MVLWB/GNWT

Guidelines for Effluent Mixing Zones

Mackenzie Valley Land and Water Board
Gwich'in Land and Water Board
Sahtu Land and Water Board
Wek'èezhìi Land and Water Board
Government of the Northwest Territories

September 2017

Mackenzie Valley Land and Water Board

SAHTU LAND & WATER BOARD

GWICH'IN LAND AND WATER BOARD

Wek'èezhìi Land and Water Board

Government of Northwest Territories

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DEFINITIONS AND ACRONYMS

Term	Definition
AEMP	aquatic effects monitoring program
acute toxicity	A toxic effect (severe biological harm or death) produced in an organism by a substance or mixture of substances within a short exposure period (usually 96 hours or less)[1].
affected party	a party that is predicted to be affected by a proposed or existing project, such as an Aboriginal organization/government, an individual occupying land for traditional purposes, a private landowner, or lease holder (e.g., for a lodge)
Boards	Land and Water Boards of the Mackenzie Valley, as mandated by the MVRMA
CCME	Canadian Council of Ministers of the Environment
COPC	contaminants of potential concern
effluent quality criteria (EQC)	numerical or narrative limits on the quality or quantity of the waste deposited to the receiving environment
GLWB	Gwich'in Land and Water Board
INAC	Indigenous and Northern Affairs Canada
Mackenzie Valley	the part of the Northwest Territories bounded on the south by the 60th parallel of latitude, on the west by the Yukon Territory, on the north by the Inuvialuit Settlement Region as defined in the Agreement given effect by the *Western Arctic (Inuvialuit) Claims Settlement Act,* and on the east by the Nunavut Settlement Area as defined in the Nunavut Land Claims Agreement Act, but does not include Wood Buffalo National Park
MVLWB	Mackenzie Valley Land and Water Board
MVRMA	*Mackenzie Valley Resource Management Act*
NWT	Northwest Territories
outfall	the discharge point of a waste stream into a body of water
proponent	applicant for, or holder of, water licences (WLs) and land use permits (LUPs)
receiving environment	the natural environment that, directly or indirectly, receives any deposit of waste (as defined in the *Waters Act* and the MVRMA) from a project
receiving waters	the waterbody that receives any effluent discharge containing waste (as defined in the *Waters Act* and the MVRMA) from an undertaking

[1] Canadian Council of Ministers of the Environment. 1999. Glossary. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg

regulated mixing zone[2]	the defined area contiguous with a point source (effluent discharge site) or a delimited non-point source where the discharge mixes with ambient water and where concentrations of some substances may not comply with water quality objectives that have been set site-specifically for the receiving environment
SLWB	Sahtu Land and Water Board
undertaking	as defined by Section 1 of the *Waters Regulations*[3]
waste	as defined by Section 2 of the *Waters Act* [4] and section 51 of the MVRMA
water quality objective (WQO)	a numerical concentration or narrative statement that has been established to protect the aquatic environment of the receiving waters at a specified site
WLWB	Wek'èezhìi Land and Water Board

[2] Mixing Zone is defined in the Water and Effluent Quality Guidelines (MVLWB 2011) as an area adjacent to the effluent outfall within which waste is deposited and first mixes with water in the receiving environment.

[3] "Undertaking" is defined (in the Waters Regulations) as:

an undertaking in respect of which water is to be used or waste is to be deposited, of a type set out in Schedule B.

[4] "Waste" is defined (in the *Waters Act*) as:

(a) a substance that, if added to water, would degrade or alter or form part of a process of degradation or alteration of the quality of the water to an extent that is detrimental to its use by people or by any animal, fish, or plant, or

(b) water that contains a substance in such a quantity or concentration, or that has been so treated, processed, or changed, by heat or other means, that it would, if added to any other water, degrade or alter or form part of a process of degradation or alteration of the quality of that water to the extent described in paragraph (a), and, includes:

(c) a substance or water that, for the purposes of the *Canada Water Act,* is deemed to be Waste,

(d) a substance or class of substances prescribed by regulations made under subparagraph 63(1)(b)(i),

(e) water that contains any substance or class of substances in a quantity or concentration that is equal to or greater than a quantity or concentration prescribed in respect of that substance or class of substances by regulations made under subparagraph 63(1)(b)(ii), and

(f) water that has been subjected to a treatment, process or change prescribed by regulations made under subparagraph 63(1)(b)(iii).

1.0 Introduction

In the Mackenzie Valley, the use of water and the deposit of waste into water is regulated under the *Waters Act*. Responsibilities associated with the approval, issuance, administration, and enforcement of water licences are shared by the Land and Water Boards of the Mackenzie Valley (the Boards) and the Government of the Northwest Territories (GNWT). In recognition of their collective responsibility for water licensing, the Boards and the GNWT have collaborated in the development of these Guidelines for Effluent Mixing Zones (the Guidelines).

As described in the Boards' Water and Effluent Quality Management Policy, mixing zones may be established on a case-by-case basis for licensed undertakings that discharge effluent into receiving waters such as rivers, streams, or lakes. Water licences for these types of undertakings typically include effluent quality criteria (EQC) prescribing the maximum allowable concentrations or quantities of any contaminants of potential concern (COPC) in the waste discharge stream. Mixing zones, if established, aid in the derivation of EQC for individual water licences. These Guidelines are intended to support future decisions involving the use of mixing zones in the regulation of effluent discharge.

1.1 Purpose

The overall purpose of these Guidelines is to improve the clarity and consistency of water licensing decisions related to effluent discharge and the use of mixing zones. Specifically, these Guidelines:

- Provide a definition for regulated mixing zones that is applicable to water licensing in the Mackenzie Valley;
- Describe the relationship between mixing zones, effluent quality criteria and water quality objectives;
- Describe the factors that may be considered by the Boards when deciding whether to allocate a mixing zone;
- Describe criteria that will guide the decision to allocate a mixing zone;
- Describe, in general, the types of water licence requirements that are based on mixing zone determinations, and;
- Summarize the information that proponents should submit to support a proposed mixing zone.

1.2 Authority

The Boards have the authority to develop and implement guidelines under sections 65, 102, and 106 of the *Mackenzie Valley Resources Management Act* (MVRMA). The Boards and the GNWT have developed these Guidelines in partnership, recognizing their collective responsibility with respect to the water licensing process.

1.3 How These Guidelines Were Developed

These Guidelines were developed as part of a continuing effort to improve and enhance water-related decision making as envisioned by the NWT Water Stewardship Strategy and Action Plan. The Mackenzie

Valley Land and Water Boards' (MVLWB) Water and Effluent Quality Management Policy (the Policy) also envisioned the development of several guideline documents that would help support implementation of the Policy, including guidance on the establishment and characterization of mixing zones. Note that the Guidelines are based on the principles and objectives of the Policy that are consistent with those of the NWT Water Stewardship Strategy; these include, for example, the principles of pollution prevention, sustainable development, and integrated watershed management.

The initial draft of these Guidelines was prepared by an independent consultant based on an extensive review of approaches used in other jurisdictions in Canada and internationally. The draft Guidelines were edited jointly by staff from the Boards and from the GNWT's Department of Environment and Natural Resources, before being subject to a public review process.

1.4 Application

This document will be applied by the GNWT and Boards in accordance with their respective mandates and responsibilities. The Guidelines will be applied by the following Boards operating under the MVRMA:

- Mackenzie Valley Land and Water Board
- Gwich'in Land and Water Board
- Sahtu Land and Water Board
- Wek'èezhìi Land and Water Board

These Guidelines apply to all new water licence applications received after the effective date of the Guidelines. In the case of existing water licences, the Guidelines may be applied, at the discretion of the Boards, to water licence amendment applications that include a proposal to amend any terms or conditions that are related to a mixing zone determination.

Applicants for water licences that will require EQC for effluent discharges should consult these Guidelines to decide whether they would like to propose a regulated mixing zone for their project. Section 6 describes the kinds of information that a proponent should submit with any proposal for a mixing zone. In all cases, the Boards will make decisions about the allocation of a regulated mixing zone based on the proponent's application and all other evidence presented during the water licensing process.

1.5 Monitoring and Performance Measurement for these Guidelines

Mechanisms will be required to monitor and measure performance and to evaluate the effectiveness of the Guidelines. In accordance with the principles of a management systems approach (e.g., plan-do-check-act), the Boards and the GNWT will develop a performance measurement framework. The Guidelines will be reviewed and amended as necessary within that framework. The framework will also describe how affected parties, industry, and government will be involved in the review process.

2.0 Uses of a Mixing Zone in Regulating the Deposit of Waste into Water

As set out in section 27 of the *Waters Act* and section 72.04 of the MVRMA, the Boards may include, in any water licence, "the quantity, concentration and types of waste that may be deposited in any waters by the licensee" as well as the "conditions under which that waste may be deposited." The Water and Effluent Quality Management Policy[5] (the Policy), which was approved by the Boards in 2011, describes the Boards' approach to regulating, through water licence requirements, the deposit of waste to the receiving environment such that the following two objectives are met:

1. *Water quality in the receiving environment is maintained at a level that allows for current and future water uses, and*
2. *The amount of waste to be deposited to the receiving environment is minimized.*

With respect to the first objective, the level of water quality that must be maintained to protect receiving waters is defined by water quality objectives (WQO), which are established[6] for each specific receiving environment. The second objective may be achieved through the implementation of waste management techniques such as source control, recycling, or treatment. The Policy describes several different types of water licence requirements (e.g., effluent discharge limits, management plans, monitoring, etc.) that are used to ensure, collectively, that each water licence meets the objectives above.

Once all reasonable measures have been taken to limit the amount of waste, concerns may still exist about the quantity, concentration, and type of waste to be deposited, and in these cases the Boards will set effluent quality criteria (EQC) in the water licence. EQC define the maximum allowable concentrations (e.g., mg/L), quantities (e.g., kg/year), or limits (e.g., pH range) of any contaminant or parameter of the waste which, in the Boards' opinion, has the potential to adversely affect water quality in the receiving environment. The Policy requires that EQC are set, at a minimum, to ensure that downstream WQOs are met in the receiving environment.

Although the Policy does not specify the location within the receiving environment that WQOs must be met, it does state that "on a case-by-case basis, the Boards may decide to define a mixing zone between the point of effluent discharge and the point at which water quality standards need to be met." Used in this way, defined 'mixing zones' become areas of the receiving water body that may have COPC concentrations that are greater than the respective WQOs. For this reason, there must be a careful consideration of 1) whether it is appropriate or necessary to allow a mixing zone at all for a specific undertaking; and 2) what conditions must be met if a mixing zone is to ensure that the receiving water body is protected to a level that is acceptable to potentially affected parties.

[5] In cases of discrepancy between these Guidelines and the Policy, the Policy prevails.

[6] Note that Section 8.1 of the Policy describes the kinds of information that the Boards will consider when setting WQOs for each specific receiving environment

2.1 Definition of a Regulated Mixing Zone

For many projects, liquid waste generated at different areas of the site (e.g., groundwater, sewage, site run-off, process water, etc.) is collected, stored, and sometimes treated prior to being discharged to a water body from a single point source or outfall using a pipe or a diffuser, for example. In general, mixing zones are only relevant to point source discharges of liquid effluent; however, in some cases, the Board may define a mixing zone for delimited non-point sources (i.e., sources of waste that can be spatially bounded in some way).

For the purposes of these Guidelines, a regulated mixing zone is defined as:

> *The defined area contiguous with a point source (effluent discharge site) or a delimited non-point source where the discharge mixes with ambient water and where concentrations of some substances may not comply with water quality objectives that have been set site-specifically for the receiving environment.*

This definition is based on that from the Canadian Council of Ministers of the Environment[7] (CCME) with changes to the language as necessary to be consistent with the Policy. Note that regulated mixing zones can be defined for continuous, temporary, or seasonal discharges of effluent.

2.2 Considerations for Allocating a Regulated Mixing Zone

The decision of whether to allocate a mixing zone for an individual undertaking will be made by the Boards based on all evidence presented in each specific water licensing process. Since decisions are always tied to the specific evidence before the Board, it is not possible to make definitive rules *a priori* of when a mixing zone will or will not be allowed. In some cases, it may not be necessary to allocate a mixing zone at all. For example, if the Board has decided to set EQC equal to or less than the WQOs set for the receiving environment (e.g., in situations where there is a requirement for maximum protection of water quality), allocating a mixing zone would serve no useful purpose.

In cases where the Boards decide to allocate a mixing zone, it is with the understanding, as stated[8] by the CCME, that "it is often possible to allow somewhat elevated concentrations of COPCs to occur within relatively small areas of a receiving water body, without significantly affecting the integrity of the water body as a whole." Generally, the use of a mixing zone in water licensing acknowledges that:

- concentrations of COPCs in effluent may be higher than the WQOs set for the receiving environment;
- because of the processes of dilution and assimilation, the end-of-pipe COPC concentrations in the effluent do not necessarily represent the final COPC concentrations in the receiving waters; and,

[7] Page 13 of CCME, 2008 (see References)
[8] Section 6.2 of CCME, 2003 (see References)

- exceeding WQOs in a relatively small area of a waterbody is not likely to impair water uses in the receiving environment if the criteria stated in Section 3 of these Guidelines are met.

To avoid or prevent any unacceptable impacts on the receiving environment, most jurisdictions that allow mixing zones require that certain principles or criteria be met. As part of preparing the Guidelines, criteria from the CCME and other jurisdictions in Canada and internationally were evaluated[9] for use in the Mackenzie Valley; Section 3 of the Guidelines lists the criteria that will be applied by the Boards when allocating regulated mixing zones. Some of the key principles that apply to decisions regarding mixing zones include:

- In no case, should a mixing zone impair the uses of a water body.
- Mixing zones are not to be used as an alternative to reasonable and practical treatment of effluent or effluent streams.
- Although exceedances of WQOs may be allowed within a defined mixing zone, the water quality within or discharged into it should never be acutely toxic to aquatic life.
- The size of the mixing zone should be minimized to the extent practical.
- Mixing zone sizes may vary from one water body to another.
- The allocation of a mixing zone may vary from one substance to another. While mixing zones may be appropriate for substances that degrade or can be assimilated into the receiving waters without long term effects, substances that are toxic, persistent and bioaccumulative (e.g., chlorinated dioxins and furans, PCBs, mercury, toxaphene) are not generally allowed in a mixing zone (i.e., EQC would be set equal to WQOs for those substances).

2.3 Summary of How Regulated Mixing Zones will be Established and Used in the Water Licensing Process

Proponents who wish the Boards to consider allocating a mixing zone for their undertaking should propose a mixing zone, including rationale, in their water licence application. To support the proposed mixing zone, the proponent must submit the information that is detailed in Section 6 of the Guidelines.

As stated in the Policy, the Boards will consider allocating a mixing zone for an undertaking on a case-by-case basis, based on the evidence provided in any given water licensing process. In addition to meeting the definition given in Section 2.1, the mixing zone should be regulated to ensure that the criteria described in Section 3 will be met.

When allowed, the main use of a regulated mixing zone in the water licensing process is to define the point at which WQOs must be met downstream of an effluent discharge point or outfall. As described in Section 5.1, defining the point at which a numeric WQO must be met serves the very practical purpose of allowing the calculation of numeric EQC, as either concentrations or loadings (i.e., quantity), that meet the requirements of the Policy. Other ways in which a regulated mixing zone may affect the water licence requirements are discussed in Section 5.

[9] See References for a full list of documents consulted in preparing these Guidelines.

3.0 Decision Criteria for Allocating Regulated Mixing Zones

As discussed further in Section 4, the dimensions allocated to a mixing zone will vary on a case-by-case basis depending on factors including characteristics of the effluent discharge (e.g., quality, flow, outfall design) and the receiving waters (e.g., quality, uses, aquatic life). The criteria listed below will be used to guide the establishment of a regulated mixing zone with the goal of minimizing effects to a waterbody. These criteria are consistent with the Boards' Policy objectives and based on criteria established for mixing zones in other provincial jurisdictions[10]. Conformance of proposed mixing zones to the criteria below will be determined by the Boards based on the evidence presented for specific water licence applications.

1. The dimensions of the mixing zone must be as small as practicable.
2. The mixing zone must not be of such size or shape as to cause or contribute to the impairment of existing or future water uses in the receiving environment.
3. Mixing zones must not be used as an alternative to reasonable and practical pollution prevention practices, including wastewater treatment.
4. The mixing zone should not impinge on or contact critical fish or wildlife habitats (e.g., spawning or rearing areas for fish, habitats for migratory waterfowl).
5. Mixing zones must not be established such that drinking water intakes are contained therein or otherwise negatively affected. Ideally, mixing zones should always be located as far away (i.e., downstream) as practical from drinking water intakes.
6. Conditions within the mixing zone should not cause acute toxicity to aquatic organisms.
7. Mixing zones must not be established for substances that are persistent, toxic and bio-accumulative[11].
8. The mixing zone must allow an adequate zone of passage for the movement or drift of all stages of aquatic life. The mixing zone should not interfere with migratory routes including migration into tributaries; specific portions of a cross-section of flow or volume may be allocated by the Boards for the purpose of migration.
9. Water in the mixing zone should be free from nutrients in concentrations that create nuisance growths of aquatic weeds or algae or that results in an unacceptable degree of eutrophication of the receiving water.
10. Mixing zones should not unduly attract aquatic life or wildlife, thereby causing increased exposure to substances of potential concern.
11. Accumulation of toxic substances in sediment to toxic levels should not occur in the mixing zone.

[10] See the following References for criteria established in other jurisdictions: Alberta, 1995; British Columbia, 2014; CCME, 2008; Manitoba, 2011; Ontario, 1994; Saskatchewan, 2015.

[11] For example, see list of chemicals on the United States Environmental Protection Agency's Toxics Release Inventory at: https://www3.epa.gov/enviro/triexplorer/list-chemical-pbt.htm

12. Mixing zones should not contain substances that render the mixing zone aesthetically unacceptable, including, for example, materials which form objectionable deposits (e.g., scums, oil, or floating debris) or substances producing objectionable colour, odour, taste or turbidity.
13. The mixing zone must be able to maintain its assimilative capacity (e.g., loading).

4.0 Regulated Mixing Zone Dimensions

The dimensions of a regulated mixing zone will be set by the Boards based on the considerations described in the Guidelines and on the evidence presented in the water licensing process. In Section 4.1 below, the Guidelines discuss the general processes of effluent mixing in the receiving environment and how those natural processes relate to the definition of a regulated mixing zone. Section 4.2 describes some of the potential spatial or fraction of flow methods that may be used to set regulated mixing zone dimensions.

4.1 Relationship Between a Regulated Mixing Zone and the Physical Process of Mixing

When effluent is discharged into a waterbody such as a river or lake, it does not, under most circumstances, completely and instantaneously mix with the receiving water. Instead, what forms is an effluent plume starting at the outfall as effluent begins to mix with the receiving waters. The mixing zone is a transitional area within a waterbody in which an effluent discharge is gradually assimilated into the receiving water. At some point downstream of the outfall, the physical process of mixing will be complete. This 'physical' mixing zone is defined as the area up to the point where there is virtually no measurable difference between unaffected receiving water and receiving water mixed with the effluent. At this point, the effluent is considered fully mixed with the receiving water.

The size of the physical mixing zone varies over time with factors such as: effluent flow rate, design of the outfall, ambient waterbody properties (e.g., depth, velocity, density, etc.), season and concentrations of water quality parameters in both the effluent and the receiving waters. Because of its inherent variability over time, the physical mixing zone is not useful for regulatory purposes. As well, the physical process of mixing may extend for very long distances from the outfall; setting regulated mixing zone dimensions equal to the physical mixing zone could therefore result in unacceptably large areas in the water body that have COPC concentrations in excess of WQOs.

For the purpose of water licensing, only a portion of the physical mixing zone will be allocated for use in setting effluent discharge limits. Unlike a physical mixing zone, which varies over time due to the factors described above, the spatial boundaries of a regulated mixing zone can be defined within a waterbody using finite dimensions such as length, width, or radius (Figure 1). At the edge of the regulated mixing zone, sufficient mixing will have occurred that measured water quality will achieve the expected water quality objective. Other jurisdictions in Canada also regulate effluent discharges using only a specific portion of the physical mixing zone, calling this area the 'allocated mixing zone,' 'limited use zone,' 'initial dilution zone,' or simply the 'mixing zone.' For consistency, the term 'mixing zone' is used in this document to refer to the regulated mixing zone.

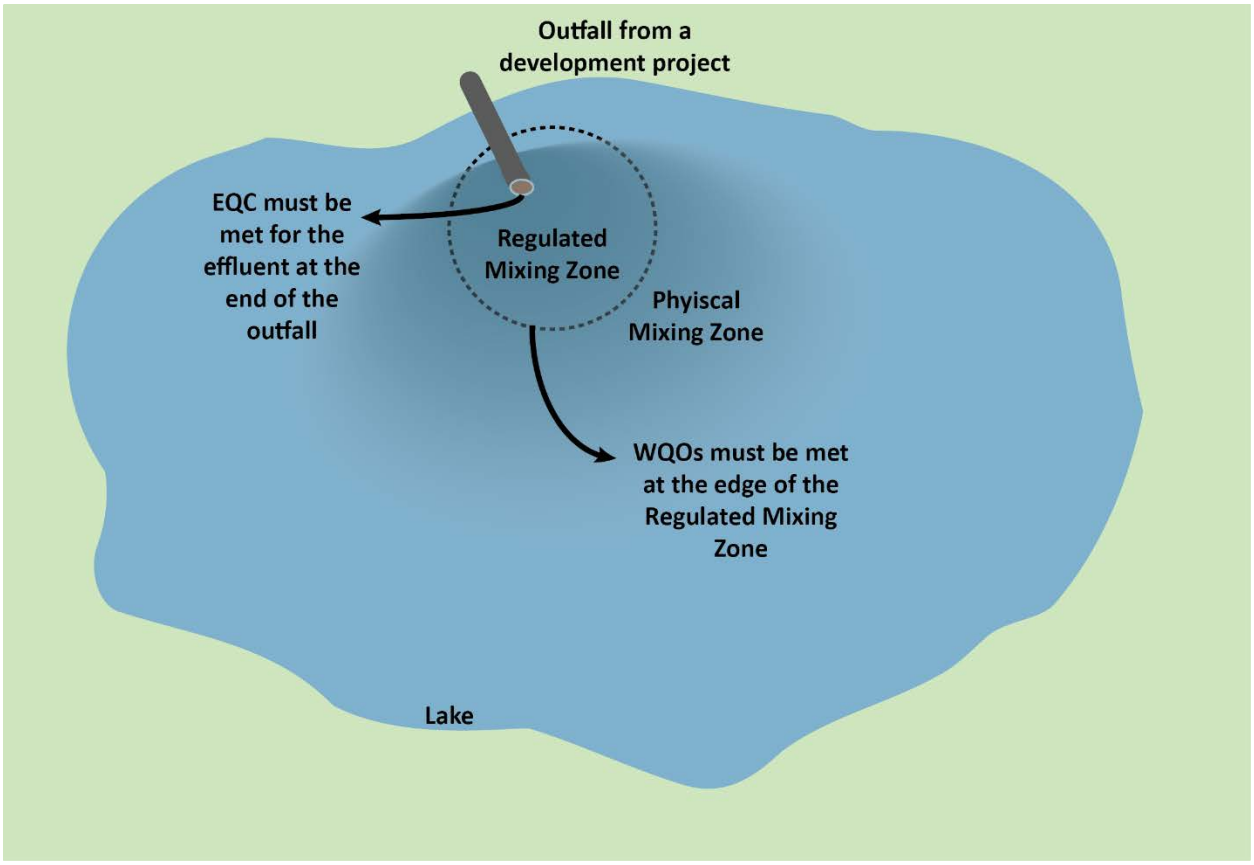

Figure 1a: Difference between a physical mixing zone and a regulated mixing zone in a lake

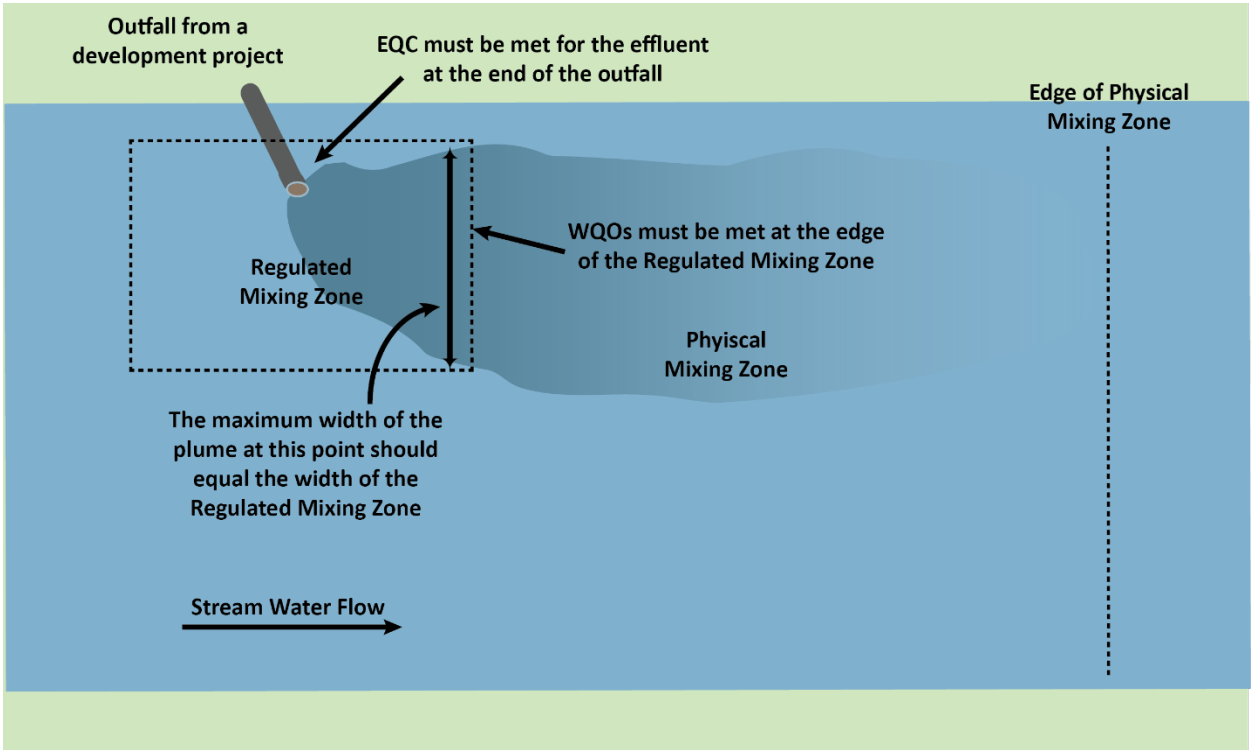

Figure 1b: Difference between a physical mixing zone and a regulated mixing zone in a stream.

4.2 Considerations for Defining the Dimensions of a Regulated Mixing Zone

As stated in Section 3, the dimensions of a regulated mixing zone are meant to be as small as practicable; in other words, the mixing zone size should be large enough to allow for initial dilution and mixing of the effluent but small enough to avoid causing adverse effects to the receiving water body. Since decisions about the size of the mixing zone must be made before an undertaking begins discharging effluent, initial conclusions about the extent to which a proposed mixing zone may meet the criteria listed in Section 3 can only be based on predictions or modelling information provided by the proponent. In recognition of the inherent uncertainty in modelling, some Canadian jurisdictions[12] have defined maximum mixing zone sizes based on a fraction of streamflow or fixed spatial restrictions (see Appendix 1 for examples). In those cases, restrictions are set very conservatively to ensure that criteria such as the ones listed in Section 3 are met under all circumstances.

In the Mackenzie Valley, the Boards consider the following restrictions as a useful starting point[13] for defining the dimensions of a regulated mixing zone:

- For lakes – regulated mixing zones should have a maximum radius of 100 m or 25% of the width of the lake (whichever is smaller), not exceed 10% of the available volume for mixing and not extend closer to shore than the mean low water mark. See Figure 2a for a visual representation.
- For streams and rivers – regulated mixing zones should have a rectangular shape where the width is the dimension perpendicular to the path of the stream and the length is parallel to the path of the stream. The width of the mixing zone should not exceed the lesser of 100 m and 25% of the width of the stream. The length of the mixing zone may be defined from a point 100 m upstream of the discharge and a point which is the lesser of 100 m downstream and a distance downstream at which the width of the effluent plume equals the maximum allowable width of the mixing zone. See Figure 2b for a visual representation.

[12] For example: Saskatchewan (2015), Manitoba (2011), British Columbia (2004), and Alberta (1995).
[13] Note that the final dimensions of a regulated mixing zone may be set larger or smaller than what is listed here based on the evidence provided during individual water licensing processes.

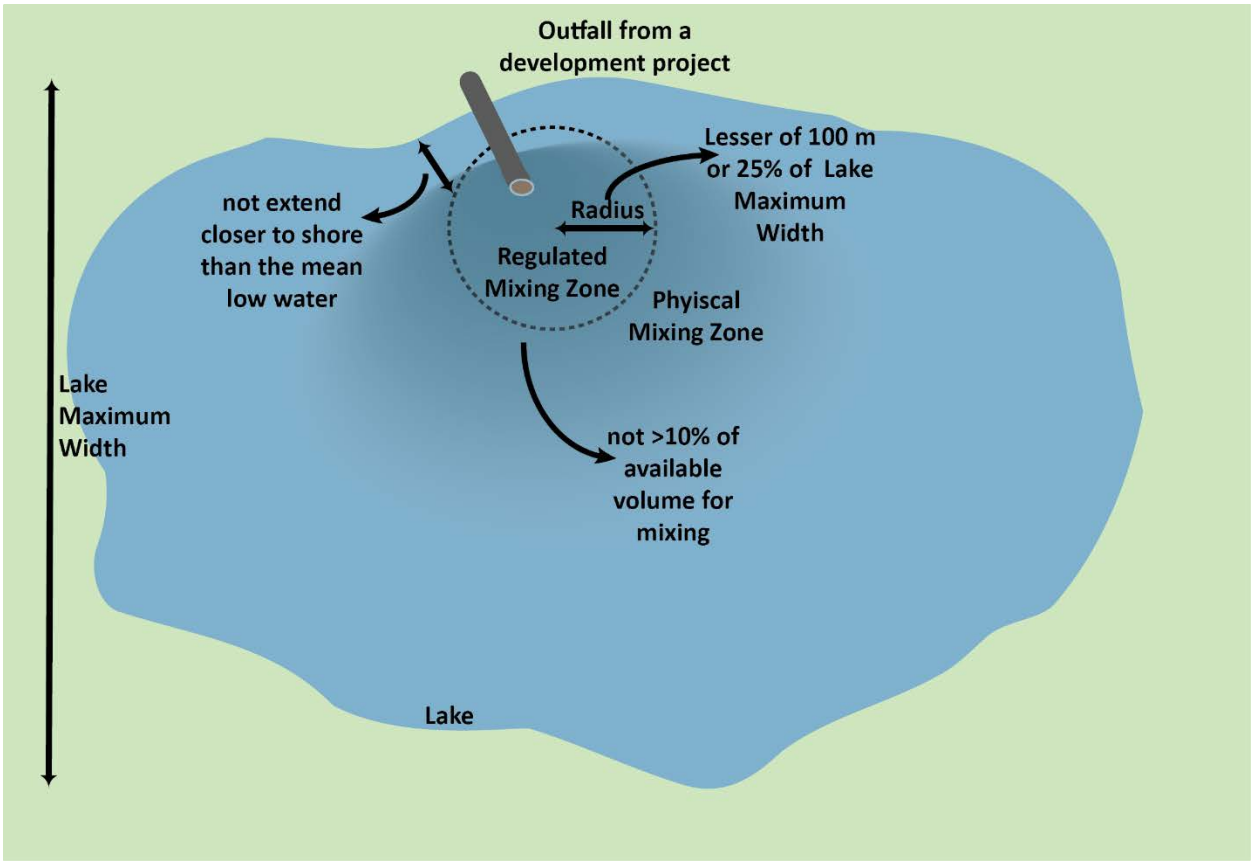

Figure 2a: Dimensions of a Regulated Mixing Zone for Lakes

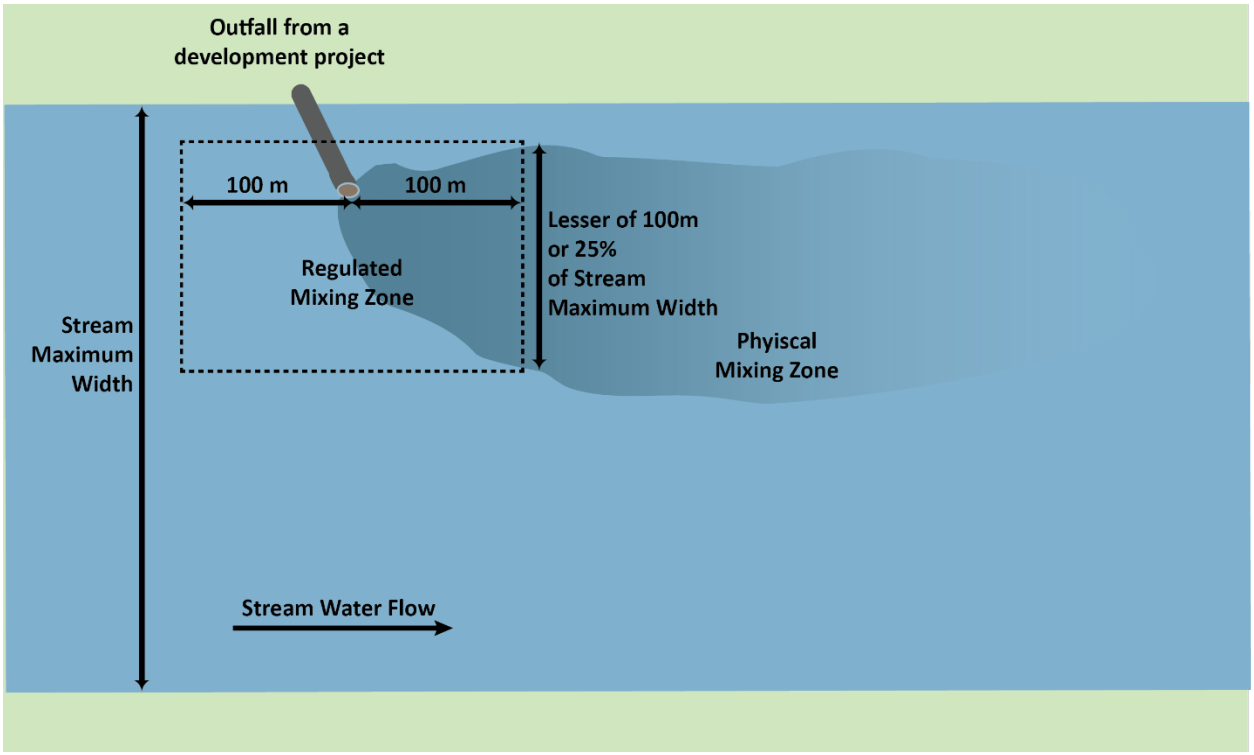

Figure 2b: Dimensions of a Regulated Mixing Zone for Streams or Rivers

Notwithstanding the information above, the exact dimensions of a regulated mixing zone will be determined by the Boards on a case-by-case basis and the sizes may vary depending on the characteristics of the receiving waters and the effluent associated with each individual undertaking. In making its final determinations, the Boards will require the information described in Section 6 as well as evidence that the criteria listed in Section 3 have been addressed to the extent practicable.

5.0 Water Licence Requirements Related to Mixing Zones

This section provides information about the types of requirements that are often incorporated into water licences for undertakings that have established mixing zones. Specific requirements for individual water licences will be decided by the Boards on a case by case basis.

5.1 Effluent Quality Criteria

Where a mixing zone is allocated, EQC represent the maximum concentration and load of a substance in the effluent that will enable receiving water to meet WQOs at the edge of the regulated mixing zone. To calculate EQC, the following information is needed:

- The WQOs that must be met in the receiving environment. Note that Section 8 of the Policy describes the kinds of information that the Board will consider when setting WQOs site-specifically for a receiving environment.
- The characteristics of effluent mixing (both vertically and horizontally), assimilation, and dilution within the regulated mixing zone. Conservative conditions such as periods of low water volume or flow in the mixing zone are generally used to back calculate EQC that will meet WQOs in the receiving environment at all times.
- The background or baseline[14] concentrations of substances in the receiving environment. Substances that are considered COPC in the effluent are often already present in lower concentrations in the receiving waters. Natural background or baseline concentrations of substances in the receiving water body must be added to the loads of substances coming from the effluent to ensure that, collectively, substance concentrations do not exceed the WQO concentration at the edge of the regulated mixing zone.

Details of the information needed to set EQC are attached as Appendix 2.

The characteristics of the mixing zone, and hence the method of EQC calculation, may be quite different for rivers/streams and lakes. In both cases, the initial dilution is based on the inflow of water into the mixing zone; but, while inflow for rivers/streams is continuous, inflows for lakes may be intermittent or consist only of run-off in the case of headwater lakes. Because of the lower inflow rates, the calculation

[14] In this context, 'background' water quality refers to the natural, pre-disturbance concentrations of substances in the water. 'Baseline' water quality refers to the concentrations of substances in the water prior to the current project; this case acknowledges that there may have already been anthropogenic activity in the area so that water is not at background levels any more.

of EQC for lakes must consider the accumulation of substances over time in addition to the instantaneous mixing and dilution of substances from the effluent in the receiving water. Waterbody flow and assimilation characteristics are generally based on a combination of baseline monitoring and modelling; therefore, EQC for new water licences are often set conservatively, and a water licence may require monitoring or a Plume Delineation Study to validate or adjust the assumptions made about initial mixing of effluent in the receiving water.

5.2 Plume Delineation Studies

Effluents from licenced undertakings generally differ from receiving waters in terms of quality (i.e., substance concentrations) and density. As discussed in Section 4.1, effluents do not generally mix instantaneously with the receiving waters after discharge. The zone of incompletely mixed effluent and receiving water forms a plume extending downstream or away from the outfall. Depending on the flow characteristics of the receiving waterbody, the plume may, for example, extend downstream along the water's edge or sink to the bottom of the water body for varying distances as substances gradually mix and assimilate into the waters. The behavior of effluent plumes within receiving waters may be estimated or modeled as described in Section 6; however, to confirm any assumptions made about effluent mixing, the Boards may also set a water licence requirement for a Plume Delineation Study.

If required, a Plume Delineation Study is typically done within a year of the beginning of effluent discharge. The Study is usually conducted by analyzing samples of water taken at different locations around the discharge point and extending into the receiving water body in a grid like pattern. Samples are taken at different depths in the water column and the study may be done both under open water and under-ice conditions as mixing differs greatly in different seasons. The results of the Study will be compared to mixing zone predictions to ensure that the assumptions upon which the EQC were set are accurate. If the results of the Study indicate that the initial modelling assumptions are inaccurate it may be necessary to adjust water licence conditions (potentially including the EQC) through a water licence amendment process.

5.3 Monitoring Requirements

Monitoring to assess attainment of the WQO is an essential component of the overall environmental management process. As described above, EQC are set to ensure that WQOs are met at the edge of the mixing zone. To check the accuracy of EQC calculations, water licences typically require the proponent to monitor water quality at stations located at the edge of the mixing zone. The monitoring stations will be located based on the predicted plume characteristics, for example:

- Within a lake, the effluent plume may diffuse out in a circular pattern around the outfall; in that case, the mixing zone may be defined by the radius of the circle and monitoring stations will be set at several points along the perimeter.
- Within a river or stream, the mixing zone may be defined as a rectangle with monitoring locations set at the downstream edge and at a distance across the width of the river.

- In all cases, if the effluent plume is predicted to float upwards or sink towards the bottom of the waterbody, the proponent may be required to take samples at one or more depths to ensure that the maximum concentration of the plume at the edge of the mixing zone is captured.

Typically, water quality monitoring at the edge of the mixing zone is required monthly so that mixing assumptions can be verified under all seasonal conditions. The location, frequency, and suite of analytical parameters for monitoring the edge of the mixing zone is generally prescribed within the Surveillance Network Program of a water licence. An analysis of the monitoring data, including a comparison to mixing predictions, may be required within the Annual Water Licence Report and/or an Aquatic Effects Monitoring Program Annual Report, depending on the project. If monitoring results indicate that WQOs are being exceeded at the edge of the mixing zone, it may be necessary to amend the EQC prescribed in the water licence.

Note that requirements for monitoring around a mixing zone will vary between water licences. Issues related to the safety of sampling in the receiving environment, such as high flows or thin ice for example, and schedule of discharge (i.e., continuous or seasonal), will also be considered when setting monitoring requirements for a mixing zone.

6.0 Information Required to Define a Mixing Zone

Proponents who wish the Boards to allocate a mixing zone for their undertaking should propose a mixing zone, including rationale, in their water licence application. It is not possible to provide a single definitive list of information requirements for mixing zone applications for all the different kinds of undertakings and receiving environments in the Mackenzie Valley; therefore, this section only provides an outline of the types of information that proponents should include in their applications. Proponents are expected to provide any information that is necessary to support their application for a mixing zone based on best professional judgement. Prior to submission, proponents are encouraged to contact Board staff to discuss information requirements for their specific applications.

To support the proposed mixing zone, the proponent must submit, at a minimum, the following information:

1) A description of why a mixing zone is necessary for the undertaking. For example, if after the implementation of pollution prevention measures and/or wastewater treatment, the proponent predicts that concentrations of some substances in the effluent will be higher than the corresponding WQO.
2) Proposed dimensions for the mixing zone with supporting rationale and information as further described below.
3) A description of how conditions in the proposed mixing zone addresses each of the criteria outlined in Section 3 of the Guidelines. Note that the evidence submitted by the proponent in this regard is especially important if the dimensions of the proposed mixing zone are greater than those discussed in Section 4.2.

4) If applicable, any relevant information provided during an environmental assessment/impact review process with respect to the proposed mixing zone.

Regulated mixing zones are required in the context of setting EQC for a project. Therefore, the information required to support a proposed mixing zone necessarily overlaps with the information needed by the Boards to set EQC. The information requirements for setting EQC are included in Appendix 2; an overview of the types of information that may support a proposal for a regulated mixing zone. These include:

- Receiving water characteristics
    - Include any information about the receiving waters that may be relevant to mixing processes within the water. Examples include, but are not limited to: the type of water body (e.g., lake, river, stream), the volume of receiving water available for assimilation or dilution, background receiving water quality, and a description of physical/hydraulic processes that affect mixing within the receiving waters (e.g., ice formation, channel characteristics, depth, turnover rates, precipitation/evaporation rates, flow characteristics, or any other metric that may affect mixing).
- Water Quality Objectives
    - Proponents should propose, with rationale, site-specific WQOs for the receiving environment that will need to be met at the edge of the proposed mixing zone. Section 8.1 of the Policy describes the kinds of information upon which site-specific WQOs may be based. Appropriate WQOs will ultimately be set by the Board as described in the Policy or by regulations established under the *Waters Act*.
- Effluent and discharge characteristics
    - For example: flow rate, concentration of COPCs in the effluent, comparison of predicted or actual COPC concentrations in effluent to relevant toxicity guideline values or site-specific WQOs, results from toxicity testing of effluent, physical and aquatic receptors of COPCs in the receiving waters, design and expected performance of the outfall, diffuser type, and expected buoyancy of the effluent relative to the receiving water.
    - Predicted quantity of effluent discharge and a description of whether discharge will occur on a continuous, temporary, or seasonal basis.
    - Proponents should propose EQC as described in Appendix 2 and final EQC determinations will be made by the Board in accordance with the Policy.
- Contaminant characteristics
    - Mixing processes can differ for different contaminants (e.g., some substances may decay over time, others can bioaccumulate, and others may be conservative,

like ions); therefore, any information relevant to the relative mixing characteristics of COPCs in the effluent should be presented.

In all cases, the proponent should provide the information necessary to demonstrate how WQOs will be met at the edge of the proposed mixing zone under a range of expected, best-case and worst-case conditions[15] for mixing and dilution. For relatively simple situations, simple mass-balance dilution models can be applied to predict contaminant concentrations in the mixing zone. More detailed modeling may be required for situations with complex effluents, varying effluent flows and/or for receiving waters in which the characteristics of mixing vary substantially with season or over time. In these cases, several commercially available computer software packages are used to assess and predict physical, chemical, and biological conditions in mixing zones. The US EPA recommends the use of the following models:

1. Visual Plumes (VS) – MS Windows-based, simulates single and merging submerged plumes in arbitrarily stratified ambient flow and buoyant surface discharges (http://www.epa.gov/ceampubl/swater/vplume/VP-Manual.pdf).
2. RSB and UM models with PLUMES model interface and manager – for plumes discharged to marine and fresh water including buoyant and dense plumes, single source and multiple diffuser outfall configurations (http://www.epa.gov/waterscience/standards/mixingzone/files/RSB UM PLUMES.pdf).
3. Cornell Mixing Zone Expert System (CORMIX) – hydrodynamic simulations suitable for complex discharge situations, such as discharges into flowing water (lakes, rivers, estuaries, and coastal waters) beyond predictive capabilities of other initial mixing models for multiport diffusers (http://www.epa.gov/waterscience/models/cormix.html).

Inputs to the models should consider the range of expected, best-case and worst-case conditions for effluent discharge and mixing to demonstrate that WQOs will be met in the mixing zone under all potential conditions of effluent quality/quantity as well as seasonal flows within the receiving waters. For example, it is common practice to use low flow statistics[16] such as the 7Q20 or 7Q10 flows for rivers to simulate worst-case conditions with respect to dilution and mixing in rivers. The climate in the Mackenzie Valley will also alter assimilation and may alter mixing under prolonged ice cover. Assimilation of contaminants over time and the effect of prolonged low water yields must also be considered for lakes.

[15] Conditions that might affect the final concentration of COPCs at the edge of the mixing zone include, for example, the predicted ranges of effluent quality and quantity, the range of hydrological conditions (i.e., low water or high water years) that might affect dilution, or the range of potential wind conditions that could affect mixing.
[16] The 7Q20 or 7Q10 values are equal to the seven day, consecutive low flow with a twenty or ten-year return frequency, respectively.

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APPENDIX 1: Examples of How Mixing Zone Dimensions Are Defined in Other Canadian Jurisdictions

Although the Guidelines are clear that the final dimensions of a regulated mixing zone will be determined by the Boards on a case-by-case basis, Section 4.2 describes mixing zone dimensions that the Boards consider a useful starting point for proponents who wish to propose a mixing zone in their water licence applications. The dimensions listed in Section 4.2 are based on guidance from other Canadian jurisdictions as listed below. Information sources are listed in the References section of the Guidelines.

1. From Section 3.2 of Saskatchewan, 2015:
    - "the limited use zone in streams and rivers should be apportioned no more than 25 percent of the cross-sectional area or volume of flow, nor more than one-third of the river width at any transect in the receiving water during all flow regimes which equal or exceed the 7Q10 flow for the area. Surface water quality objectives applicable to the area must be achieved at all points along a transect at a distance downstream of the effluent outfall to be determined on a case-by-case basis".
    - "in lakes and other surface impoundments, surface water quality objectives applicable to that waterbody must be achieved at all points beyond a radius of 100 metres from the effluent outfall. The volume of limited use zones in lakes should not exceed 10 percent of that part of the receiving waters available for mixing".

2. From page 13 of Manitoba, 2011:
    - "The mixing zone should be designed to allow an adequate zone of passage for the movement or drift of all stages of aquatic life: (i) For those materials that elicit an avoidance response from aquatic life, the mixing zone should contain no more than 25 % of the cross-sectional area or volume of flow at any transect in the receiving water. Should a proportion of the stream width greater than 25 % be selected for these materials, the mixing zone could act like a physical barrier and could effectively preclude the passage of aquatic life".
    - "In lakes and other surface impoundments, the volume of mixing zones should not exceed 10 % of the volume of those portions of the receiving waters available for mixing or 100 m in radius, whichever is less".
3. From Part 6, Items 92-93 of the British Columbia Municipal Wastewater Regulations (British Columbia, 2004):
    - **"92** (1) For calculating the initial dilution zone for marine waters or a lake, both of the following, measured from the point of discharge and from mean low water, apply:

      (a) the height is the distance from the bed to the water surface;

      (b) the radius is the lesser of

      (i) 100 m, and

(ii) 25% of the width of the body of water.

(2) For discharge from an outfall diffuser, the radius referred to in subsection (1) (b) (i) must be measured from the first and last diffuser ports.

(3) In embayed marine waters and lakes, the initial dilution zone must not extend closer to shore than mean low water.

(4) In open marine waters, the edge of the initial dilution zone must be located outside of the shallow water zone in which surf will form along the shore."

- **"93** (1) For calculating the initial dilution zone for a stream, river or estuary, all of the following, measured from the point of discharge and from mean low water, apply:

  (a) the height is the distance from the bed to the water surface;

  (b) the width, perpendicular to the path of the stream, is the lesser of

  (i) 100 m, and

  (ii) 25% of the width of the stream or estuary;

  (c) the length, parallel to the path of the stream, is the distance between a point 100 m upstream and a point that is the lesser of

  (i) 100 m downstream, and

  (ii) a distance downstream at which the width of the municipal effluent plume equals the width determined under paragraph (b)."

4. From Table 12, Section 6, page 8 of Alberta, 1995:
   - "Chronic guidelines are preferably met before 10 times the stream width for a length restriction and ½ the streamwidth laterally (streamwidth calculated at design flow), or using 10% of the 7Q10."

APPENDIX 2: Information Requirements for Setting Effluent Quality Criteria

General Principals for Setting Effluent Quality Criteria (EQC)

As per the Water and Effluent Quality Management Policy[17] (the Policy), the Board sets water licence conditions, including EQC, with the goal of ensuring that current and future water uses in the receiving environment will be protected. As stated in the Policy:

> *"Protection of water quality in the receiving environment is the primary objective. The level of protection will be defined by the water quality standards that have been set site-specifically for the receiving environment in question. Effluent Quality Criteria (EQC) will be set for a project (undertaking) to ensure that water quality standards will be met."*

EQC that are set to meet this Policy objective are called "water quality-based EQC." As described below, water quality-based EQC are considered with the goal of protecting water uses in the receiving waters of an undertaking.

The second objective of the Policy is to ensure that the amount of waste to be deposited to the receiving environment is minimized. As stated in the Policy:

> *"The Boards expect proponents to identify and implement waste prevention and/or minimization measures, whenever feasible. Implementation of such measures may be stipulated in the terms and conditions of a water licence. The Boards can assess how these measures are expected to impact effluent from a project (undertaking) to set EQC that proponents can reasonably and consistently achieve."*

EQC that are set to meet this Policy objective are called "technology-based EQC." Some undertakings may employ formal wastewater treatment methods through, for example a water treatment plant while others rely only on waste minimization practices implemented on site. In either case, technology-based EQC are dependent on what is reasonably and practically achievable for specific effluent streams. In the case of a new water licence, technology-based EQC may be based on predictions made by the proponent based on an analysis of all waste streams and the predicted treatment efficiencies (if applicable).

As described in the reasons for decision for water licences issued[18] since the Policy was developed, the Board's general process for setting EQC is to first derive water quality-based EQC and then consider whether a) the EQC are reasonably achievable, and b) if the EQC could be made more stringent based on

[17] MVLWB, Water and Effluent Quality Management Policy, March 31, 2011

[18] See, for example, Reasons for Decision from the MVLWB for MV2011L2-0004 (renewal of De Beers Canada water licence for the Snap Lake Diamond Mine. MV2005L2-0015 (De Beers' Gahcho Kue Mine) and MV2008L2-0002 (Canadian Zinc's Prairie Creek Mine) as well as the WLWB decisions on W2023L2-0001 (Dominion Diamond's Ekati Diamond Mine) and W2008L2-0003 (Fortune Mineral's NICO Mine).

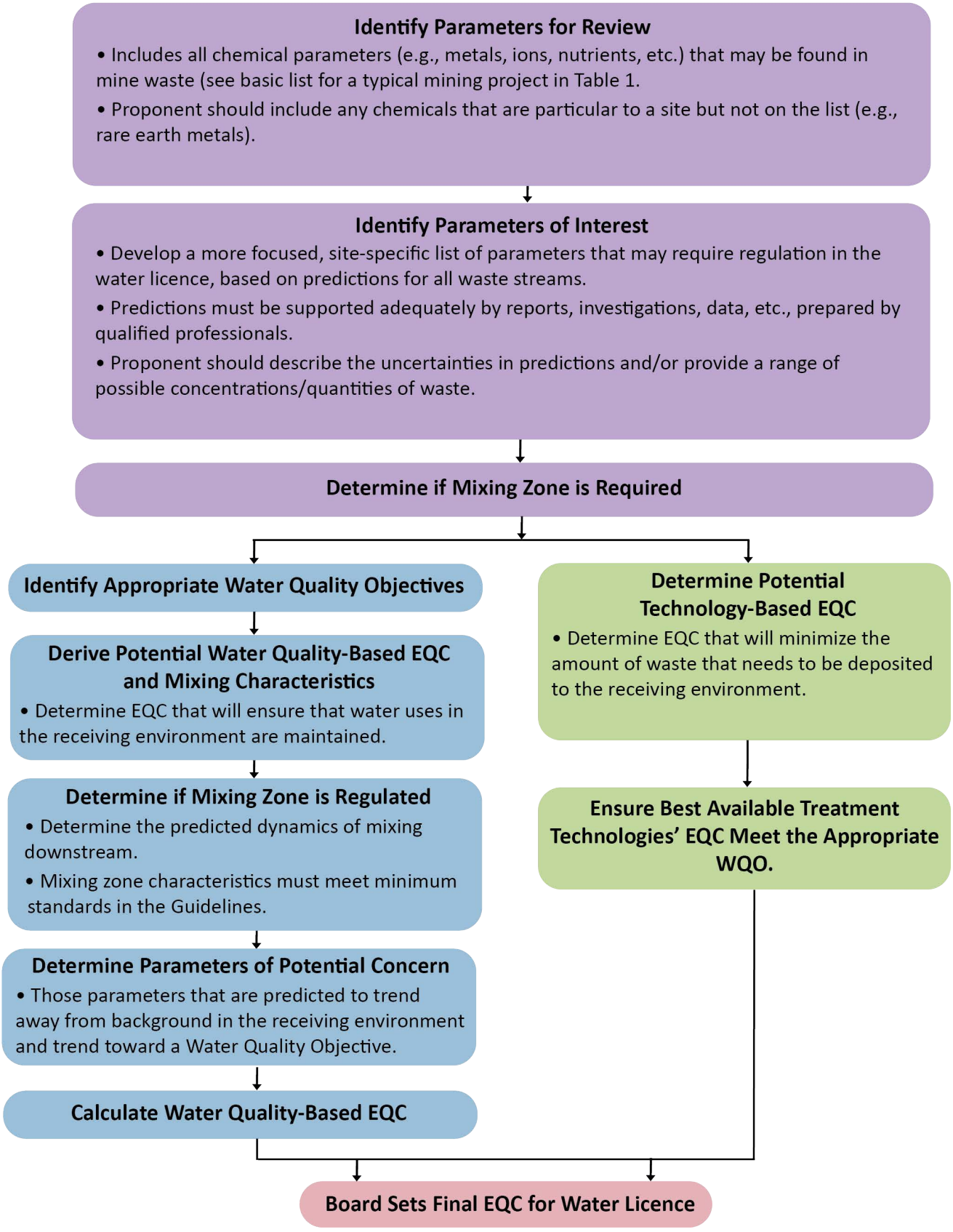
what is technologically feasible for the site. The step-wise process for deriving EQC is depicted in Figure 3 and summarized as:

- Identify the Parameters for Review. In this step, the Board evaluates the evidence to determine which chemical parameters may be elevated in the effluent relative to background concentrations and that, therefore, may need to be regulated through EQC in the water licence.
- Derive Water Quality-Based EQC. As described in the Introduction above, EQC are first derived with the goal of ensuring that the water quality objectives (WQOs) for the receiving environment will be met during all phases of the project.
- Determine Technology-Based EQC. These EQC are not calculated per se but are based on what effluent quality the proponent can reasonably and practically achieve at the end-of-pipe. This could include any specified variability in treatment performance from the plant manufacturer.
- Determination of final EQC values for the water licence. Generally, the Board will choose those EQC that are the lower of the values derived as per step 2) or 3) above. However, and as per the Policy, the Board will ensure that EQC are set at levels that the proponent can reasonably achieve on a consistent basis[19].

To set EQC, the Board requires that the proponent submit an EQC Report with the application for a new water licence as well as for the renewal or amendment of an existing water licence. The information required in an EQC Report may vary depending on the type of undertaking (e.g., municipal, oil and gas, mining, exploration).

[19] Ibid

Figure 3: Summary Process for Setting Effluent Quality Criteria



Information Requirements for Setting Effluent Quality Criteria – the EQC Report

The purpose of the EQC Report is to provide a standalone document containing all information required by the Board to set EQC and related water licence conditions. If prepared appropriately, the Effluent Quality Criteria Report should provide the Board with the information necessary to ensure that the Board has all the information it needs to set EQC and other water licence conditions such that the objectives[20] of the Water and Effluent Quality Management Policy will be met.

The Board has provided details below of what information is specifically required and has recommended the way in which the information should be organized. This will ensure that this report meets the Board's expectations. To put the information requirements into context, each step in the process is summarized below along with a list of specific information the Proponent is required to submit to enable completion of that step.

Step 1: Identify Parameters for Review

In this step, all chemical parameters that are typically associated with a proposed undertaking should be identified. The list that is generated, called the Parameters for Review, represents all the parameters that should be evaluated with respect to the quantity that will be generated by the undertaking and that may need to be discharged. Each type of undertaking (e.g., mining, exploration, oil and gas production, municipal, etc.) will have a different list of Parameters for Review that may include metals, organics, nutrients, major ions, or biological components (e.g., *E. coli*, biological oxygen demand).

A comprehensive list of Parameters for Review for a typical mining project is provided in Table 1, below, as an example. Depending on the project site, additional parameters may need to be included; the Proponent should add those parameters that are not on the list in Table 1 but that could be of concern at its unique site (e.g., rare earth metals). Proponents should contact Board staff for information on typical Parameters for Review for undertakings other than mining.

Information Required from the Proponent:

- Provide a final list of Parameters for Review that includes all those chemical parameters that are typically associated with the proposed undertaking. For mining applications, Proponents may start with the parameters listed in Table 1 as well as any other parameters that may be unique to this project site and that should be considered in the EQC evaluation.

[20] The Board's Water and Effluent Quality Management Policy outlines the two objectives that are to be met with respect to the deposit of waste:
1. Water quality in the receiving environment is maintained at a level that allows for current and future water uses.
2. The amount of waste to be deposited to the receiving environment is minimized.

Table 1*: Basic List of Parameters for Review for Mining

Aluminium	Colbalt	Nitrate as N	Total Organic Carbon (TOC)**
Ammonia as N	Copper	Nitrite as N	Total Petroleum Hydrocarbons
Antimony	Fluoride	pH	Total Suspended Sediments (TSS)
Arsenic	Hardness**	Total Phosphorus	Turbidity
Barium	Iron	Potassium	Uranium
Beryllium	Lead	Selenium	Vanadium
Boron	Manganese	Strontium	Zinc
Cadmium	Mercury	Sulphate	*Escherichia coli*
Chloride	Molybdenum	Temperature	Biological Oxygen Demand
Chromium	Nickel	Total Dissolved Solids (TDS)	

*Notes to Table 1: This table contains a typical list of parameters for review for a mine, although the proponent may need to add other parameters specific to its project (e.g., rare earth metals). This list was generated by taking a list of what is monitored in a typical Aquatic Effects Monitoring Program and eliminating those parameters that are either:

1. Numerical indicators of water quality (rather than constituents of the water itself), e.g., alkalinity, conductivity, ion balance, and in some cases temperature, or,
2. Adequately and appropriately represented by another parameter that is on the list above – for example:
    - Major ions that do not cause toxicity, like bicarbonate, calcium, magnesium, sodium. These are not parameters for review because the analysis of TDS is sufficient.
    - Total Kjeldahl Nitrogen (TKN). This is not a parameter for review because other nitrogen species that have known toxicity are in Table 1 (e.g., ammonia, nitrate, and nitrite).
    - Other forms of phosphorus (e.g., orthophosphate, dissolved phosphate, and total phosphorus). Total phosphorus has been requested in Table 1 because this is the measure used by the CCME in its Guidance Framework for Phosphorus (CCME 2004).
    - Dissolved metals: Generally, WQOs are set for total metals instead of dissolved metals although there may be some exceptions (e.g., cadmium). Since the concentration of total metals includes the contribution of the dissolved form, it is most conservative to perform the analysis on total metals. Accommodation for individual cases where dissolved metals are of interest can be made if and when necessary.

** Although TOC and Hardness are very unlikely to be regulated parameters, they are included in Table 1 because they influence toxicity for certain parameters; therefore, the Board requires the information described below in Step 2 for TOC and Hardness.

Step 2: Identify Parameters of Interest (POI)

Parameters of Interest (POI) are those chemical parameters that may need to be regulated through water licence conditions such as EQC. The list of POI will be unique for each undertaking and can only be identified after a thorough analysis of the predicted quantity and quality of waste generated on site. The idea of this step is to eliminate those parameters from the list of Parameters for Review for which there is no evidence that their respective concentrations could increase in the receiving environment due to the undertaking. The final determination of whether a parameter is "of interest" or not will be made by the

Board based on the specific evidence before it. Factors the Board may consider in its determination include, but are not limited to, the following:

- Whether predicted concentrations of a parameter are at or below method detection limits in any of the wastewater streams.

- Whether predicted concentrations of a parameter in any of the wastewater streams exceed the natural range of background concentrations in the receiving environment.

- The uncertainty in the predictions of wastewater quality and quantity. For example, in some cases the Board may only consider setting EQC based on effluent quality and quantity scenarios that have the highest probability of occurring. However, there may also be cases in which the Board will set EQC based on a low probability scenario if there is the potential for a high impact to the environment.

- Whether there is a reasonable mitigation or treatment method for a given parameter – that is, can the Proponent control the amount of a parameter that needs to be discharged. For example, the Board often sets EQC for ammonia to ensure that the Proponent will use best practices when blasting. Another example might be based on the proposed treatment technology.

Although the Board will make the final determination of what constitutes a POI for each project, the Proponent should propose its own list with rationale.

Information Required from the Proponent:

- Identification of all wastewater streams for the project as well as the predicted annual water balance for the site (for some undertakings, this may already be summarized in a Draft Water Management Plan).
    a. For each wastewater stream, the Proponent should provide:
        i. the predicted concentrations of each of the Parameters for Review, including those concentrations before and after treatment; and
        ii. the predicted quantities of each waste stream that will be collected, stored, treated and or discharged.
    b. The predicted concentrations and/or loads of each parameter in the effluent that the Proponent proposes to discharge to the receiving environment.
    c. A description of how predicted waste may change over time or during different phases of the undertaking (e.g., construction, operation, closure etc.), if applicable.
    d. Each of the information items above should include an analysis of the amount of uncertainty in the predictions/results given. That is, if there is a range of possible values, please give the range and an indication of what factors will increase the likelihood of the low or high extremes being realized. For example, it is common for there to be a range of possible mine water quantities depending on whether certain assumptions (e.g., hydraulic connectivity in the underground) prove to be true once mining commences.

Where possible, it would be helpful to describe the likelihood of different events to occur – low probability, high probability, best (i.e., most likely) estimates etc. Another example is provided by the difficulty in simulating a sample of effluent prior to the construction of the mine. In this case, the Proponent should describe the ways in which the simulated sample may differ from the final effluent and, again, estimate a range of possible values.

- Evidence that supports the above predictions must be submitted as well. Evidence should be in the form of investigations or reports from suitably qualified professionals. Examples of supporting reports are listed below; however, it is up to the Proponent to provide those supporting reports that are specifically relevant for its unique undertaking:
    i. Geotechnical investigations of mining area
    ii. Geochemical analysis of waste rock and ore samples
    iii. Analysis of process water from milling and/or simulated effluent samples
    iv. Tailings analysis
    v. Groundwater analysis
    vi. Precipitation data/reports
    vii. Design criteria for any structures that are meant to contain water (for seepage etc.)
    viii. Explosives use and management
    ix. Summary of treatment technology and expected treatment efficiency including bench-scale testing results with simulated effluent

- A list of the background concentrations of each Parameter for Review in the receiving environment (i.e., the water body (or bodies) to which the Proponent proposes to deposit waste), including enough of the statistical (e.g., average, 90th percentile, median etc.) as well as seasonal information to fully describe the background condition.

- The Proponent should propose a list of POI based on its own analysis of the above information with an appropriate level of rationale.

Step 3: Determine Potential Water Quality Based EQC

One of the objectives of the Water and Effluent Quality Management Policy is to set water licence conditions to ensure that current and future water uses in the receiving environment will be protected. As stated in the Policy:

> *"Protection of water quality in the receiving environment is the primary objective. The level of protection will be defined by the water quality standards that have been set site-specifically for the receiving environment in question. Effluent Quality Criteria (EQC) will be set for a project (undertaking) to ensure that water quality standards will be met. A Board may set other terms and conditions in the water licence that, in its opinion will aid in achieving this objective."*

Water quality based EQC are, therefore, considered for parameters where there is some concern over potential effects on water uses. The determination of water quality based EQC requires information about the receiving environment which is listed below.

Information Required from the Proponent:

- Identification of the appropriate current and future water uses for the receiving environment with rationale and supporting evidence. For example, water uses may have been identified by stakeholders during engagement with the Proponent. Water uses that must be protected may also have been identified during the environmental assessment or environmental impact review of the project.

- Proposed water quality objectives (WQOs) for the receiving environment that would protect the identified water uses. Proposed WQOs should consider site-specific receiving water conditions if appropriate (e.g., hardness, temperature, types of aquatic life, etc.).

- Definition of the location at which the proposed WQOs must be met, as per the CCME definition of a WQO[21]. In some cases, the environmental assessment or environmental impact review may have described assessment boundaries that could be used to define a location for meeting WQOs. The Proponent may also propose to define a mixing zone such that WQOs will be met at the edge of the mixing zone.

- If a regulated mixing zone is proposed, the Proponent should provide all information listed in Section 6 of the MVLWB/GNWT Guidelines for Effluent Mixing Zones. For example, Proponents must define the dimensions with rationale and provide an analysis of how the effluent will dilute and mix in this zone. The Proponent should also provide an estimate of the amount the effluent should be diluted at the edge of the proposed mixing zone.

- An analysis of how the effluent will physically mix with and disperse into the receiving environment past the proposed mixing zone. The analysis should extend away from the outfall to the point at which the effluent is diluted to less than 1% if possible.

- Estimated concentrations of each POI at the edge of the proposed mixing zone or other assessment boundary as defined above. If the amount of waste to be discharged is predicted to change over time or during different project phases (e.g., construction, operation, closure etc.), then estimates may have to be provided for the different conditions. Estimates of receiving water

[21] Canadian Council of Ministers for the Environment (CCME) 1999 "Canadian Water Quality Guidelines for the Protection of Aquatic Life", CCME, Winnipeg, MB. For the latest guideline values see: http://ceqg-rcqe.ccme.ca/. In this document, the CCME defines a water quality objective (WQO) as "a numerical concentration or narrative statement that has been established to support and protect the designated uses of water at a specified site."

concentrations of POIs should be provided for a range of potential conditions at this stage. For example:

- if there was a range of predicted effluent quality concentrations then it would be helpful to model the best-case, worst-case, and average or expected concentrations.
- if there was a range of predicted effluent quantities then it would be helpful to model the best-case, worst-case, and average or expected quantities.
- If effluent is being discharged to a flowing watercourse such as a river, stream, or creek:
  - effluent dilution should be modelled on the seasonal low, high, or average flow conditions of the watercourse;
  - it should be assumed that the fraction of upstream flow that will be available for dilution of the effluent is equal to only 10% or lower, and;
  - the upstream (background) load of each parameter should be included when estimating downstream concentrations.
- If effluent is being discharged to a lake it may be necessary to account for the accumulation of contaminants in the lake over time. This is especially important when discharging to small lakes or headwater lakes for example. To do this analysis, it is likely a mass-balance model or simulation should run using the following data:
  - estimates of the amount of effluent that will be discharged over the life of the mine;
  - estimates of the recharge rate of the lake – which will include precipitation and flows from other streams or lakes to the receiving lake, and;
  - inclusion of background concentrations of parameters in lakes in estimation of in-lake or in-stream water quality concentrations in the receiving environment.

- A table that compares, for each POI, the background concentration, the WQO and the estimated concentration at the edge of the mixing zone or at the relevant assessment boundaries.

- Proposed Contaminants of Potential Concern (COPC) are those parameters that may negatively affect water quality in the receiving environment to the extent that water uses are potentially at risk. The Board will make the final decision on which parameters are "of concern" but the Proponent should propose COPC with rationale.

- The Proponent may calculate water quality based EQC for each proposed COPC. Water quality based EQC should be calculated with the goal of ensuring water quality objectives are met at the edge of the mixing zone or other relevant assessment boundary. Calculations of proposed EQC should be accompanied by a rationale for assumptions made in the calculations. If calculations are performed in EXCEL spreadsheets, those EXCEL files should be submitted as well.

Step 4: Determine Potential Technology Based EQC

The second objective of the Water and Effluent Quality Management Policy is to ensure that the amount of waste to be deposited to the receiving environment is minimized. As stated in the Policy:

> *"The Boards expect proponents to identify and implement waste prevention and/or minimization measures, whenever feasible. Implementation of such measures may be stipulated in the terms and conditions of a water licence. The Boards can assess how these measures are expected to impact effluent from a project (undertaking) to set EQC that proponents can reasonably and consistently achieve."*

With respect to waste minimization, note that the Policy also states that "the Boards may set EQC that are more stringent than what is necessary to meet quality standards in the receiving environment."

Waste prevention or minimization measures should have already been identified in the Updated Project Description or in the other management plans requested as part of the post-environmental assessment of environmental impact review Information Package; if that is so, then there is no need to repeat any of that information here. Instead, technology based EQC may be proposed at this stage based on treatment technology.

Information required from the Proponent

- A description of all mitigations or other best practices that will minimize the amount of waste that needs to be discharged. For example, grouting may be used to minimize the inflow of water into an underground mine. Another example is the use of best practices for blasting to minimize the amounts of ammonia and nitrate in the final discharge. A summary should be included if it is known how source reduction activities will affect parameter concentrations in the effluent.
- For each POI, list:
    a. its concentration in the influent to the proposed water treatment process and the concentrations of the POI post-treatment and pre-discharge. Influent concentrations should reflect the effects of any source reduction activities that reduce parameter concentrations.
    b. the range of effluent concentrations possible during different phases of the undertaking (e.g., construction, operation, closure) if applicable.

Step 5: Determination of Final EQC for the Water Licence

Per the Policy:

> "*Once all reasonable measures have been taken to limit the amount of waste, concerns may still exist about the quantity, concentrations, and type of waste deposited, and in these cases the Boards will set EQC in the water licence.*"

The Board will consider all the evidence before it to set EQC for the water licence per the principles and objectives of the Policy. However, the Proponent should propose what EQC should be included in its water licence, with rationale.

Information Required from the Proponent:

The Proponent may propose EQC for its undertaking based on the evidence provided in the EQC Report.

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