Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories

1992

Foreword

Under the Northern Inland Waters Act the Northwest Territories Water Board is charged with the responsibility for licensing water use and waste disposal in the Northwest Territories. Municipal wastewater discharges are a most important consideration in that they have a direct impact on public health and general environmental quality. Reflecting public input at numerous public hearings, the Board has adopted the policy of requiring the treatment of all municipal waste by the best practical means before it is discharged into the receiving environment. It is believed that such a policy will help to keep the North's waters pure and clean and avert the problems allowed to build up in Southern Canada where often strict controls were not imposed in the early days of municipal growth. Fortunately the Board's goals and objectives are shared by departments and agencies of all levels of government, such as the Northwest Territories Association of Municipalities and the Department of Municipal and Community Affairs of the Government of the Northwest Territories. This results in a high level of cooperation between all the parties involved.

As a service to those operating and planning municipal waste systems, the Board published its first edition of "Guidelines" in 1981. The work of revision started almost contemporaneously with publication and so many people have participated in the process over the years that it is impossible to name them all. Much of the work was done by the Board's Technical Advisory Commitee as well as special committees established for specific purposes. Constant advice, assistance and committee participation were forthcoming from the Federal departments of Environment, National Health and Welfare, and Indian Affairs and Northern Development, and from the territorial government's departments of Health and Municipal and Community Affairs. The Board would like to acknowledge the special assistance of Mr. Ron J. Kent, who chaired a working committee, Mr. Richard E.K. Feilden of Reid Crowther and Partners Ltd. and Dr. Daniel W. Smith of the University of Alberta. Board Members who were intimately involved with the revisions include Mr. Glenn Warner who oversaw the process for a period of ten years, Mr. Scott Howarth and Mr. Brian Wilson of the Federal Department of Environment and Dr. Ian Gilchrist of the Territorial Department of Health. The Board's Executive Assistant, Mrs. Pamela LeMouel deserves special thanks for the exercise of her administrative talents throughout the process from first draft to final publication

The principal changes incorporated into the revised Guidelines come as a result of empirical data collected since the original publication. Together with recommendations made by a variety of people with an expertise or general knowledge of Northern wastewater treatment, they centre on the following topics:

a) the updating of effluent quality criteria including the replacement of total coliform with fecal coliform as a discharge parameter;
b) the establishment of differing effluent quality criteria for summer and winter discharges; and
c) the addition of the requirement for proper operation and maintenance plans for waste treatment facilities.

The Board thanks all those who have participated in the preparation of these revised Guidelines and hopes that they will provide a sound basis for municipal wastewater planning for the next decade.

Dave Nickerson
Chairman
N.W.T. Water Board

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

BOD_5	— biochemical oxygen demand, 5 days and 20 degrees C, mg/L
CFU	— colony forming units
dL	— decilitre (100 mL)
F. Coli	— fecal coliform
g	— gram
GNWT	— Government of the Northwest Territories
ha	— hectare
kg	— kilogram
L	— litre
Lcd	— litres per capita per day
L/d	— litres per day
m	— metre
m^3	— cubic metre
m^3/d	— cubic metres per day
mg	— milligram
mg/L	— milligrams per litre
mL	— millilitre
N	— nitrogen
NWT	— Northwest Territories
P	— phosphorus
pH	— hydrogen ion concentration (-log [molar conc. of H^+])
SS	— suspended solids
TL_m	— median tolerance limit concentration in mg/L at which half of the test organisms die within a specified time period.
T_r	— residence time in years

1.0 Introduction

The objectives of the Northwest Territories Water Board "are to provide for the conservation, development and utilization of the water resources" in the Northwest Territories (Northern Inland Waters Act, 1970). These guidelines for the discharge of treated municipal wastewater serve those objectives, and as well seek to protect public health. They are based on the following precepts:

(a) Water is a renewable resource to be conserved and protected;
(b) Municipal wastewaters may pollute receiving waters by depletion of oxygen, deposition of solids, eutrophication, toxicity, release of pathogenic organisms, release of mutagens and carcinogens and aesthetic nuisance;
(c) The discharge of raw wastewater should be eliminated due to the special relationship between northern residents and northern inland waters;
(d) The discharge of treated municipal wastewater needs to be regulated, and the Water Board accomplishes this function through a licensing and monitoring process;
(e) The Water Board should consider each case on a site-specific basis because the range of environmental conditions found throughout the Northwest Territories is so broad;
(f) Receiving water quality objectives need not be satisfied in a defined initial mixing zone immediately around an effluent discharge point;
(g) The onus is on the applicant to obtain all the information necessary to design an adequate treatment and disposal system, and to demonstrate that the proposed system will meet these guidelines after implementation;
(h) These guidelines are subject to the provisions of the Northern Inland Waters Act and Regulations, as amended;
(i) The Water Board expects that these guidelines will be appropriate in most cases, and intends to follow them. The Water Board will, however, include more stringent or less stringent limits in water licences whenever it is deemed appropriate to do so in light of site-specific circumstances;
(j) The Water Board is committed to full public consultation prior to making any licensing decision;
(k) Licensees are to comply with the terms of their water licences;
(l) Licences which are granted by the Water Board prior to the effective date of these guidelines remain in effect and are not altered by these guidelines; and
(m) Compliance with these guidelines, the Northern Inland Waters Act and Regulations, and the terms and conditions of any licence issued thereunder does not absolve the owner or operator of any wastewater collection, treatment or disposal system from the responsibility to comply with any other applicable Federal, Territorial or Municipal legislation. For example, subsection 36(3) of the Fisheries Act prohibits the deposit of a deleterious substance of any type into waters frequented by fish. Deleterious is generally accepted as acutely lethal, whereby undiluted effluent kills more than 50% of the trout or daphnids in their respective bioassay tests. This end-of-pipe requirement may or may not be more stringent than the mixing zone approach incorporated within these guidelines. Potential licensees may obtain additional information by contacting the NWT District Office of Environmental Protection, Conservation and Protection, Environment Canada, (403) 920-6060."

2.0 General Requirements

2.1 Application

These guidelines apply throughout the NWT. They apply to

(a) discharge of effluent from wastewater collection and treatment systems,
(b) discharge of effluent on to land used for treatment or disposal of wastewater,
(c) discharge of effluent or runoff from sanitary landfill sites and garbage dumps,

by or from

(a) cities, towns, villages, hamlets, settlements, and unorganized communities,
(b) work camps of 10 or more people.

All those whose water use equals or exceeds 227 m^3/d are required to apply to the NWT Water Board for a water licence, and then to comply with the provisions of any water licence that the Water Board subsequently issues. Users of water whose use is less than 227 m^3/d may also apply for a water licence. A water licence confers the right of access to the water supply. It also establishes a prior right and interest with respect to any subsequent application for water use that may affect the licensed use.

2.2 Licensing Process

The process of application, reviews, and hearings (if needed), which leads to the granting of a licence, is shown in Figures 2.1 and 2.2. Figure 2.1 applies to non-tax based communities, and Figure 2.2 to tax based communities.

In all cases, the onus is on the applicant to initiate the process in good time. The NWT Water Board should be contacted if there is any question about the applicability or need for specific steps in the normal process.

A water licence will specify whether a licensee needs to advise the Water Board of intended modifications to wastewater collection or treatment facilities. In cases where notification is required, plans and specifications prepared by a professional engineer should be submitted to the Water Board before construction begins. Final "as-built" documents should also be submitted to the Water Board upon completion of the facility.

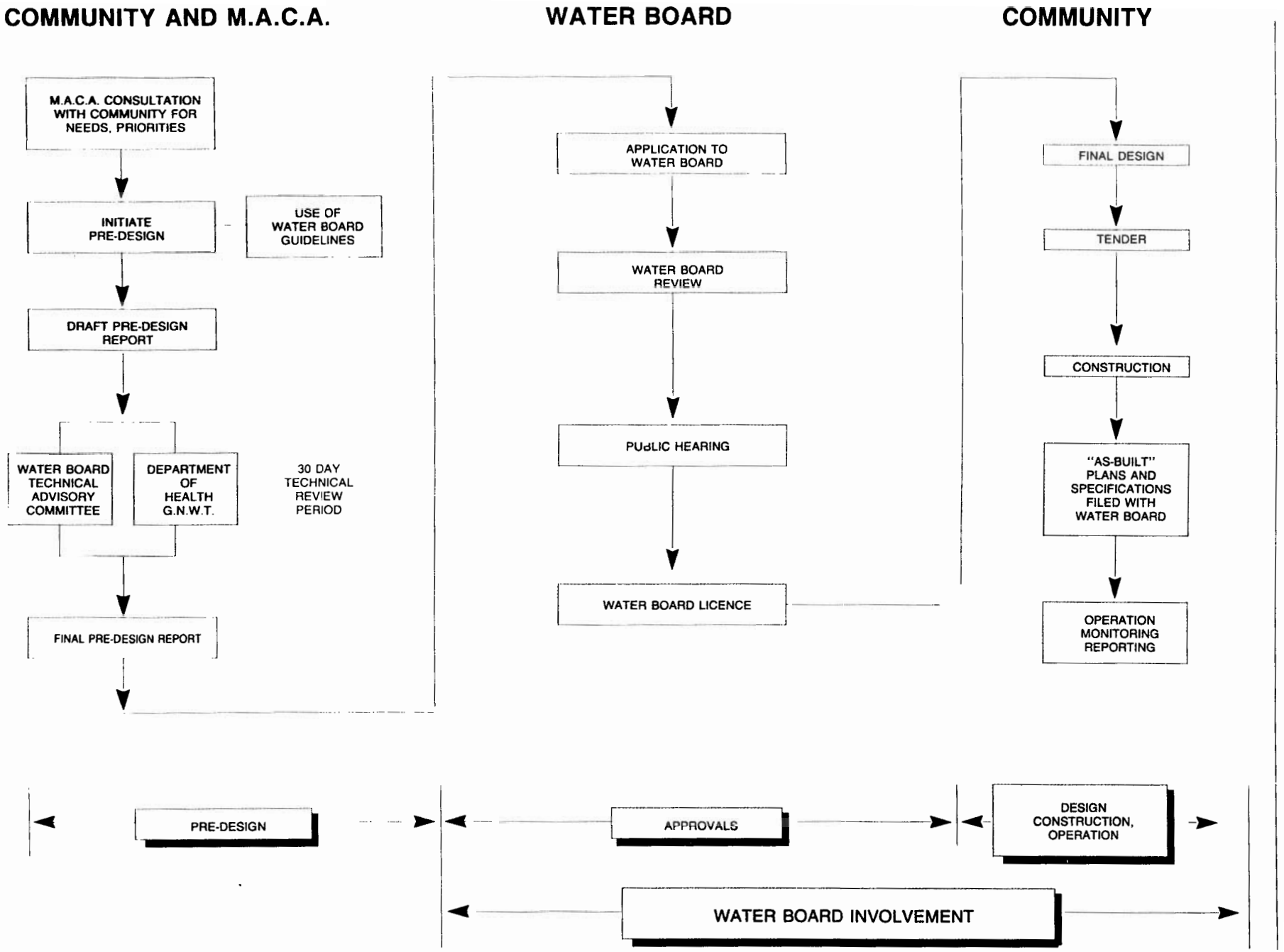


FIGURE 2.1: PROCESS FOLLOWED FOR PROJECTS REQUIRING N.W.T. BOARD LICENSING IN HAMLETS, SETTLEMENTS AND UNORGANIZED COMMUNITIES.

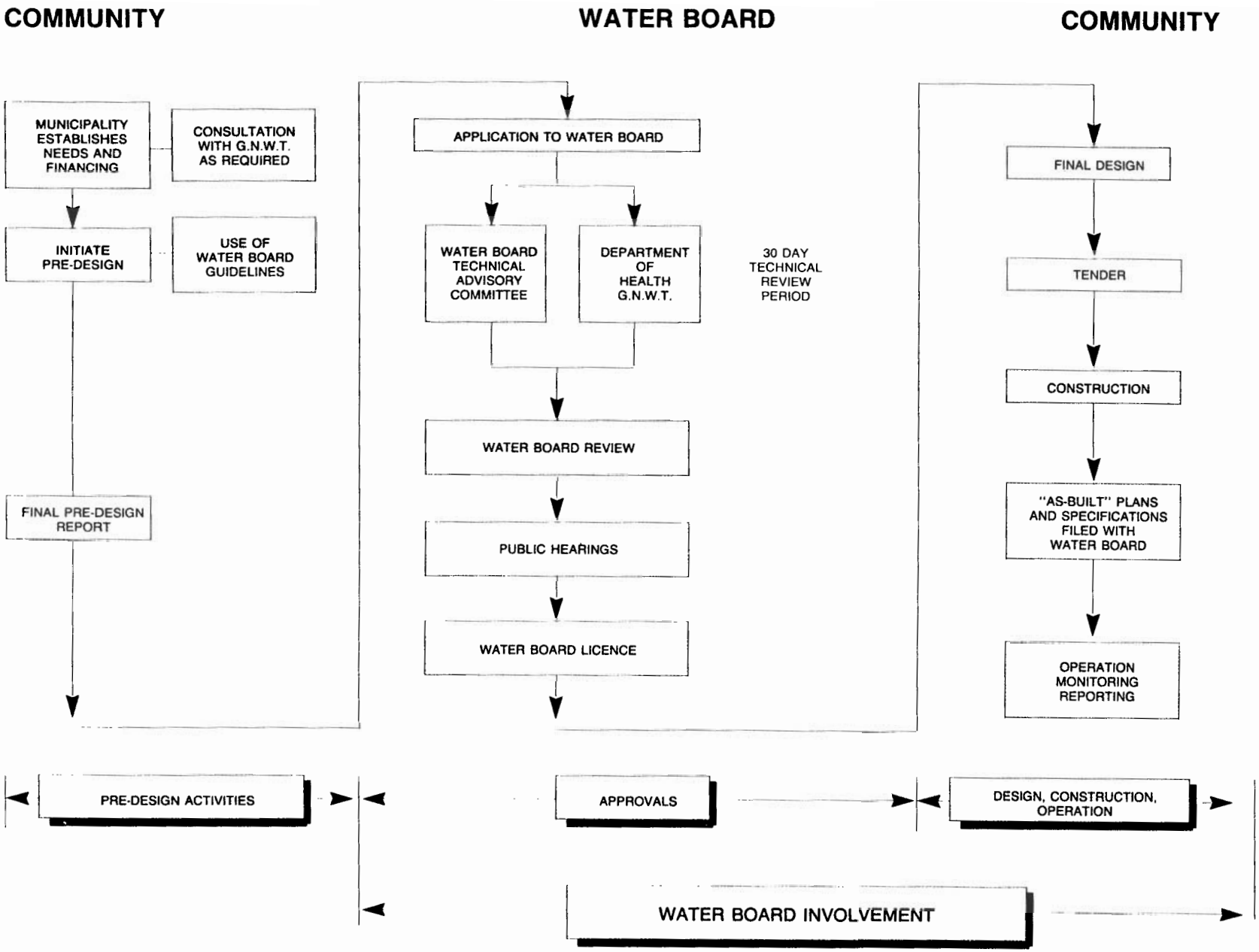


FIGURE 2.2: PROCESS FOLLOWED FOR PROJECTS REQUIRING N.W.T. WATER BOARD LICENSING IN CITIES, TOWNS AND VILLAGES.

3.0 Receiving Water Quality Objectives

Any discharge of effluent affects the quality of the receiving water. The purpose of treating wastewater before it is discharged is to maintain the quality of the receiving water within reasonable and acceptable limits.

Table 3.1 presents the Water Board's objectives and criteria for receiving water quality. Most criteria are expressed either as a maximum permitted change above the background level, or as a maximum level not to be exceeded. Criteria which are not readily quantified are described qualitatively.

TABLE 3.1
RECEIVING
WATER QUALITY OBJECTIVES (a)(b)
(To be met outside the initial mixing zone)

Parameter	**Objective**
Dissolved Oxygen	Decrease not to exceed 10% of original background level (c).
Residual Chlorine	Below 0.1 mg/L.
Nutrients	Avoid nuisance conditions (d).
Coliforms:	Geometric means of individual determinations are not to exceed:
— shellfish meat, fecal	230/100 g
— shellfish waters, fecal	14/dL
— all waters, fecal	100/dL
— all waters, total	1000/dL
Toxicity	No toxicity as measured in a standard 96 hour TL_m static fish bioassay test.
Suspended Solids	Not to increase above background level by more than 10 mg/L.
Floatable Solids and Scum	No observable increase.
Oil and Grease	None visible on water surface; no observable increase; in any case not greater than 5 mg/L.
Metals	Increase not to exceed 10% of original background levels.

Notes:

(a) These objectives protect the quality of the receiving water outside the initial mixing zone. Objectives are expressed in terms of maximum allowable change, or in terms of a maximum value not to be exceeded. Objectives do not apply within the "initial mixing zone" (Section 4.4).

(b) The Water Board may apply more stringent criteria if deemed necessary for the protection of the receiving water. In determining if more stringent criteria are needed, the Water Board may take into account the effects of other discharges. The Water Board may add parameters and criteria to those listed in Table 3.1.

(c) The Water Board may specify a minimum dissolved oxygen concentration if the receiving environment is sensitive to oxygen depletion.

(d) The following nuisance conditions are typical of those to be considered.

  (i) In freshwater lakes, presence of massive growths of planktonic bluegreen algae (Cyanophyceae) for more than several days duration and/or massive growths of attached, filamentous diatoms (Bacillariophyceae) and/or rooted aquatic plants especially near the shoreline.

  (ii) In rivers and streams, presence of massive growths of attached green algae (Chlorophyceae), filamentous diatoms (Bacillariophyceae) and/or rooted aquatic plants, slime-forming bacteria (as Sphaerotilus), sludge worms (Tubificidae) or chironomids (Chironomidae).

Limits may be set on productivity parameters if the Water Board considers such limits to be warranted by site-specific considerations. The usual parameters are phosphorus and/or nitrogen forms.

The objectives in Table 3.1 have been formulated with due regard to social and environmental circumstances, and to the types

of wastewater treatment systems that have been found to be operable and affordable in small northern communities. As indicated, they are to be met outside the "initial mixing zone", defined in Section 4.4.

If the effluent guidelines set out in Table 4.1, and in Table 4.2 if applicable, do not achieve the receiving water quality specified in Table 3.1, the Water Board may require effluent quality to be improved further in order to reach the stated receiving water objectives.

Health and Welfare Canada publishes national standards and objectives for drinking water quality (Canadian Drinking Water Quality, Health and Welfare Canada, 1989). Recommended limits on concentration of selected elements and compounds are reproduced in Appendix C.

Environment Canada publishes national guidelines for water quality in natural environments, which have been developed for protection of freshwater aquatic life. Selected guideline concentrations are reproduced in Appendix D.

4.0 Wastewater Discharge Guidelines

4.1 Introduction

This chapter sets out effluent quality guidelines intended to achieve the receiving water quality objectives stated in Section 3. The guidelines have been developed giving due consideration to the types of sewage treatment facilities that have been found to be practical in northern community settings (i.e. lagoon systems, in most cases).

The Water Board will use these guidelines and site-specific information to determine the effluent quality limits to be applied in each water licence. The Water Board may set limits that are more stringent or less stringent than these guidelines, depending on site-specific considerations.

Although operation and enforcement are based on effluent quality measurements, the receiving water quality objectives stated in Section 3 remain the paramount considerations. If it is determined that a particular licence limit or effluent quality limit will not achieve the intended receiving water objective, then the Water Board may adjust the licence limit as necessary to achieve the desired result.

4.2 Guidelines for Discharges to Receiving Waters

Water licences usually will state limits on effluent concentrations of BOD_5, suspended solids, pH, oil and grease, fecal coliforms and, where warranted, phosphorus.

Guidelines for these parameters are presented in Table 4.1 and accompanying notes. Guidelines for a number of additional parameters, which the Water Board may include in water licences, are presented in Table 4.2.

Rates of water use vary widely between NWT communities, when compared on a volume per person (litres per capita per day; Lcd) basis. In particular, water use tends to be much lower in truck serviced communities, as compared to piped ones. Low water use results in proportionally "stronger" (more concentrated) raw domestic wastewater.

As indicated in Table 4.1, licence limits will be chosen considering the type and relative size of the receiving environment, and the community's per capita wastewater flow rate.

Generally, Table 4.1 imposes higher effluent standards in communities where the per capita use of water and discharge of wastewater is high. Less stringent requirements may be applied to small communities, where daily water withdrawal is less than 30 m^3/d.

A discharge is not normally acceptable if the dilution afforded by the receiving stream is less than 10:1, unless the quality of the effluent equals or betters that of the receiving water.

TABLE 4.1
MUNICIPAL WASTEWATER EFFLUENT QUALITY GUIDELINES

Wastewater Flow (Lcd) & Season	Parameter	Unit	Receiving Environment: Stream, River or Estuary (a) — Dilution (b): >10:1 <100:1	>100:1 <1,000:1	>1,000:1 <10E4	>10E4:1	Lake (a) — Residence Time or Dilution (c): T_r > 5 yr	T_r < 5 yr	Marine (d) — Mixing Condition: Open Coastline	Bay or Fjord
<150 Lcd	BOD	mg/L	30	80	100	360	30	80	360	100
Summer	SS	mg/L	35	100	120	300	35	100	300	120
	P (e)	mg/L	10	—	—	—	—	—	—	—
	F. coli.	CFU/dL	10E3 (f)	10E4 (f)	10E5 (f)	10E6 (f)	10E3 (f)	10E4 (f)	(g)	(g)
<150 Lcd	BOD	mg/L	no	special	100	260	30	80	same	same
Winter	SS	mg/L	discharge	permit	100	240	35	100		
	P (e)	mg/L			—	—	—	—	—	—
	F. coli.	CFU/dL			10E6 (f)	10E6 (f)	10E3 (f)	10E4 (f)		
150 - 600	BOD	mg/L	30	40	120	120	30	40	120	120
Lcd	SS	mg/L	35	60	180	180	35	60	180	180
Summer	P (e)	mg/L	9	—	—	—	—	—	—	—
	F. coli.	CFU/dL	10E4 (f)	10E4 (f)	10E5 (f)	10E6 (f)	10E3 (f)	10E4 (f)	(g)	(g)
150 - 600	BOD	mg/L	no	special	100	120	same	same	same	same
Lcd	SS	mg/L	discharge	permit	100	180				
Winter	P (e)	mg/L			—	—				
	F. coli.	CFU/dL			10E6 (f)	10E7 (f)				
>600 Lcd	BOD	mg/L	25	30	80	80	25	30	80	80
Summer	SS	mg/L	30	30	70	70	30	30	70	70
	P (e)	mg/L	2	—	—	—	2	—	—	—
	F. coli.	CFU/dL	10E3 (f)	10E4 (f)	10E5 (f)	10E6 (f)	10E3 (f)	10E4 (f)	(g)	(g)
>600 Lcd	BOD	mg/L	no	70	70	70	same	same	same	same
Winter	SS	mg/L	discharge	70	70	70				
	P (e)	mg/L		—	—	—				
	F. coli.	CFU/dL		10E4 (f)	10E6 (f)	10E7 (f)				

Legend: Same indicates that the summer guideline applies in winter.
Lcd is flow rate in litres per capita per day.
10E3 is 1,000; 10E4 is 10,000; 10E5 is 100,000; 10E6 is 1,000,000; 10E7 is 10,000,000.

Notes to Table 4.1

(a) Untreated wastewater discharges are not permitted to any inland waters, except where the Water Board has specifically permitted the use of inland waters for the containment or treatment of municipal wastewater;

(b) Dilution in streams, rivers and estuaries is calculated as follows:

$$\text{dilution} = \frac{\text{minimum average monthly stream flow}}{\text{average daily wastewater flow}}$$

where both flows are expressed in the same units.

If discharge is discontinuous, the stream flow is based on the average flow at the time of discharge. Note that the minimum monthly streamflow will occur during winter;

Stream flow in estuaries is to be based on the fresh water component;

(c) Residence time in a lake is calculated as follows:

$$\text{residence time } T_r \text{ (years)} = \frac{V}{Q_t}$$

where V = volume of lake (m^3)
Q_t = annual outflow from lake (m^3/yr)

(d) Marine outfalls are to meet the design specifications in Appendix A. Where treatment is not practicable, discharge of untreated wastewater to the open sea is permitted if, as a minimum, floatable materials are removed and the wastewater is comminuted or macerated. The requirements for discharges to bays and fjords may be relaxed, depending on the findings of site-specific studies. Similarly, the minimum distance offshore may be relaxed, depending on effluent quality and on the findings of site-specific studies;

(e) Guidelines for the concentration of phosphorus are considered to be flexible. A site-specific study may indicate that a less stringent limit is appropriate or that a more stringent limit is needed. Site-specific studies are to address effects on any lakes less than 10 km downstream. Appendix B describes the site-specific determination of permissible phosphorus concentration;

(f) Guidelines for fecal coliform levels are intended to limit concentrations everywhere outside the initial mixing zone so that the geometric mean of the fecal coliform density does not exceed 100 CFU/dL. Treated effluent ordinarily need not be disinfected; however, disinfection will be required in any case where site-specific studies show that it is needed for protection of public health;

(g) In the case of an open, well flushed marine bay or fjord, bacteriological standards will be of concern only where the discharge might affect a fishery (including shellfish harvesting) or water contact recreation;

(h) pH is to be in the range 6 to 9;

(i) Guidelines for oil and grease: none visible and in any case not greater than 5 mg/L;

(j) "Same" indicates that the guideline for summer applies in winter; and

(k) Where wetlands are used as part of the treatment system, limits may be chosen to suit the point of measurement and control.

Table 4.2 lists guidelines for additional parameters that may be included in a licence, if the Water Board deems it to be appropriate. The usual source of substances listed in Table 4.2 is industrial effluent. The onus is on the applicant to establish that there is no significant industrial waste contribution that may cause the tabulated guidelines to be exceeded. Parameters listed in Table 4.2 need to be monitored only if they are listed in the licence, or if so ordered by the Water Board.

TABLE 4.2
LIMITS FOR ADDITIONAL EFFLUENT PARAMETERS THAT MAY BE OF CONCERN IN SPECIFIC DISCHARGES (a) (c)

Parameter	Maximum Concentration (mg/L) (b)
Aluminum (total)	2.0
Arsenic (total)	0.05
Barium (dissolved)	1.0
Boron (dissolved)	5
Cadmium (dissolved)	0.005
Chromium (total)	0.1
Cobalt (dissolved)	0.1
Copper (dissolved)	0.2
Cyanide (total)	0.1
Fluoride (dissolved)	5.0
Iron (dissolved)	0.3
Lead (dissolved)	0.05
Manganese (dissolved)	0.05
Mercury (total)	0.0006
Methylene Blue Active Substances (MBAS)	5
Molybdenum (total)	0.2
Nickel (dissolved)	0.3
Selenium (total)	0.05
Silver (total)	0.1
Sulphate (dissolved)	500
Sulphide (dissolved)	0.5
Tin (total)	5
Zinc (total)	0.5

Notes to Table 4.2

(a) Table 4.2 normally applies to wastewaters that

contain a significant non-municipal component, i.e. discharge from an industrial or commercial process, which is likely to contribute elements or compounds listed in the table.

(b) Limits may be adjusted to take background levels into account, particularly where water supplies may be affected.

(c) The Water Board may prescribe limits for additional elements or compounds not listed in Table 4.2.

4.3 Compliance

Effluent must comply with licence limits. Compliance is defined as follows:

(a) the arithmetic mean of all parameters (other than coliform) measured in the last four (4) samples collected in the same season shall not exceed the licence limit;

(b) of the samples referred to in (a) above, three (3) shall not exceed the licence limit;

(c) of the samples referred to in (a) above, no sample shall exceed one hundred and fifty (150) percent of the licence limit;

(d) the geometric mean of the last four (4) fecal coliform samples shall not exceed the licence limit; and

(e) spring and fall samples shall meet the mean of the licence limits stated for summer and winter.

The design of treatment systems shall include appropriate safety factors to ensure compliance. Lagoon systems, for example, should be subjected to a regular maintenance program, which includes the management and disposal of accumulated sludge. Applicants will be required to submit their proposed plan to the Water Board. It may also be appropriate to design to more stringent effluent criteria than those in Tables 4.1 and 4.2, depending on the reliability of the treatment system.

In the event that an emergency or upset condition precludes compliance, refer to Section 9, *Spills and Other Emergencies*.

4.4 Site-Specific Studies for Discharges to Receiving Waters

The Water Board may require site-specific studies to be conducted, as described below, to establish effluent quality limits appropriate to the particular setting. Site-specific studies may also be required where a municipal system collects process effluent from industrial or commercial enterprises, etc.

The onus is on the applicant to determine from the Water Board whether a site-specific study is required. Details of the study's scope and program are subject to approval by the Water Board, as provided for in Section 13 (2) of the Northern Inland Waters Act.

4.4.1 Effluent Discharges to Streams and Rivers

A site-specific study will be required in every case where discharge to a stream or river results in dilution less than 100:1.

A site-specific study may be required
- if the effluent discharge exceeds 5,000 m^3/d,
- if the receiving stream or river is used for other purposes (e.g. water extraction or for water contact recreation,)
- if there are other discharges to the same stream or river, and
- if the receiving stream or river empties into a lake less than 10 km downstream.

4.4.2 Effluent Discharges to Lakes

A site-specific study may be required
- if the effluent discharge exceeds 5,000 m^3/d,
- if the ratio of average outflow from the lake to design average high effluent flow into the lake is less than 200:1,
- if the ratio of average outflow from the lake to design average effluent flow into the lake is less than 1,000:1,
- if local conditions indicate that effluent may drift into an area that is used for water extraction or for water contact recreation, or an area that is due particular consideration for any other reason, and
- if the proposed discharge increases the total of all discharges to the lake so that the ratios listed above are exceeded.

4.4.3 Effluent Discharges to Estuaries

A site-specific study will be required in every case where discharge to an estuary results in dilution less than 100:1.

A site-specific study may be required
- if the effluent discharge exceeds 5,000 m^3/d,
- if dilution by the freshwater component is less than 100:1.

4.4.4 Effluent Discharges to the Ocean

A site-specific study will be required:
- if receiving water objectives are to be met by use of a long outfall (as described in Appendix A), and
- if the boundary between marine and estuary conditions is in question.

A site-specific study may be required:

— if the discharge may affect waters that provide habitat for shellfish, or are used by fish for spawning, or are used extensively by marine mammals, or are used for recreation,
— if the receiving area is embayed or otherwise confined.

4.4.5 Effluent Discharges from Land Disposal Sites

Methods for land disposal of municipal wastewaters include but are not limited to: swamps and wetlands; percolation basins, irrigation, and subsurface disposal.

Site-specific studies of discharges from land disposal sites may be required by the Water Board. If so, consideration should be given to: permafrost conditions, effects on ice lenses, ground water, migratory birds and animals, aesthetic nuisance, and impacts on other uses of land, including hunting and trapping.

4.4.6 Discharges from Sanitary Landfill Sites and Garbage Dumps

Discharges from sanitary landfill sites and garbage dumps are not desirable. Where they occur, or seem likely to occur, the Water Board may require site-specific studies.

4.5 Initial Mixing Zone

4.5.1 Initial Mixing Zone Definition

The limits of the initial mixing zone are defined as follows:

(a) The initial mixing zone around a point discharge in a river or stream may extend up to 100 metres downstream of the discharge point, but it shall not encompass more than one-third (⅓) of the transverse cross-sectional area of the river or stream;
(b) The initial mixing zone around a point discharge in a lake, estuary or marine water may extend up to 100 metres horizontally in all directions, but it shall not encompass more than one-third (⅓) of the least cross-sectional area of the water along any horizontal direction through the discharge point;
(c) The initial mixing zone around a multiple point discharge, as in the case of a multiport outfall, may extend up to 100 metres horizontally from all points of discharge, but it shall not encompass a larger cross-sectional area than would be permitted with a single point discharge; and
(d) In all cases, the initial mixing zone extends from the bed of the receiving water to the surface.

Receiving water objectives do not apply within the initial mixing zone.

4.5.2 Initial Mixing Zone Limitations

The following limitations apply to the location and boundaries of initial mixing zones, and to conditions within initial mixing zones:

(a) Initial mixing zones shall not intrude on intakes for drinking water supplies. Initial mixing zones should not intrude on shellfish beds, on restricted routes known to be followed by anadromous fish, on other areas significant to biological resources, or on recreational areas;
(b) Initial mixing zones shall be free of objectionable materials such as oil, grease, scum, or floating debris which constitute any aesthetic nuisance;
(c) No condition shall be permitted within the initial mixing zone that results in sudden fish kills and mortality of organisms passing through the zone, or that causes an irreversible response, which could result in detrimental post-exposure effects, or that results in bio-concentration of toxic materials harmful to any organism or to its predators; and
(d) Initial mixing zones may overlap provided that cumulative effects within and outside initial mixing zones remain within applicable water quality objectives and license limits.

4.6 Upgrading Existing Discharges

Existing municipal effluent discharges that do not meet the Guidelines are to be upgraded. Deadlines for upgrading will be determined by the Water Board in co-operation with the user involved and the Government of the Northwest Territories, with due regard both to practical limitations and to protection of the receiving environment.

5.0 Sewerage

5.1 Introduction

This section refers to sewerage only insofar as system design concepts broadly affect wastewater quality. In general, design of sewerage is to conform to all applicable regulations and to good engineering practice.

5.2 Industrial Waste

In general, it is permissible to combine industrial and domestic wastewater. The possible advantages of separate pre-treatment of different classes of wastewater should be considered carefully, in light of effluent and receiving water quality guidelines and objectives, and in light of possible effects of industrial waste on the operation of treatment systems.

5.3 Stormwater

Separate storm drains and sanitary sewers should be used for new systems, under normal circumstances.

New combined systems, which are designed to carry total ultimate volumes without overflow until they reach the treatment plant location, may be acceptable, provided it can be shown that the effluent quality objectives shown in Table 4.1 will be met.

Existing combined systems will be allowed to continue, if storm overflows and final discharges meet the effluent quality objectives given in Table 4.1. Where values are not met, an approved program will be required to ensure that they are met at some future date, as determined by the Board.

5.4 Storm Sewers

If sanitary drains are connected to storm sewers, the Water Board may apply the Guidelines to the storm discharge.

6.0 Wastewater Treatment Options

6.1 Introduction

The treatment of municipal wastewater in the Northwest Territories is subject to several constraints, which must be considered carefully. Most communities are small and quite remote from technological support. Design choices may be limited by climatic effects on treatment processes, by freezing of receiving waters, ice scour, difficult terrain or soil conditions including thaw sensitive permafrost or absence of natural aggregate, shortage of construction equipment, short construction season, and many other factors. Under harsh winter conditions, a seemingly minor lapse by the designer or the operator may result in serious damage, suspension of service, and great expense. This is especially true in technologically complex installations, a problem that currently is compounded by a shortage of highly skilled operators.

6.2 Standard of Practice

Treatment options will be evaluated according to the following considerations:

1. protection of public health;
2. protection of the environment;
3. suitability of technology;
4. total life cycle costs;
5. aesthetic considerations; and
6. public concerns.

All of these matters are important and all are to be addressed in appropriate detail.

6.3 Suitable Technology

Operational simplicity is a factor that favours lagoons over mechanical treatment plant options in many northern municipal settings. Lagoon systems that may be approved where shown to be appropriate include short detention lagoons, long detention lagoons, and storage lagoons (all described in the references). A lagoon may be entirely manmade, or it may be an engineered adaptation of a natural lake, if appropriate within the setting.

Other proven technology may be appropriate to certain settings, or may be needed to achieve a level of treatment not economically attainable by lagoons. However, the consideration of chlorination as a treatment technique is not recommended without special permission of the Water Board.

7.0 Outfalls

7.1 Objective

The objective of an outfall is to introduce the effluent stream into its receiving water in a place and manner chosen to achieve efficient mixing, and maintenance of receiving water quality objectives outside the initial mixing zone. If winter discharge is permitted, wintertime conditions probably will control hydraulic design.

7.2 Prohibited Discharges

Neither sludge nor excess solids are to be discharged through outfalls.

7.3 General Design Considerations

Minimum outfall lengths, depths, and depth-distance combinations for marine discharges, that may be permitted for disposal of untreated wastewater, are given in Appendix A. For discharges to non-marine waters, outfalls are to extend below the lowest water level that may reasonably be anticipated. This would generally refer to the lowest under-ice water level during the winter season. Both marine and non-marine outfalls should be located and designed to make optimal use of the mixing and dilution characteristics of the receiving water.

The cases in which a site-specific study of the outfall length and depth may be required are outlined in Section 4. Approval of shoreline discharges is subject to site-specific considerations.

7.4 Ice Scour

Designers are cautioned to consider carefully the effects of ice scour in all settings.

7.5 Posting of Outfalls

Signs are to indicate the location of outfalls, of treatment and disposal areas on land, and of all initial mixing zones.

8.0 Monitoring

8.1 General

Both the effluent and the receiving water need to be monitored to ensure that effluent quality and receiving water quality meet licence limits and water quality objectives. The Water Board will specify the parameters to be monitored. The licensee is responsible for monitoring the effluent, while the Water Board normally will arrange for monitoring of the receiving environment. In specific cases, the Water Board may require the licensee to undertake the receiving environment monitoring program or components of that program. Groundwater sampling and monitoring may be required where pollution of groundwater is suspected or anticipated.

The Water Board may amend monitoring requirements during the licence period, based on performance.

8.2 Sampling Procedures

Field sampling and analytical methods are to be acceptable to the Water Board, and normally are to be as described in the current edition of Standard Methods for the Examination of Water and Wastewater (see references). Results from low-accuracy techniques may be acceptable for small discharges or in emergency situations.

Grab samples are acceptable except as stated otherwise in the water licence. The Water Board usually will specify composite sampling for BOD_5, suspended solids, oil and grease, and phosphorus in the case of

(i) any discharge in excess of 5000 m^3/d, whether continuous or intermittent, or
(ii) continuous discharge from a mechanical *treatment plant*.

Licensees will submit data in a manner stipulated by the Water Board.

8.3 Sampling Frequency

Licensees are to monitor effluent quality to ensure that it meets the conditions of the Water Licence. Monitoring is to be initiated within one month of the commencement of any discharge.

Sampling frequency for effluent, and for lagoon contents, will be stated in the water license. The Water Board may specify any frequency deemed to be appropriate. The following are guidelines:

(a) Continuous discharge less than 500 m^3/d: fecal coliforms monthly; BOD_5 and suspended solids quarterly;
(b) *Continuous discharge greater than 500 m^3/d:* BOD_5, suspended solids, fecal coliforms and temperature weekly; oil and grease quarterly;
(c) Lagoon, discharge during the open water season only, annual discharge less than $10^6 m^3$: sample BOD_5, suspended solids and temperature in the lagoon before discharge, in good time so that the quality of the proposed discharge is measured and known before discharge is to take place; and
(d) Lagoon, discharge during the open water season only, annual discharge greater than $10^6 m^3$: sample lagoon contents during the open water season; BOD_5, suspended solids, fecal coliforms and temperature weekly, oil and grease quarterly (before discharge).

8.4 Receiving Water Monitoring

Receiving water quality will be monitored to ensure that the objectives in Table 3.1 are met and that undesirable conditions do not develop.

Pre-discharge (or background) data may be required by the Water Board for a full year or longer. Authority to discharge may be delayed if, in the opinion of the Water Board, sufficient data have not been gathered. Design and construction schedules should allow for this possibility.

9.0 Spills and Other Emergencies

All spills and other emergencies must be reported immediately to:

24 hour Spill Report Line
Yellowknife, Northwest Territories
Telephone (403) 920-8130
Fax: 873-5763

Incidents to be reported include accidental spills of contaminants or hazardous materials into collection or treatment systems; spills of sewage due to breaks or breaches in pipes, chambers, dikes, etc; malfunction of a treatment plant; and any other spill or emergency situation, which could adversely affect public health, the quality of the effluent, or the quality of the receiving water.

Apart from any other actions taken under the Northern Inland Water Act or any other act or regulation, the Water Board may require the licensee to undertake a survey that is adequate in extent and frequency to assess the magnitude of the problem. Such emergency monitoring is to be continued until the problem is brought under control and a return to previous conditions can be demonstrated. Survey data and a review of the problem and control measures are to be reported to the Water Board.

References

American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, current edition.

Health and Welfare Canada, *Guidelines for Canadian Drinking Water Quality*, 1978, and proposed amendments, 1987.

Heinke, G.W., D.W. Smith and G.R. Finch, *Guidelines for the Planning, Design, Operations and Maintenance of Wastewater Lagoon Sytems in the Northwest Territories*, Vol. I, *Planning and Design*, prepared for the Department of Municipal and Community Affairs, Government of the Northwest Territories, 1988.

Heinke, G.W. and D.W. Smith, *Guidelines for the Planning, Design, Operations and Maintenance of Wastewater Lagoon Systems in the Northwest Territories*, Vol. II, *Operation and Maintenance Manual*, prepared for the Department of Municipal and Community Affairs, Government of the Northwest Territories, 1988.

Glossary

BOD_5 — Five day, 20 degree C, biochemical oxygen demand. A standard test used in assessing wastewater strength.

Coliforms — All of the aerobic and faculative anaerobic gram-negative non-spore-forming, rod shaped bacteria which ferment lactose with gas formation within 48 hours of 35 degrees C.

Comminutor — A device used to cut up and screen solids in wastewater before it enters pumps and other units in the treatment plant.

Disinfection — The destruction of micro-organisms with the objective of killing disease-causing organisms. All organisms are not destroyed during the process.

Embayed — In general, the end of an outfall shall be considered embayed if located on the shore side of a line up to 6.4 km long drawn between any two points on a continuous coastline, or located so that the maximum width of ocean access by any route is under 1.5 km wide, but may be taken to include other waters if flushing action is considered to be inadequate. Exceptions may be made where adequate flushing of an "embayed" area is documented. "Coastline" and "sea access" refer to the mean low tide alignment.

Estuary — A passage in which the tide meets a river current; especially an arm of the ocean, at the mouth of a river.

Excess Solids — The sludge produced in a wastewater treatment system that is not needed to maintain the process and is withdrawn from circulation.

Fecal Coliforms — Those coliforms which ferment EC medium with gas formation within 24 hours at 44.5 degrees C.

Lake — A standing body of fresh water with an average retention time of at least one year.

Licence — A license for the use of waters issued by the Water Board.

Licensee — The holder of a valid license.

Percolation Basin — An engineered facility designed to allow rapid infiltration of water into the ground. This treatment method depends on free-draining, coarse-textured soil for successful operation.

Receiving Water — Any body of surface water into which treated wastewater may flow. Receiving waters wholly contained within a licensee's property are not included in this definition, provided that pollutants in such waters cannot be transported outside the property.

Screening — An operation for the removal of relatively coarse floating and suspended solids by straining through screens.

Shellfish Waters — Waters which are inhabited by edible species of shellfish (bivalve molluscs) and from which shellfish for human consumption are taken either commercially or domestically.

Sludge — The accumulated solids separated from liquids.

Standard Methods — "Standard Methods for the Examination of Water and Wastewater" Current Edition, published by the American Public Health Association.

Waste —

(a) any substance that, if added to any waters, would degrade or alter or form part of a process of degradation or alteration of the quality of those waters to an extent that is detrimental to their use by man or by any animal, fish, or plant that is useful to man, and

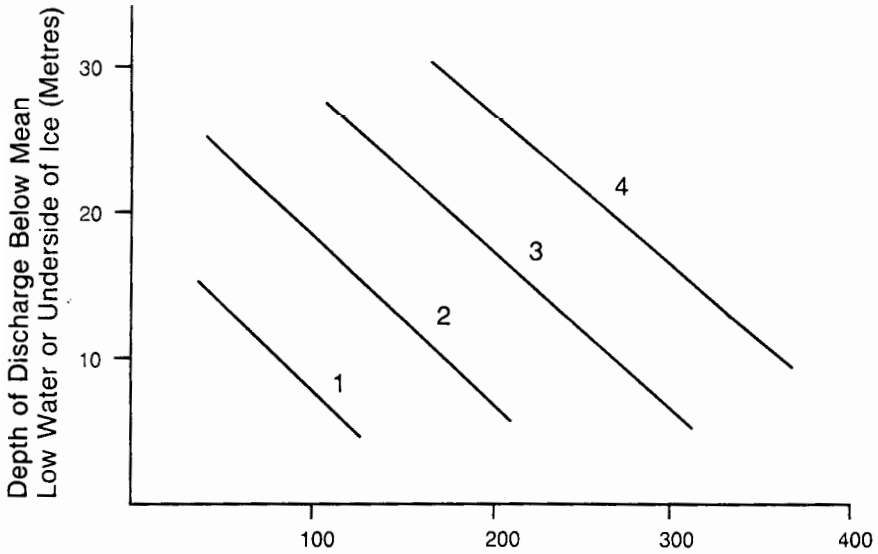
(b) any water that contains a substance in such a quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any waters, degrade or alter or form part of a process of degradation or alteration of the quality of those waters to an extent that is detrimental to their use by man or by any animal, fish, or plant that is useful to man, and without limiting the generality of the foregoing, includes anything that, for the purposes of the Canada Water Act, is deemed to be waste.

Water Board — The Northwest Territories Water Board.

Work Camp — Work camp means a camp as defined in Section 12 of the Public Health Act and includes the sleeping, kitchen, dining and recreation quarters and facilities thereof and the areas between and adjoining the same, but does not include a camp of less than 10 occupants.

APPENDIX A
Depth-Distance Combinations for Outfalls into Marine Waters

(Applicable to Discharges with Effluent Quality Prescribed in Table 4.1)

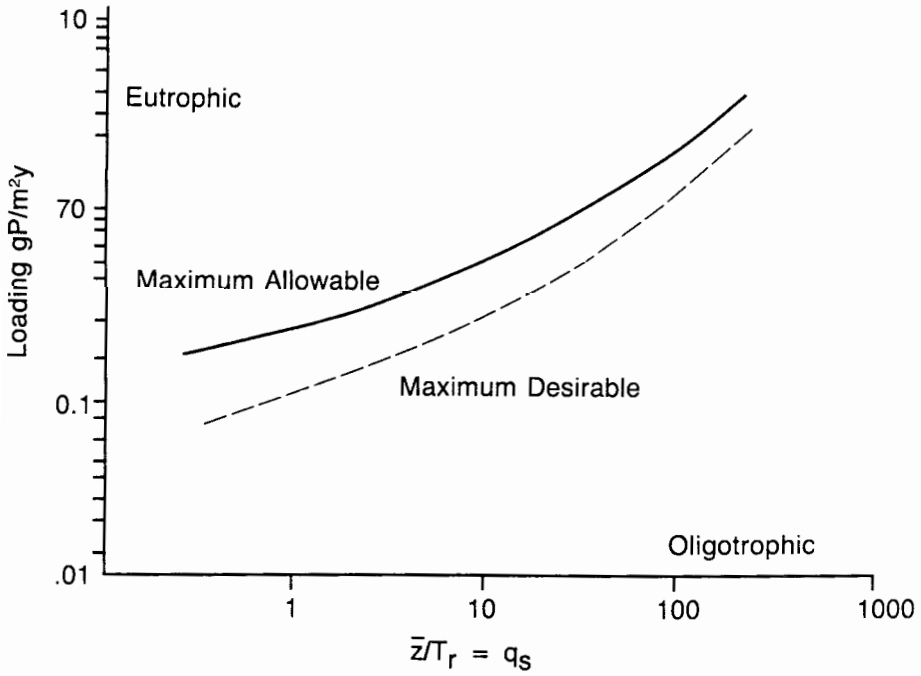


1 Q = 50 m^3/d or less
2 Q = 500 m^3/d (25 m^3/d in shellfish waters)
3 Q = 2,500 m^3/d (125 m^3/d in shellfish waters)
4 Q = 5,000 m^3/d (250 m^3/d in shellfish waters)

Where Q = design average dry weather flow.

Notes:
1. For discharges in excess of 5,000 m^3/d (250 m^3/d in shellfish waters) see Section 2.2.3.
2. Interpolated lines may be used for intermediate flows.
3. Minimum outfall length in shellfish waters is normally 120 m.

APPENDIX B
Determination of Maximum Phosphorus Concentrations in Wastewater Discharges to Lakes



Total Phosphorus Loading vs
Mean Depth ÷ Lake Residence Time

As a rule, calculations should be based on the line labelled "maximum desirable".

To determine the maximum phosphorus concentration for a particular wastewater discharge:

1. Calculate q_s for the water body under consideration

   $$q_s = \frac{\bar{z}}{T_r}$$

   Where $\bar{z}$ = mean depth of lake (metres)
   T_r = lake residence time = $\frac{\text{volume of lake } (m^3)}{\text{annual outflow } (m^3/yr)}$
2. Read the maximum loading from the graph for the given q_s, L_1
3. Estimate the phosphorus loading from sources other than domestic wastes, L_2
4. Calculate maximum loading from the domestic waste source, $L_3 = L_1 - L_2$
5. Determine the maximum concentration of phosphorus in domestic wastewater in mg/L
   Concentration of P = $\frac{L_3 \times \text{lake surface area } (m^2)}{\text{annual wastewater discharge } (m^3/yr)}$

APPENDIX C
Guidelines for Canadian Drinking Water Quality

Table C1 lists the maximum acceptable concentrations (MACs) and aesthetic objectives (AO's) published in *Guidelines for Canadian Drinking Water Quality* (Health and Welfare Canada 1989) for selected elements and compounds.

TABLE C1

Selected Canadian Drinking Water Quality Limits and Objectives

Parameter	Maximum Acceptable Concentration	Aesthetic Objective Concentration	Basis	Notes
Arsenic	0.05	—	H	Under review
Barium	1	—	H	
Benzene	0.005	—	H	
Boron	5	—	H	
Cadmium	0.005	—	H	
Carbon tetrachloride	0.005	—	H	
Chloride	—	<250	A	
Chromium	0.05	—	H	
Colour (TCU)	—	<15	A	
Copper	—	<1	A	Under review
Cyanide	0.2	—	H	
Fluoride	1.5	1	H	(c) Under review
Hardness(as $CaCO_3$)	500	Between 80 and 100	A	
Iron	—	<0.3	A	
Lead	0.01	—	H	
Manganese	—	<0.05	A	
Mercury	0.001	—	H	
Nitrate (as N)	10	—	H	
Nitrite (as N)	1	—	H	
Odour	—	Inoffensive	A	
pH	6.5-8.5	—	A	No units
Selenium	0.01	—	H	
Sodium	—	<200	A	
Sulphate	—	<500	H&A	
Sulphide (as H_2S)	—	<0.05	A	
Taste	—	Inoffensive	A	
Temperature (°C)	—	<15	A	
Total Dissolved Solids	—	<500	A	
Trihalomethanes	0.35	—	H	Under review
Turbidity (NTU)	1	<5	H&A	
Uranium	0.1	—	H	
Zinc	—	<5	A	

Notes:

(a) Unless indicated otherwise, the maximum acceptable and objective concentrations are specified in mg/L.

(b) Maximum acceptable and objective concentrations have been established on the basis of either aesthetic (A) or health (H) considerations.

(c) It is recommended that the concentration of fluoride be adjusted to 1.0 mg/L which is the optimum level for the control of dental caries. Where the annual mean maximum temperature is less than 10°C, a concentration of 1.2 mg/L should be maintained.

(d) *Guidelines for Canadian Drinking Water Quality* contains limits for many substances. Substances represented in Table C1 are those most commonly of significance in water supplies in the N.W.T.

APPENDIX D
Canadian Water Quality Guidelines for Freshwater Aquatic Life

Table D1 lists guidelines for maximum concentrations of selected elements and compounds published in *Canadian Water Quality Guidelines* (Task Force on Water Quality Guidelines, 1987).

TABLE D1

Selected Canadian Water Quality Guidelines for Protection of Freshwater Aquatic Life

Parameter	Guideline Concentration	Notes
Arsenic	.05	
Cadmium	.0002	Hardness 0 - 60 mg L^{-1} ($CaCO_3$)
	.0008	Hardness 60 - 120 mg L^{-1} ($CaCO_3$)
	.0013	Hardness 120 - 180 mg L^{-1} ($CaCO^3$)
	.0018	Hardness >180mg L^{-1} ($CaCO_3$)
Chlorine (total residual chlorine)	.002	Measured by amperometric or equivalent method
Chromium	.002	To protect fish.
		To protect aquatic life, including zooplankton and phytoplankton.
Copper	.002	Hardness 0 - 120 mg L^{-1} ($CaCO_3$)
	.003	Hardness 120 - 180 mg L^{-1} ($CaCO_3$)
	.004	Hardness >180 mg L^{-1} ($CaCO_3$)
Cyanide	.005	Free cyanide as CN
Dissolved oxygen	6.0	Warm water biota - early life stages
	5.0	- other life stages
	9.5	Cold water biota - early life stages
	6.5	- other life stages
Iron	0.3	
Lead	.001	Hardness 0 - 60 mg L^{-1} ($CaCO_3$)
	.002	Hardness 60 - 120 mg L^{-1} ($CaCO_3$)
	.004	Hardness 120 - 180 mg L^{-1} ($CaCO_3$)
	.007	Hardness >180 mg L^{-1} ($CaCO_3$)
Mercury	.001	
Nickel	.025	Hardness 0 - 60 mg L^{-1} ($CaCO_3$)
	.065	Hardness 60 - 120 mg L^{-1} ($CaCO_3$)
	.11	Hardness 120 - 180 mg L^{-1} ($CaCO_3$)
	.15	Hardness >180 mg L^{-1} ($CaCO_3$)
Nitrogen Ammonia (total)	2.2	pH 6.5; temperature 10°C
	1.37	pH 8.0; temperature 10°C
Nitrite	.06	
Nitrate		Concentrations that stimulate prolific weed growth should be avoided.
pH	6.5 - 9.0	
Selenium	.001	
Silver	.0001	
Zinc	.03	

Notes:

(a) Unless indicated otherwise, concentrations are reported in mg/L.

(b) Concentrations of metals are reported as total metal in an unfiltered sample.

(c) The referenced publication contains guidelines for many substances. Substances represented in Table D1 are ones most commonly of significance in the N.W.T.