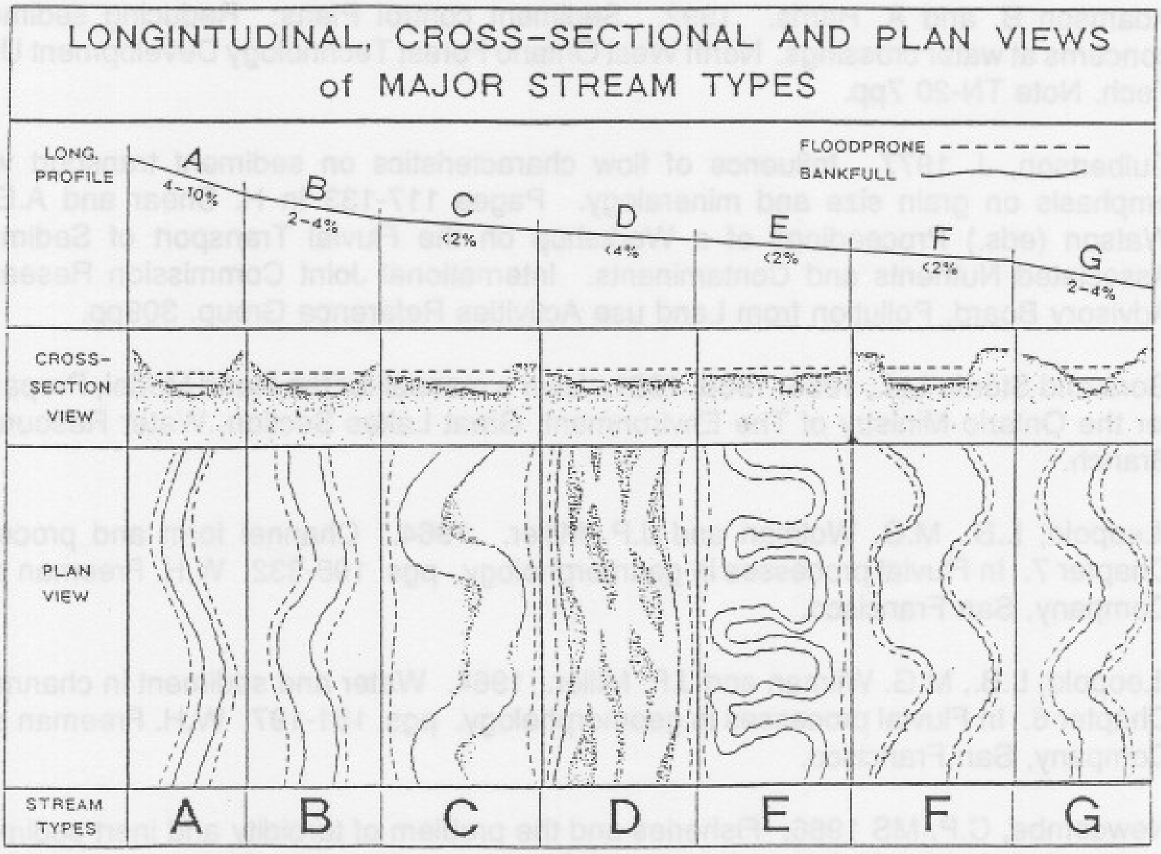

Figure 9 Major Stream Types. [from Rosgen (1992)]

APPENDIX "C"

DEFINITIONS

I MITIGATION

Actions/measures taken during the planning, design, construction and operation of works undertakings to alleviate potential adverse effects on the productive capacity of fish habitats and including:

A) **Prevention -** avoiding the effect by not doing the activity, or choosing a less sensitive location.

B) **Minimization -** limiting the magnitude of the effect during the construction activity (short term solution such as installing a sediment trap).

- limiting the magnitude of the effect after the construction activity (long term solution such as installing a diversion berm or fishway).

C) **Remedy -** rectifying the effect by repairing, rehabilitating or restoring the affected environment.

II COMPENSATION

A) **Replacement -** compensating lost fish habitat due to the effect by replacing natural habitat ("like for like") or providing substitute resources such as the maintenance of fish production by artificial means.

B) **Development -** creating additional fish habitat, or enhancing existing habitat by improving environmental conditions such as regulating flows, providing access to spawning areas and modifying nutrient loads.

Compensation may be required where mitigation techniques and other measures are not adequate to maintain fish habitats. Compensation is a project proponent's responsibility.

OTHER TERMS AND DEFINITIONS (con't.)

Fish Habitat - 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)*

Deleterious Substance - any substance that, if added to water would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat. (see *Fisheries Act complete definition)*

Restoration (of habitat) - The treatment or clean-up of fish habitat that has been altered, disrupted or degraded for the purpose of increasing its capability to sustain a productive fisheries resource.

Sediment - Sediment is classified by particle size. The three major classes being sand, silt and clay. Particle size and water velocity dictate how silt is transported in the water column. Coarser particles usually move by rolling along the substrate as "bedload sediment" whereas silt and clay are usually distributed as suspended sediment throughout the water column (after Culbertson, 1977 in Ward 1992).

Macrophyte - Vascular aquatic plants which usually possess leaves, stems, and root systems and can be either submergent, emergent or floating (rooted or free-floating).

APPENDIX "D"

LIST OF PARTICIPANTS

Serge Metikosh - *Facilitator*
Fisheries and Oceans Canada
Fisheries and Habitat Management
Burlington, Ontario

Gareth Goodchild - *Recorder*
Fisheries and Oceans Canada
Fisheries and Habitat Management
Burlington, Ontario

Ed DeBruyn
Fisheries and Oceans Canada
Fisheries and Habitat Management
Burlington, Ontario

Jack Imhof
Ontario Ministry of Natural Resources
Fisheries Policy Branch
Maple, Ontario

Rob Swainson
Ontario Ministry of Natural Resources
Nipigon District
Nipigon, Ontario

Kim Armstrong
Ontario Ministry of Natural Resources
Northeast Region
Cochrane, Ontario

Dave Holla
Ontario Ministry of Natural Resources
Central Region
Sudbury, Ontario

Henk Rietveld
Ontario Ministry of Natural Resources
Central Region
Huntsville, Ontario

Neville Ward
Ontario Ministry of Natural Resources
Kenora District
Kenora, Ontario

Steve Belfry
Ontario Ministry of Natural Resources
North Bay District
North Bay, Ontario

Hal Schraeder
Ontario Ministry of Natural Resources
Aylmer District
Aylmer, Ontario

Dave Maraldo
Ontario Ministry of Natural Resources
North Bay District
North Bay, Ontario

Steve McGovern
Ontario Ministry of Natural Resources
Hearst District
Hearst, Ontario