Atlantic Canada Standards and Guidelines Manual

for the Collection, Treatment, and Disposal of Sanitary Sewage

prepared for

Environment Canada / Environnement Canada

prepared by

CBCL Limited
Consulting Engineers

1996

* NOTICE TO THE ENGINEER *

This manual has been prepared for use as a guideline for minimum standards to be met in the collection, treatment, and disposal of sanitary sewage in the Atlantic Provinces. Every effort has been made to ensure that the manual is consistent with current technology and environmental considerations.

THIS MANUAL DOES NOT ELIMINATE THE NECESSITY FOR DETAILED DESIGN. ENGINEERS WHO USE THIS MANUAL IN PREPARING REPORTS, DESIGN DRAWINGS AND SPECIFICATIONS MUST RECOGNIZE THAT HE/SHE RETAINS FULL RESPONSIBILITY FOR THEIR WORK.

This manual is divided into three sections.

Section One is the **Policy Section.** This section initially outlines all relevant and applicable legislation and guidelines which control the subsequent design criteria. The section then describes the minimum required effluent and water quality standards, and the requirements of a receiving water study. The policy section further describes monitoring and enforcement requirements as well as mandatory approval requirements and procedures.

Section Two is the **Design Section.** This section is intended for use as a guide in the design and preparation of plans and specifications for sewage works and sewage collection and treatment systems; to list and suggest limiting values for items upon which an evaluation of such plans and specifications will be made by the reviewing authority; and to establish as far as practicable, uniformity of practice in Atlantic Canada with practice in other parts of Canada and the United States.

A complete documentation of all parameters related to sewerage works design is beyond the scope of these guidelines, but an attempt has been made to touch upon the parameters of greatest importance from process and reliability standpoints.

By issuing these guidelines, it is not the intention of the regulatory agencies to stifle innovation. Where the designer can show that alternate approaches can produce the desired results, such approaches will be considered for approval.

Wherever possible, designers are encouraged to use actual data obtained from sewage treatment plant flow records, operational studies, etc., rather than use arbitrary design parameters. This is particularly important with sewage treatment plant expansions where the designer may want to use hydraulic and/or organic loading rates in the upper levels of the acceptable loading ranges, or where the designer proposes to deviate from the recommended design parameters.

Where the term "shall" is used, it is intended to mean a mandatory requirement insofar as any confirmatory action by the reviewing authority is concerned. Other terms such as "should", "recommended", "preferred", and "the like" indicate discretionary use on the part of the reviewing authority and deviations are subject to individual consideration.

Designers are advised to familiarize themselves with the requirements of all legislation (as outlined in the policy section) dealing with sewage treatment works, their associated equipment and labour safety requirements.

Section Three is the **Operations Section.** This section outlines typical manpower requirements for various types and sizes of treatment plants, as well as operator training requirements. The section also describes treatment plant process control techniques and the recommended format for plant operation and maintenance manuals.

Definition of terms and their use in this document is intended to be in accordance with *Glossary - Water and Sewage Control Engineering*, published by APHA, ASCE, AWWA, and APCF.

The considerable experience of other provincial agencies, authorities and commissions have been freely referred to in the presentation of this manual. Material from the Ministry of the Environment of Ontario, the Water Pollution Control Federation (WPCF), the Environmental Protection Agency

Office of Technology Transfer, the Nova Scotia Interim Guidelines for the Collection and Treatment of Municipal Wastewaters (1976), the New Brunswick Guidelines for the Collection and Treatment of Wastewater (1987), the Great Lakes - Upper Mississippi River Board of State Sanitary Engineers (1990), and the Alberta Standards and Guidelines for Municipal Water Supply, Wastewater, and Storm Drainage Facilities (1988) have all been carefully reviewed and applicable standards have been adopted.

Policies and Criteria contained in this publication will be changed from time to time to conform with advances and improvement in the science, art and practice of Sanitary Engineering. These changes shall be noted in the revision record.

TABLE OF CONTENTS

Page

POLICY SECTION

CHAPTER 1 LEGISLATION

CHAPTER 2 MINIMUM EFFLUENT STANDARDS

CHAPTER 3 MONITORING AND ENFORCEMENT

Page

DESIGN SECTION

CHAPTER 1 DESIGN OF SEWERS

Page

CHAPTER 8 TERTIARY TREATMENT

CHAPTER 9 LAND APPLICATION OF WASTEWATER

Page

OPERATIONS SECTION

Environment Canada
Environnement Canada

Atlantic Canada Standards and Guidelines Manual

Policy Section

New Nouveau Brunswick

This manual is intended to present minimum required design standards and guidelines for all new or modified sewerage systems. In the event that a particular Municipality has incorporated its own design criteria, the most stringent of the two procedures shall govern.

Where the designer uses standards other than those outlined in this Manual, he/she shall clearly indicate in all appropriate documents and plans those areas of difference.

POLICY SECTION

This section presents all relative policy requirements for all new or modified sewerage systems. Clarification or explanation of policy issues may be obtained by contacting any of the regulatory authorities. In the event that certain municipalities have adopted their own policies, the most stringent of the various policies shall govern.

1.1 GENERAL

A summary of provincial and federal legislation that apply to sewerage works are presented in this section. Applicable sections from all acts that appear in bold text are located in Appendix A at the back of this document. Other acts are available from the applicable administering department. The designer, operator and owner of any sewerage works should become familiar with the relevant legislation, as well as any environmental assessment requirements.

1.2 PROVINCIAL LEGISLATION

1.2.1 New Brunswick

The **Water Quality Regulation** under the **Clean Environment Act** is the main legislation administered by the New Brunswick Department of Environment which has application to sewerage works. The Health Act administered by the New Brunswick Department of Health and Community Services, has similar applicability.

1.2.2 Newfoundland

The main legislation administered by the Newfoundland Department of Environment and Labour include the **Environment Act** and the **Environmental Control (Water and Sewage) Regulations.** Other legislation such as the Public Health Act and other standards such as the Department of Municipal & Provincial Affairs, Municipal Water, Sewer, and Roads Master Specifications will also be applicable to sewerage works.

1.2.3 Nova Scotia

The **Environmental Protection Act** and the Nova Scotia Water Act are the two main statutes administered by the Nova Scotia Department of the Environment which have application to sewerage works. The Nova Scotia Health Act, administered by the Nova Scotia Department of Health, has similar applicability.

Other Acts which may have some jurisdiction over a particular project include the Nova Scotia Towns Act, the Nova Scotia Municipal Act, the Nova Scotia Environmental Assessment Act, and the Nova Scotia Lands and Forest Beach Protection Act. The proponent should investigate whether there are any applicable Municipal by-laws that may limit which materials may be disposed of via the sanitary sewer system.

The Nova Scotia Departments of the Environment and Health have also adopted a **"Sewage Effluent Discharge Policy"**. This policy outlines minimum effluent requirements for any sanitary sewerage system.

1.2.4 Prince Edward Island

The **Environmental Protection Act** and the **Water and Sewerage Act** are the main statutes administered by The Prince Edward Island Department of Environmental Resources. The

Island Regulatory and Appeals Commission Act creates the Island Regulatory and Appeals commission which also has some jurisdiction over sewerage projects.

Other Acts which may have some jurisdiction over a particular project include the Charlottetown Area Municipality Act, the City of Summerside Act, the Municipalities Act, the Provincial Affairs and Attorney General (Miscellaneous Amendments) Act, and the Administration Act.

1.3 FEDERAL LEGISLATION

1.3.1 THE FISHERIES ACT

The Federal Fisheries Act, with respect to sanitary sewage collection, treatment and disposal, provides for the protection of fish habitat. Under Section 35 of the Act:

"(1) No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat;

(2) No person contravenes subsection (1) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act."

In other words, no person shall cause the alteration, disruption, or destruction of fish habitat unless approved by the Minister of the Department of Fisheries and Oceans (DFO).

Under Section 36 of the Act, any person who is authorized by DFO to deposit any deleterious substance into any water frequented by fish shall, when directed by the Minister:

> "...conduct such sampling, analyses, tests, measurements or monitoring, install or operate such equipment or comply with such procedures, and report such information, as may be required by the Minister in order to determine whether the person is depositing the deleterious substance in the manner authorized."

Under Section 37, the intent or strength of the Act is described as follows:

> "Where a person carries on or proposes to carry on any work or undertaking that results or is likely to result in the alteration, disruption or destruction of fish habitat, or in the deposit of a deleterious substance in water frequented by fish or in any place under any conditions where that deleterious substance or any other deleterious substance that results from the deposit of that deleterious substance may enter any such waters, the person shall, on the request of the Minister or without request in the manner and circumstances prescribed by regulations made under paragraph (3)(a),

provide the Minister with such plans, specifications, studies, procedures, schedules, analyses, samples or other information relating to the work or undertaking and with such analyses, samples, evaluations, studies or other information relating to the water, place or fish habitat that is or is likely to be affected by the work or undertaking as will enable the Minister to determine

(a) whether the work or undertaking results or is likely to result in any alteration, disruption or destruction of fish habitat that constitutes or would constitute an offence under subsection 40(1) and what measures, if any, would prevent that result or mitigate the effects thereof; or

(b) whether there is or is likely to be a deposit of a deleterious substance by reason of the work or undertaking that constitutes or would constitute an offence under subsection 40(2) and what measures, if any, would prevent that deposit or mitigate the effects thereof.

If, after reviewing any material or information provided under subsection (1) and affording the persons who provided it a reasonable opportunity to make representations, the Minister or a person designated by the Minister is of the opinion that an offence under subsection 40(1) or (2) is being or is likely to be committed, the Minister or a person designated by the Minister may, by order, subject to regulations made pursuant to paragraph (3)(b), or, if there are no such regulations in force, with the approval of the Governor in Council,

(a) require such modifications or additions to the work or undertaking or such modifications to any plans, specifications, procedures or schedules relating thereto as the Minister or a person designated by the Minister considers necessary in the circumstances, or

(b) restrict the operation of the work or undertaking,

and, with the approval of the Governor in Council in any case, direct the closing of the work or undertaking for such period as the Minister or a person designated by the Minister considers necessary in the circumstances."

1.3.2 THE NAVIGABLE WATERS PROTECTION ACT (NWPA)

The Navigable Waters Protection Act, R.S.C. 1985, Chapter N-22, is a Federal Statute designed to protect the public right to navigation by prohibiting the building or placement of any work in navigable waters without the approval of the Minister of Transport. The Act is administered by the Canadian Coast Guard of the Department of Transport.

Sewer pipes or outlets and outfall structures lying within navigable waters are subject to the NWPA.

"Navigable Waters" includes any body of water capable, in its natural state, of being navigated by floating vessels of any description for the purpose of transportation, recreation or commerce; it also includes a canal and any other body of water created or altered for public use, as a result of the construction of any work, as well as any waterway where the public right of navigation exists by dedication of the waterway for public purposes, or by the public having acquired the right to navigate through long use. The authority to determine navigability of waterways rests with the Federal Minister of Transport.

Under the Act:

"(1) No work shall be built or placed in, on, over, through or across any navigable water unless

(a) the work and the site and plans thereof have been approved by the Minister, or such terms and conditions as the Minister deems fit, prior to commencement of construction;

(b) the construction of the work is commenced within six months and completed within three years after the approval referred to in paragraph (a) or within such further period as the Minister may fix; and

(c) the work is built, placed and maintained in accordance with the plans, the regulations and the terms and conditions set out in the approval referred to in paragraph (a).

(2) Except in the case of a bridge, boom, dam or causeway, this section does not apply to any work that, in the opinion of the Minister, does not interfere substantially with navigation. R.S., c. N-19, s.5."

An approval granted for the construction of a work, and the site and plans thereof, is only an authorization to interfere with the public right of navigation to the extent of the work for which site and plans have been approved. It is not a general approval of construction nor an authorization in respect of any law, regulation or bylaw, Federal, Provincial or Municipal which may require some other form of authorization (e.g. land use, noise, weed or pollution control, zoning or like manners).

An approval granted under the Navigable Waters protection Act remains applicable to the work notwithstanding the transfer of title to the work. Alterations to the originally approved work will also require approval.

1.3.3 FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS (EARP)

The Environmental Assessment and Review Process (EARP) Guidelines Order has been in effect since 1984 and applies to all Federal departments, boards and agencies and, in some circumstances, regulatory bodies and Schedule DFAA corporations. The process is a planning tool for predicting the potential environmental consequences of proposals that require a Federal Government decision. EARP is intended to ensure that the Government understands the environmental consequences of its decisions before those decisions are taken. EARP does not demand an exhaustive study when none is warranted. EARP is a procedural regulation. It requires certain steps to be taken at key points, when those steps are required. EARP is not an environmental protection regulation. It does not require a particular degree of environmental protection; it requires understanding of the environmental consequences of proposals. The definition of "proposal" to which EARP applies "includes any initiative, undertaking or activity for which the Government of Canada has a decision-making responsibility." A Federal department with the authority to make a decision about a proposal is called the "initiating department." The private sector organization or the department that intends to undertake the proposal is called the "proponent."

Recent Federal Court of Appeal rulings have elevated the EARP guidelines order to new heights. Rather than constituting guidelines for use by departments in the exercise of the powers and duties, it imposes duties independently of any particular statutory scheme. EARP guidelines must be complied with. As part of this process, public review of a proposal may be required. It is also no longer enough simply for an initiating department to determine that mitigation is feasible; they must also outline specific measures that can be taken to lessen environmental impacts.

1.4 LAND ACQUISITION

Approval, under any of the above Acts, does not vest in the recipient any title, easement, restriction or other property rights in respect of the land on which the work is to be placed or in respect of any property adjacent to or in the vicinity of the work. In view of the foregoing, it is suggested that application be made for permits of occupation where these are applicable. Where Federal or Provincial lands are involved, arrangements should be made with the department or agency charged with the administration of such land before construction is commenced.

1.5 SEWER-USE BY-LAWS

The discharge of industrial wastes to a public sewer system can result in a wide variety of problems. Industrial waste dischargers are the major sources of toxic organic chemicals and metals in wastewater. These materials may be sufficiently high to upset the treatment process; high concentrations may discharge through the treatment process and negatively affect the receiving water or; if removed in the treatment process, they will affect the sludge quality. Since many industrial wastes have the potential to cause these adverse effects, certain control measures are necessary. The normal method of exerting control of industrial discharges is through sewer-use by-laws administered by the individual municipalities. These by-laws typically set out the maximum permissible concentrations of various waste constituents, and otherwise define the acceptable characteristics of wastes which can be discharged to municipal sewer systems. Sewer-use by-laws may also be used as a means of controlling infiltration/inflow and illicit connections into a sanitary sewerage system.

A municipality must adopt an approved sewer-use by-law to be eligible for a permit to operate a sewage treatment plant.

2.1 WATER QUALITY OBJECTIVES AND WATER USE GUIDELINES

The typical level of treatment required for any new treatment plant in the Atlantic Provinces is secondary treatment with disinfection. However, each new plant will be evaluated on a case by case basis. In the province of Nova Scotia effluent requirement are outlined in the Sewage Treatment Plant Effluent Discharge Policy which is located in an appendix at the back of this manual. Required levels of treatment may be determined to be higher or lower than secondary treatment based on waste assimilation studies. The procedure for carrying out these studies is described in the following section.

2.2 WASTE ASSIMILATION STUDY PROCEDURES

a) Level of Effort

As part of the pre-design evaluation (described in Policy Section 4.2), the engineer shall determine from the applicable regulatory agencies the level of effort required for the particular waste assimilation study. The regulatory agencies will require one of three possible levels of effort as outlined in Figure 2.1.

The regulatory agencies may conclude that the effects of the proposed project on the receiving water will be minimal. In this case, the regulatory agencies will set effluent limitations based upon a simple model (possibly basic dilution calculations). In this case, only a minimal level of effort is required for the receiving water study (RWS). The regulatory agencies will determine which parameters will require measurement.

When the regulatory agencies are unsure of the possible effects of a project on the receiving water, they may require that an intermediate RWS and model simulation be conducted as a preliminary assessment tool. If the results of this study indicate that the proposed project would have only a minor effect on the receiving water, the regulatory agencies may, at that point, set effluent limitations. The regulatory agencies shall set the data requirements for the intermediate RWS's.

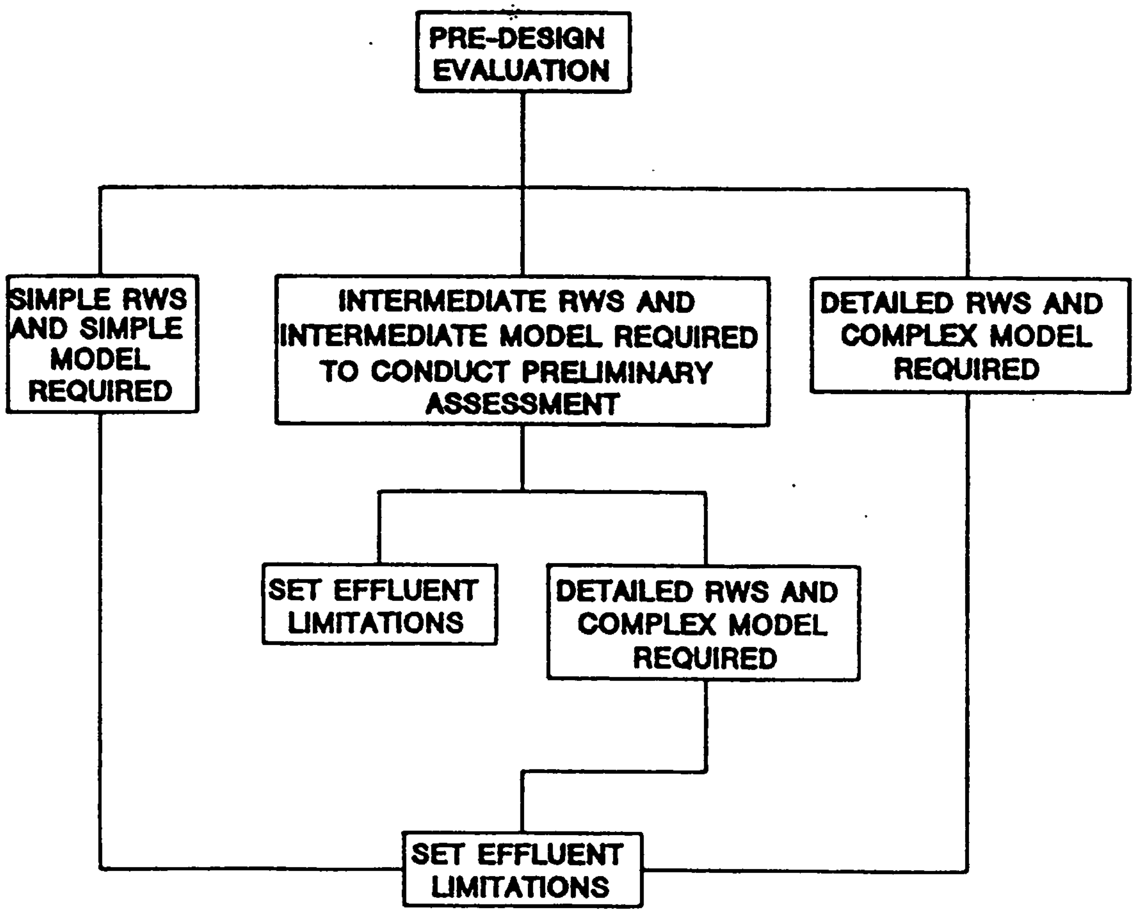
The third level of effort that may be required is a detailed RWS and complex modelling application. The results of this procedure will determine required effluent limitations. This approach will be required when the regulatory agencies believe that a proposed project may have a significant impact on the receiving water quality. The regulatory agencies will determine RWS data requirements.

b. Water Sampling Procedures

Instruments for electronic *in situ* determination of water quality parameters should be calibrated at least before and after each sampling trip. For example, samples should be collected for salinity to verify field measurements and samples fixed in the field for dissolved oxygen to verify dissolved oxygen probes.

FIGURE 2.1

WASTE ASSIMILATION STUDY PROCEDURES



NOTE: RWS - RECEIVING WATER STUDY

All field collection equipment should be listed and prepared before each sampling trip, insuring that all collection containers are clean and proper log forms and labelling equipment are available. Different containers should be available for metals, nutrients, organics, dissolved oxygen, etc. due to their cleaning and preservation requirements.

An established sequence of collection should be developed and maintained throughout the monitoring effort, insuring that new personnel are trained in the proper methods and sequence of data collection. All samples should be logged and sample log sheets should include station location, time, depth, results of *in situ* sampling, and container numbers for each type of sample. Datum should always be clearly specified (e.g. time of day standard, datum for water surface elevations).

All samples should be preserved on board, where the preservation technique will vary with the type of analysis required, but may involve icing, acidification, organic extraction, etc. The preservation techniques should be documented prior to implementation to the monitoring study. For some samples that do not preserve well it may be necessary to either conduct analyses on board or quickly transfer them to nearby on-shore facilities.

Additional samples should be collected to determine sampling variability and individual samples may be split prior to analysis to determine analytical variability. The number of replicate samples should be established as part of the planning for the monitoring effort. Field samples may also be spiked with a known amount of a standard prior to analysis. The identity of the spiked, split and duplicate samples should be kept on separate logs and the analyst should not be aware of their identity.

The samples should be transferred from the field to the laboratory in a timely manner. The field logs should be recorded and a laboratory log kept of the samples and their arrival. Custody sheets may be kept to further document the transferral of samples.

2.3 WASTE ASSIMILATION CAPACITY

2.3.1 General

In essence, a waterbodys dilution/assimilative capacity for wastes depends on waste characteristics and a host of physical, chemical and biological factors, such as the flow or volume of the waterbody and the waste discharges, dispersion of effluent, depth and width of the waterbody, type of substrate, algal growths, benthic deposits or organic sludges, etc.

A waste assimilation study is the mechanism to be used in estimating a waterbody's assimilative capacity and establishing effluent requirements to meet the CCREM guidelines. Either simple dilution formulae or more sophisticated mathematical models can be used as assessment techniques, depending on the circumstances. For example, with a dilution ratio greater than 20 to 1, simple dilution formulae may be adequate for estimating effluent requirements for discharges with a high degree of treatment (e.g. secondary treatment) and which do not contain hazardous substances. With a dilution ratio less than 20 to 1, more complex assessment techniques may be required to estimate assimilative capacity. Further, under complex situations (e.g. multiple uses of water, flood control requirements, etc.) sophisticated mathematical models may be used to estimate assimilative capacity and effluent requirements.

In areas with existing water quality better than the CCREM Guidelines, it is a good general principle not to allocate the entire assimilative capacity of a receiving waterbody. The need for maintenance of a reserve capacity should be established on a case-by-case basis.

In addition to meeting the CCREM Guidelines a thorough receiving water assessment may be required before the discharge of effluent containing toxic substances will be permitted. Such an assessment should include studies of the potential accumulation and concentration of the substances in the environment (such as bed sediments and aquatic flora and fauna), synergistic effects with other substances and physical factors (such as temperature changes or radiant energy) that may affect the environmental impact of contaminants.

2.3.2 Dilution Ratio

Dilution ratio is a simple measure of a receiving water's assimilative capacity. Dilution ratios should be based upon the 7 consecutive day average low streamflow occurring once in 20 years (7Q20), and the peak hourly effluent discharge rate (both expressed in the same units).

2.3.3 Mixing Zone

2.3.3.1 General

It may not be practical to treat all effluents so they meet the Water Quality Objective concentrations. Therefore, some volume of water must be provided for dilution or modification of the waste effluent before the Objectives can be met.

A mixing zone is a region of a waterbody in which an effluent discharge of quality (chemical/physical/biological) characteristics different from those of the receiving water is in transit and is progressively assimilated from the immediate outfall area to the outer limits of the region. At the boundaries or outer limits of the mixing zone, water quality objectives established by the regulatory authorities to protect beneficial water uses should be achieved. Within the mixing zone, where the objectives are not met, there will be some damage or loss to the aquatic environment. Nevertheless, at no point should conditions be immediately lethal so that swimming organisms cannot evade the area.

2.3.3.2 Mixing Zone Requirements

Terms and conditions related to the mixing zones may be outlined in the "Permit to Operate," based on the minimum requirements outlined below. Inherent in these conditions, a mixing zone may not be used as an alternative to adequate treatment.

1 The mixing zone should be as small as practicable, and shall not be of such size or shape to cause or contribute to the impairment of existing or likely water uses.

Mixing zone size shall be established on a case-by-case basis, but in no case shall it exceed the following:

a) in streams and rivers the mixing zone shall be apportioned no more than 25% 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 7Q20 flow for the area;

b) in lakes and other surface impoundments the mixing zone volume shall not exceed 10% of that part of the receiving water available for mixing, and surface water quality objectives must be achieved at all points beyond a 100m (300 ft) radius from the effluent outfall.

2 The mixing zone shall be:

a) Free from substances in concentrations or combinations which may be harmful to human, animal or aquatic life;

b) free from substances that will settle to form putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life or waterfowl;

c) free from debris, oil, grease, scum or other materials in amounts sufficient to be noticeable in the receiving water;

d) free from colour, turbidity or odour-producing materials that would:

i) adversely affect aquatic life or waterfowl;
ii) significantly alter the natural colour of the receiving water;
iii) directly or through interaction among themselves or with chemicals used in water treatment, result in undesirable taste or odour in treated water, and;

e) 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;

3. The presence of a mixing zone should in no way pose a threat to the species survival of any organism in the receiving water outside the mixing zone.

4. No conditions within the mixing zone should be permitted which:

a) are rapidly lethal to important aquatic life (resulting in conditions which result in sudden fish kills and mortality of organisms passing through the mixing zones) ; or

b) cause irreversible responses which could result in detrimental post-exposure effects; or

c) result in bioconcentration of toxic materials which are harmful to the organism or its consumer; or

d) attract organisms to the mixing zones, resulting in a prolonged and lethal exposure period.

5. The mixing zone should be designed to allow an adequate zone of passage for the movement or drift of all stages of aquatic life; specific portions of a cross-section of flow or volume may be arbitrarily allocated for this purpose;

6. Mixing zones should not interfere with the migratory routes, natural movements, survival, reproduction, growth, or increase the vulnerability to predation, of any representative aquatic species, or endangered species;

7. Mixing zones should not interfere with fish spawning and nursery areas;

8. Rapid changes in the water quality which could kill organisms by shock effects must not be present. Such conditions could have the effect of creating a higher toxicity value;

9. Municipal and other water supply intakes and recreational areas, as a general rule, should not lie within a mixing zone. However, knowledge of the effluent characteristics and the type of discharge associated with the mixing zone could allow such a mixture of uses;

10. Mixing zones may overlap unless the combined effects exceed the conditions specified in these mixing zone guidelines;

11. Limitations on mixing zones should be established by the regulatory authorities on a case-by-case basis, where "case" refers to both local considerations and the waterbody as a whole or segments of the waterbody;

12. Existing biological, chemical, physical and hydrological conditions should be known when considering the location of a new mixing zone or limitations on an existing one;

13. The design and location of the outfall should be considered on a case-by-case basis to reduce the impact of the mixing zone on the receiving waters;

14. Total loadings into all the mixing zones within a river, lake or segment thereof, must not exceed the acceptable loadings from all point-source discharges required to maintain satisfactory water quality;

15. Mixing zones should not result in contamination of natural sediments so as to cause or contribute to exceedences of the water quality objectives outside the mixing zone.

2.3.4 Waste Assimilation Study Field Procedures For Streams and Rivers

2.3.4.1 General Strategies

2.3.4.1.1 Defining Problem and Objectives

Before any field work is carried out on a stream, the problem(s) should first be defined, and the objective(s) of the study laid out.

2.3.4.1.2 Preliminary Office Planning

Maps and aerial photographs of the survey area should be obtained, as well as any previous reports on the waterbody and municipal and/or industrial discharges. All discharges to the waterbody should be pinpointed on the map. The drainage area of the stream or river should also be calculated.

All existing data on water quality monitoring, streamflow, water takings and consumption, water uses, and volumes and characteristics of waste discharges should be obtained.

2.3.4.1.3 Preliminary Field Studies

The entire reach of stream to be studied should be inspected. Waste discharges, dispersion patterns of effluent and tributaries, physical characteristics of the stream (depth, width, water velocity, type of substrate), water uses, algal growths, the presence of benthic deposits or organic sludges and any other pertinent characteristics should be noted.

Preliminary chemical data (BOD_5, nutrients, day and night-time DO) should be obtained to determine the length of stream to be studied, expected concentrations of chemical parameters, and whether night-time sampling is necessary. This data should be collected far enough in advance of the proposed intensive survey data to allow for the lab analyses to be completed and evaluated.

Based on the preliminary information, sampling stations can be selected. Times of travel (TOT) should be determined between sampling stations, also noting times of waste inputs and tributary confluences. Observations should be made at three or more different stream flow stages over a suitable range from low flow to average summer flows and data plotted on log-log graph paper (Times of Travel vs. Streamflow) which will permit interpolation or limited extrapolation for the streamflow conditions to be modelled.

Mixing studies should be carried out on waste discharges and tributary inflows to determine if lateral and/or vertical multi-point sampling is necessary at any downstream stations where complete mixing of the inflows with the stream water has not occurred.

Stream cross-sections should be obtained at about 300 m (1,000 ft). intervals and at those points where the physical character of the stream changes significantly.

At each sampling location, a staff gauge or other stage measuring device (e.g. bench mark) should be installed. Each time the station is visited the gauge height and date should be recorded to develop a gauge height vs. flow curve to provide stage height at any flow. Flow may be obtained by streamflow gauging and/or may be extrapolated by drainage area ratios.

The low flow to be used in the loading designs must be determined or obtained from a hydrologist. The recommended design streamflow for continuous discharge to a stream is the seven consecutive day average low streamflow occurring once in 20 years (7Q20). Physical data affected by streamflow, such as depth, TOT, mixing, etc., must be extrapolated to this flow. It is therefore important to conduct assimilation studies under flow conditions as close as possible to low flow so extrapolation of data to design conditions (low flow) will be minimal.

Where benthic deposits are believed to exert an appreciable demand on the oxygen resources of the stream, benthic respiration studies should be carried out.

2.3.4.1.4 *Pre-Intensive Survey Planning*

Based on the preliminary data and the objectives of the study, the type of survey to be conducted will be determined. If 24 hour dissolved oxygen concentrations fluctuate greatly or if wastewater loadings or streamflows fluctuate greatly, then "round-the-clock" sampling will be necessary. However, if streamflows and waste loadings are stable and dissolved oxygen concentrations do not fluctuate greatly (i.e. more than 2 mg/l) from day to night then a simple water quality study with limited sampling may be sufficient (enough samples should be taken, however, to provide statistically valid data). Generally a minimum of 12 samples per station will provide statistically valid data.

Once the type and scope of the study has been determined, the number of samples that will be submitted to the laboratories can be determined. Parameters that may be measured during an assimilation study are:

- pH
- turbidity
- dissolved oxygen (DO) and temperature
- total and fecal coliforms
- BOD_5
- total phosphorous
- soluble reactive phosphorus
- filtered ammonium nitrogen
- total kjeldahl nitrogen
- nitrate and nitrite nitrogen
- BOD_{20}
- plus any other waste component that may affect water quality and use such as heavy metals or volatile suspended solids

A tentative survey date, when streamflow conditions are low and water temperatures high (mid-July to early September), should now be selected. This date should be verified with all participating personnel and the laboratories. At this time the laboratories will need to know the number of samples expected and parameters requested. Water Pollution Control Plant (WPCP) operators and/or industrial contacts must be informed of the expected date of the survey and access to their plants should be arranged for sampling personnel.

A few days before the survey, the local police departments, the local conservation authority and municipal offices should be informed of survey plans. If dye is to be used in the river during the study, these same agencies should be informed. Regional and district regulatory agency staff and Federal DFO/EPS officers must also be informed of the survey.

2.3.4.1.5 *The Field Survey*

The culmination of the preliminary field work and the office planning is a well-executed field survey. This survey generally extends for 30 to 60 hours with samples collected at selected time intervals (generally 3 to 6 hours apart depending on manpower, equipment and time constraints). The duration of the survey depends upon various factors such as:

a) manpower constraints
b) laboratory capabilities
c) if Photosynthesis and Respiration modelling will be attempted
d) time constraints
e) length of time for sampling run.

Enough samples must be collected to provide statistical validity to the data (generally 10 to 12 samples at each station). If discrete sampling (grab samples taken at a specific location and specific time) cannot be carried out, composite samples may be collected with the approval of the regulatory agency.

If sampling runs can be conducted every 3 hours, then 12 samples can be collected during a 36 hour period providing statistically valid data and adequate DO data for modelling. The study could be conducted from 9:00 pm. one day to 9:00 a.m. two days hence, to obtain the proper DO curve. If time constraints dictate sampling every 4 hours, then a 48-hour study should be conducted. Timing of the beginning of a 48 hour survey is not too critical as only one complete 30-hour DO cycle can be obtained. However, if data is collected at intervals greater than 4 hours it is difficult to obtain a good diurnal-nocturnal DO graph. A 60 hour study with 4 hour sampling intervals will provide 15 samples and if started at 9:00 p.m. and finished at 9:00 a.m. 60 hours later, will provide two complete diurnal-nocturnal cycles for modelling needs. In any event a survey should not be started or ended at a critical low point on the DO graph (i.e. early morning - 4:00 am to 8:00 a.m.).

Situations may arise which may force cancellation or modification of a study. Among them are:

- overcast weather - if a survey had been planned to obtain data during hot, dry weather, then overcast weather will change the DO curve if diurnal-nocturnal effects of algae are of significance.

- streamflow changes (including rain) - concentrations of parameters change greatly during a rainfall, especially during the first 1/2 hour of the rain.

- abnormal changes in waste loading - waste loadings are averaged over the survey period; large changes in loads result in changes of concentrations of parameters in the stream during the survey.

These three situations result in changes in the "steady-state" conditions which are desirable for ease of modelling.

Cancellation of surveys because of these conditions may be minimized by:

a) checking with the weather bureau prior to conducting the study;

b) arranging with the proper authorities if streamflow is controlled by dams to ensure steady streamflows for the period of the survey;

c) arranging with the WPCP or Industrial Plant operator to attempt to ensure that atypical loading conditions do not prevail during the study, due to construction, plant or equipment breakdown etc.

Duties and manpower generally required to carry out an assimilation study are approximately as follows:

- day sampling - one person and vehicle per route
- night sampling - two people and 1 vehicle per route
- time of travel - one person and 1 vehicle
- co-ordinator - one person and 1 vehicle
- sample transport - one person and 1 vehicle
- flows by velocity measurement (if necessary) - two people and 1 vehicle.

Some pointers for carrying out an intensive survey are:

- DO meters should be calibrated to a Winkler titration before each run to ensure accuracy of data. Meters should be calibrated to DO levels in the same range as those expected to be measured.

- Recording DO/temperature meters and/or automatic samplers should be installed prior to the start of the survey.

- Care should be taken when installing recording DO meters in the streams to ensure that water is moving past the probe with a velocity of at least 1 cm per second (0.4 in/sec) to prevent oxygen depletion at the membrane.

- DO recorders should be calibrated and automatic samplers checked at least once per day. Samples should be removed from the sampler at least once per day as levels of non-conservative parameters may change with time and temperature.

- Samples at each location should be collected at least 12 times during the survey (tributaries may not need to be sampled as often). This number of samples should provide statistical reliability to the data.

- DO readings should be taken no more than 4 hours apart to provide a smooth representative DO graph.

- Data should be recorded on field data cards (e.g. Figure 2.1 a) and b) and any observation out of the ordinary should be noted on the cards (e.g. turbid discharge, rainfall, etc.).

- Laboratory submission sheets should be completed at the end of each sampling run to avoid confusion and a back-log of samples with no lab sheets.

- Time of travel data can be collected during the survey. If graphs of TOT vs. flow have been previously drawn up and encompass the flow regime at the time of the study and if manpower is limited, this function may be eliminated.

- The survey co-ordinator should be available for consultation any time of the day or night during the intensive survey. Portable radios may prove valuable in maintaining communication with crews.

- Data should be reviewed as it is collected and changes made to plans if the data warrants such changes (e.g. re-locating stations, changing sampling frequency etc.).

2.3.4.2 *Survey Procedures*

2.3.4.2.1 *Station Selection*

Many factors are involved in deciding the location of stations for water quality sampling. These include: objectives of the survey, accessibility to the streams, time of travel from waste source, mixing of wastes with the stream, physical characteristics of the stream (e.g. is the location on a sharp bend in the river, upstream or downstream of a dam, in the middle of a large impoundment etc.), length of survey reach, and personnel and equipment availability.

An ideal sampling station is one which would yield the same concentration of parameter no matter where in the cross-section the sample is taken. However, immediately downstream of waste inputs, complete lateral mixing of wastes and stream water rarely exists, so samples should be collected at various locations across the stream. Sometimes vertical mixing does not occur necessitating vertical sampling. Ideally, samples should be collected at various locations and the concentration at each location multiplied by the fraction of flow at each location to give the total loading. Dye dispersion studies can be very helpful in establishing sampling points in a cross-section of stream.

It is good practice to sample at quarter points in the cross-section. Samples should be collected from exactly the same location at each station. Multi-point sampling locations should be marked with paint (if on a bridge) or with poles driven into the steam bed (if shallow enough) or with anchored floats in the stream.

Time of travel between stations should be approximately 2 hours (less for small streams, more for larger).

Sampling from the edge of a stream should be avoided. However, if a sample must be collected from the river bank, select a location on the outside of a bend where the current flows along the bank.

Stations should be spaced far enough apart that changes in water quality are measurable, but not too far apart that too great a change in water quality has occurred since the previous station.

All waste sources and tributaries should be sampled where they enter the stream and their volumes should be known. Samples of final effluent shall also be taken prior to chlorination. The mainstream should also be sampled immediately upstream of the waste source or tributary to properly assess the effects of that load on water quality. If direct sampling of the waste source or tributary is impossible, then the river should be sampled and gauged directly above the source and at an appropriate distance downstream (immediately downstream for gauging and after complete mixing for sampling). The differences between the downstream and upstream loadings can then be attributed to the input.

Control samples (upstream from waste sources) should be obtained for comparative purposes.

2.3.4.2.2 *Stream Cross-Sections*

Cross-sections of the stream bed should be obtained wherever there is a significant change in the physical characteristics of the stream channel. These are used for calculating the reaeration coefficient (Ka) for each different section of the stream.

Cross-sections may be obtained using a graduated pole, a weighted rope or depth sounder. Stream widths must also be measured (using a tape, graduated rope or stadia and transit). The distances between cross-sections must also be obtained (from a map, by stadia or with a graduated rope).

If stream profiles must be known for flows greater than those under which the cross-sections were obtained, then the profiles should be continued up the stream bed to the height required.

2.3.4.2.3 *Flows*

Flow information must be known when carrying out time of travel and dispersion studies, cross-sectioning and intensive sampling. For modelling purposes it is necessary to know the stream flow, tributary flows and the volumes of all waste inputs.

Streamflows may be obtained from the DOE regional hydrologist for rivers that are gauged by the Water Survey of Canada or the DOE (either by continuously recording or staff gauges.) If flow data are not available from this agency, it will be necessary to gauge the stream. Flow data for the stream and major tributaries should be obtained at least once per day during the survey. WPCP and industrial wastewater flows can normally be obtained from the plant operators (usually in the form of continuous flow chart).

Otherwise, temporary weirs, upstream-downstream flow gauging or some other method of measuring the wastewater flows must be implemented.

2.3.4.2.4 *Time of Travel Studies*

Time of travel (TOT) data are a vital part of a water quality study (e.g. K_d rates are calculated from BOD vs TOT graph, K_n rates from TKN vs TOT graph). Time of travel is an important consideration when selecting sampling station locations.

Time of travel data will not change unless some physical change is made to, or occurs naturally in the stream (e.g. straightening oxbows, installing dams etc.) Varying densities of aquatic weed growths can change TOT values under similar flow conditions.

Extrapolation of TOT data to low flows may result in erroneous values if data has not been collected over a reasonably large flow range that includes low streamflows.

Time of travel may be determined for river reaches by any one of three methods:

a) floats;
b) volume-displacement method;
c) tracers.

2.3.4.2.5 *Reaeration Coefficient Measurement*

Occasionally, the expense and effort required to measure stream reaeration coefficients directly in the field may be justified. A technique which has been used with a fair degree of success is the modified tracer-ethylene gas technique developed by Rathbun, Schultz and Stephens.[1]

1 *Rathbun, R.E., Schultz and Stephens; 1975; "Preliminary Experiments with Modified Tracer Technique for Measuring Stream Reaeration Coefficients"; U.S. Department of Interior Geological Survey Open File Report No. 75-256; Bay St., Louis, Miss., U.S.A.*

2.3.4.2.6 *Sample Transportation*

Samples for chemical and bacteriological analyses should be transported to the laboratories within 24 hours following sampling; all samples should be refrigerated and shipped in a cooler if possible. Samples for BOD_5 analysis should be kept cool.

2.3.4.2.7 *Field Notes*

To aid in recording field data in intensive surveys, a separate card should be made up for each station and kept in a note book. Each card should clearly indicate the station number, its location and any special sampling instructions (Figure 2.1a). The run number, time of day, DO and temperature and any notable remarks should be entered as the data are collected (Figure 2.1b).

FIGURE 2.1a

WATER QUALITY STUDY

WATER QUALITY STUDY

RIVER BASIN:	SAMPLED BY:
STREAM:	SAMPLING POINT:

LOCATION OF WATER SAMPLING STATION:

SKETCH OF LOCATION:

ANALYSIS:

5 DAY BOD

SOLIDS - TOTAL
- SUSPENDED

CONDUCTIVITY

TURBIDITY

PHOSPHORUS - TOTAL
- SOLUBLE

NITROGENS - FREE AMMONIA
- TOTAL KJELDAHL
- NITRITE
- NITRATE

CHLORIDES

FIGURE 2.1b

FIELD DATA

FIELD DATA						
DATE OF SAMPLE D	M	Y	TIME OF DAY	WATER TEMP. °C	D.O. PPM	REMARKS (FLOW, WEATHER, ETC.)

2.3.4.2.8 *Sample Numbering*

It is very important to clearly label samples to identify the exact time and place the sample was taken.

WPCP and industrial effluents should be clearly labelled as such so the laboratory will recognize these samples and be able to give them special attention.

If there is more than one sampling point at a location, number the points A, B, C, etc. (or L, C, R) from left to right side of the stream facing upstream.

2.3.4.3 ***Water sampling procedures***

2.3.4.3.1 *Chemical*

a) Manual

Samples should be collected, if possible, directly in the bottle submerged in the river. If sampling by immersing the bottle is not possible then the sample should be collected with a stainless steel, plastic or brass sampling apparatus and transferred to the bottle taking care not to contaminate the sample with the hands or with water from previous sampling.

When sampling by hand (i.e. wading into the stream) the sampler should face upstream and grasp the bottle so the water coming into contact with the hands does not enter the bottle, thereby contaminating the sample. The bottle should be immersed below the water surface (except phenol samples which are skimmed from the surface, and samples for ammonium nitrogen analysis, which should not be bubbled) and the water should be allowed to overflow the bottle to ensure a representative sample.

b) Automatic

Samples may be obtained using an automatic sampler where manpower is limited or access is poor. Automatic samplers should never be used to collect samples for bacteriological or DO analyses. The sampling hose should be placed in the main current on a stake or rod to obtain a representative sample and to allow the current to continuously cleanse the intake so the build-up of algae will be reduced on the intake. Samples should be removed daily.

2.3.4.3.2 *Dissolved Oxygen (DO)*

When taking a water sample for DO analysis, care should be taken to ensure that there is no bubbling of water into the bucket. After the bucket is filled with water let it settle underwater for a few seconds to allow the river water to be exchanged, thereby ensuring that a representative sample is obtained. If possible, obtain the sample for DO analysis directly from the stream using the bottle in a DO field kit.

When measuring DO with a meter, insert the probe directly into the river or sample bucket and gently agitate the probe (at a velocity of about 1 cm/sec) to prevent oxygen depletion around the membrane. When the readings have stabilized, record the DO and temperature values. Take care to avoid banging the probe on rocks or the sides of the bucket as erratic readings will result.

When installing a DO meter for continuously recording DO, care should be taken to ensure that the probe is situated in the mainstream to avoid oxygen depletion around the membrane and to cleanse the probe. Fouling of the probe by floating debris can be minimized by positioning a 30 cm by 30 cm mesh screen about 2.5 m upstream from the probe. This screen must be cleaned periodically.

When calibrating DO meters, 3 Wet Winkler DO determinations should be made and the values averaged. DO meter readings must also be adjusted for differences in elevation (atmospheric pressure).

2.3.4.3.3 *BOD_{20} (for k_1 Rate)*

A 20 day incubation test shall be performed to determine the relationship between BOD_5 and the ultimate BOD (BOD_u) of the streamwater. Samples for incubation tests should be taken at the first station downstream from the waste discharge where complete mixing of the waste and streamwater has taken place. If possible, samples for another BOD_{20} test should also be taken in the effluent and also near the downstream end of the survey reach.

A total of 12-1 litre bottles should be taken at each site and all numbered identically. The lab submission sheet should be labelled "For k_1 Analysis - complete nitrogen analyses to be performed on the incubated sample on days 0, 5, 10, 15, and 20 days." The nitrogen analyses are performed concurrently to establish a true k_1 attributable to carbonaceous BOD (CBOD).

2.3.4.3.4 *BOD_5 with Nitrogen in Parallel*

To determine the portion of the BOD_5 that is actually carbonaceous, BOD_5 analyses, with complete nitrogen analyses on the first and fifth days, should be taken at least three times at all stations. The difference between the total BOD_5 and the BOD attributed to nitrogen is the carbonaceous BOD_5 (CBOD) which is used to calculate the true CBOD loadings from which a true L_o and K_d can be calculated.

2.3.4.3.5 *Special Sampling Techniques and Handling of Samples*

a) Input Sampling

One of the most important samples collected during an assimilation study is from the final effluent of an STP or industrial plant. This effluent often contains residual chlorine for disinfection purposes. Chlorine is a strong oxidizing agent which inhibits the BOD test. Although the chlorine may be eliminated by the addition of the proper amount of sodium thiosulphate, the titration procedure is somewhat complicated to perform in the field. It is therefore very important that all samples of final effluents be taken prior to chlorination to ensure a representative BOD_5 concentration.

It is wise to obtain a good number of samples (at least 12) of the final effluent, as the BOD_5 and nutrient levels form a very important input to the dissolved oxygen model. It is also a good idea to obtain samples directly upstream from the inputs (including tributaries) and after complete mixing of the stream with the input as a check on the input loading (using mass balance equation).

b) Sampling for Ammonium Nitrogen

As ammonia gas is released by bubbling action (or converted to other forms of nitrogen) care should be taken to minimize bubbling of the sample for ammonium nitrogen analysis. This may be accomplished by special sampling devices (such as a Kemmerer sampler) which can be used to obtain a representative sample below the surface of the water, special pumps which will not bubble the sample, or by carefully obtaining a sample from the surface of the water by allowing the water to gently flow down the sides of the bottle. Wide-mouthed bottles can best be used to sample by this method.

2.3.4.4 *Equipment*

2.3.4.4.1 *Water Sampling*

a) Buckets

Sampling buckets should be made from relatively non-contaminating materials such as stainless steel or plastic (e.g. PVC). However, care should be taken when sampling for certain parameters that the bucket material does not contaminate the sample. The sampling bucket should always be rinsed thoroughly before taking the sample.

b) Depth Samplers

Various types of samplers can be used to sample water from depths. These are made from brass, PVC or acrylic; some are nickel-plated or teflon-lined to virtually eliminate any chance of sample contamination.

2.3.4.4.2 *DO Meters*

Electronic DO meters considerably reduce the manpower required to perform DO tests.

To save effort and reduce chance of errors, consideration should only be given to the use of temperature compensated models when purchasing DO meters.

2.3.4.4.3 *Fluorometer*

Approved fluorescent dyes used in time of travel, effluent dispersion and flow measuring studies may be detected in the stream using a fluorometer with filters which measure the appropriate wavelength of fluorescence. Fluorometers are usually portable and may be powered in the field by a small A.C. generator. Fluorometers should be calibrated before each use.

2.3.4.4.4 *Pyranograph*

This portable instrument measures and records solar radiation in g cal/cm^2/min, for either a 24 hour or 7-day period. The recorded data will provide the time of sunrise and sunset and the intensity of sunlight for that day. This information is necessary for input to the dissolved oxygen balance when modelling for photosynthesis and respiration.

2.3.4.4.5 *Depth Sounder*

This equipment is useful for determining the cross-sectional area of the stream. The data is used in K_a calculations and time of travel calculations in large rivers. Some points to consider when purchasing a depth sounder are:

- chart speed (the faster the better)
- printout - perpendicular printout rather than circular to prevent distortion of recording
- ensure that scale provides adequate profiles at shallow depths
- portability (including the necessary power supply-battery/generator)
- accuracy
- precision
- durability
- splash proof case

2.3.4.4.6 *Current Meter*

If flows must be obtained manually a suitable current meter should be used.

2.3.5 Waste Assimilation Study Field Procedures For Lakes

2.3.5.1 Conditions Necessitating a Waste Assimilation Study

When sewage discharge is proposed to a lake, a waste assimilation study will be required when any of the following conditions are expected or present:

a) The waste discharge exceeds 2.2 L/s);

b) The average lake outflow rate is less than 200 times the effluent design average flow;

c) The average lake outflow rate is less than 1000 times the effluent design average flow and the lake's theoretical retention time is greater than 10 years; or

d) The proposed discharge increases the total discharge to a lake to greater than 44 L/s.

In addition, a waste assimilation study will be required where local conditions indicate that sewage effluent may drift into certain areas. These could include areas which might reasonably be utilized for water contact recreation or where water is extracted for any purpose.

2.3.5.2 *General Strategies*

2.3.5.2.1 *Defining the Problem and Objectives*

Before any field work is carried out on a lake, the problem(s) should first be defined, and the objective(s) of the study laid out.

2.3.5.2.2 *Preliminary Office Planning*

Maps and aerial photographs of the survey area should be obtained, as well as any previous reports on the waterbody and municipal and/or industrial discharges. All discharges to the waterbody should be pinpointed on the map. All existing data on water quality monitoring, water takings and consumption, water uses and volumes, and characteristics of waste discharges should be obtained.

An outline map should be prepared showing the lake outline, all inflowing and outflowing waters, any rock outcrops and shoal locations, and any musky, bog and flooded areas. Man-made features such as settlements, railroads, highways, bridges, docks, dams and access points should also be shown. From this map the surface water area and perimeter of the lake and islands should be measured and recorded. The lake's drainage area should also be calculated and shown on the map.

2.3.5.2.3 *Preliminary Field Studies*

A shoreline cruise of the lake should be conducted. The shoreline cruise is intended to collect and record specific information about the physical attributes of a waterbody. These particular attributes are as follows:

a. Fluctuation
b. Number of Resorts and available discharge data
c. Number of Cottages and available discharge data
d. Dams (type and location)
e. Slope Angle of Terrain
f. Inlets and Outlets
g. Shoreline Soil Types
h. Bottom Soil Types
i. Pollution
j. Vegetation

The collection of this information should be carried out prior to the field survey, so as to familiarize the survey personnel with the lake.

a. Fluctuation

- Fluctuation refers to the change in water levels. However, in a number of cases it will be difficult to detect water fluctuations if there is no exposed rock, so it will be up to the discretion of the survey crew to obtain the measurement. The vertical distance in metres between the high water mark and the low water mark is the fluctuation. These marks are usually stains on the rock. The high water mark is indicated by the growth of lichens which give rocks a dark stain and a light exposed surface below. The low water level is recognized by a light area exposed to weathering and a dark stain below indicating permanent submergence by water. Of course, if there is a permanent monitoring station such as a power dam on the lake, the appropriate authorities can be contacted and the accurate measurements can be obtained.

b. **Number of Resorts**

- The number of resorts is the total number of commercial establishments on the lake.

c. **Number of Cottages**

- The number of cottages is the total number of private residences (year round living), cottages and cabins. A distinction should be noted between the number of year round and seasonal residences.

d. **Dams**

- Dams are any structures, natural or man made, that impede the flow of water into or out of a lake. These can be beaver dams, log jams, hydro dams, etc.

e. **Slope Angle of Terrain**

- Slope angle of terrain is the inclination at which the backshore is elevated from the water surface. The inclination is normally measured on-site at regular intervals using a clinometer and is expressed in degrees.

  To accurately measure the slope angle with a clinometer, the boat must be at the shoreline. A reading is then taken from the front seat of the boat.

f. **Inlets and Outlets**

- Inlets and outlets are the streams and rivers flowing in and out of a lake. These waters should be divided into two groups: ***perennial***, being a stream which has a continuous flow and ***non-perennial***, being a stream which has a discontinuous flow. The discharge from each inlet and outlet should be calculated.

  Since a quick approximation is needed to calculate flows into and out of lakes, the following formula can be used.

$$\text{Discharge} = \frac{W\,D\,L\,K}{\Delta t}$$

W = average width (m)
D = average depth (m)
L = length of station (m)
Δt = average time(s)

K = velocity correction factor
= 0.8 (rough bottom)
= 0.9 (smooth bottom)

The section of stream selected should be as straight as possible, without obstructions, of approximately the same width and the same type of bottom throughout and far enough away from the lake that there is no effect of wind or wave action. Ten metres of stream is a convenient length.

A floating object should be clocked to determine the time it takes to float the length of the station. The float should be timed over the distance at least three times then averaged.

g. **Shoreline Soil Type**

- Shoreline soil type is the material on the foreshore.

h. **Bottom Soil Type**

- Bottom soil type is the material on the offshore.

i. **Pollution**

- Pollution should be checked for and noted. Any visible signs of contamination and possible sources should be noted. Examples could range from litter to algal blooms caused by sewage. All waste discharge to the lake should be pinpointed on the map.

j. **Vegetation**

- Vegetation is important to inventory but only in a generalized manner. Vegetation whether it be terrestrial or aquatic enhances the environment by impeding the erosion of soils, providing food whether direct or indirect, producing oxygen and increasing surface area for larger populations of animals. The type and quality of vegetation is limited by climate and soils. Soils derived from infertile hard rock have significantly less abundant vegetation than do soils derived from glacial till and sedimentary rocks.

2.3.5.2.4 *Pre-Intensive Survey Planning*

Parameters that should be measured during an assimilation study are:

- total and soluble phosphorus
- total and soluble nitrite

- total and soluble nitrate
- total and soluble ammonia
- total and soluble organic nitrogen
- pH
- dissolved oxygen (DO)
- temperature
- algal biomass in the upper mixing zone
- alkalinity
- suspended and dissolved solids
- BOD_5
- Bacteria
  - Fecal coliforms
  - Fecal streptococcus
- chlorophyll a
- pheophytin a
- Turbidity, colour and Secchi depth throughout all vertical Zones

2.3.5.2.5 *The Field Survey*

The field survey should be conducted over the period of one year. The actual duration of the survey depends upon various factors such as:

a) manpower constraints
b) laboratory capabilities
c) time constraints

Enough samples, at each station, must be collected to provide statistical validity. Samples should be collected on a monthly basis during the months of September through April and bi-weekly during May through August.

The bi-weekly samples must be scheduled to coincide with the period of elevated biological activity. If possible, a set of samples should be collected immediately following spring turnover of the lake. Samples should be collected between the hours of 1130 and 1400.

The preparation of a contour map is essential to develop the profile characteristics of the lake basin and to calculate the volume of water. To prepare the contour map, the various depths of the water basin should be measured by an echo sounder. Transects must be straight runs from and to visible shoreline features which can be identified on the field map, (i.e. projections, centre of indentations, landmarks, etc.) Transects must be kept as short as possible and perpendicular to the shore. Transects must be run at a constant outboard motor speed. Speeds may vary from line to line but never while running the same transect. If variation occurs, return to the starting point and recommence the sounding run. If the echo sounder has adjustable paper speed, it should not be changed during a sounding run. Line number, direction of run and distance from shoreline(s) of the sounding recording terminals must be indicated on the transect map and on the tape. This eliminates any doubt in the interpretation of the sounding tape.

2.3.5.3 *Survey Procedures*

2.3.5.3.1 *Station Selection*

The following criteria are recommended as guidelines in establishing chemistry stations:

1) One chemistry station must be conducted in the deepest basin of the waterbody. If the echo sounding tapes indicates more than one basin of equal depth (within ± 5 metres), then sample each basin at the deepest part.

2) If there is a basin in proximity to an inlet(s) and/or and outlet(s), a sample station should be set up. However, do not sample where there is movement of water since these data will reflect the inlet characteristics and not those of the lake. Also, if the discharge is less than $0.5m^3/s$ a station is not required.

3) If a basin is 75% of the maximum depth of the deepest basin of the waterbody, a sample station should be set up.

4) If there are bays that are isolated from the main body of water, it is advisable to set up a station.

5) As a rule of thumb, there should be at least one chemistry station for every 250 hectares of water surface area.

2.3.5.3.2 *Sample Transportation*

Samples for chemical and bacteriological analysis should be transported to the laboratories within 24 hours following sampling. All samples should be refrigerated and shipped in a cooler if possible.

2.3.5.3.3 *Sample Numbering*

It is very important to clearly label samples to identify the exact time and place the sample was taken.

2.3.5.4 *Water Sampling Procedures*

2.3.5.4.1 *Water Transparency*

Transparency describes the extent of light penetration into water. As light plays an important part in many biological processes, this measurement must be performed accurately. Transparency is always measured at the time of each and every chemistry test. If the chemistry tests are done before noon the transparency tests are done on completion of the chemistry tests. If in the afternoon, transparency is done first so as to get the reading as close to high noon as possible. The actual times of Secchi depth readings should be recorded.

Transparency in lakes is measured with a weighted metal disc, twenty centimetres in diameter with alternate white and black quadrants. This instrument is known as a Secchi disc. A line, graduated in metres and centimetres is attached to the disc.

To obtain a Secchi disc reading:

1) Lower the disc into the water on the shady side of the boat and note the depth at which the disc **disappears** from view in descent.

2) Raise the disc and note the depth at which the disc **reappears** in ascent.

3) Calculate and record the arithmetic mean of these two readings. This is the Secchi disc reading.

4) If the lake bottom is contacted during visual descent, record station depth for Secchi depth and indicate that this depth is bottom.

Surface conditions will alter the Secchi disc readings. Therefore, it is important that these conditions are recorded when the test is performed. The various categories are listed below:

Calm	-	complete absence of wind glass like appearance of water
Rippled	-	lightly ruffled - not more than a 2 cm (1 in) rise in the undulations
Wavy	-	ruffled - not more than 5 cm rise in the undulations
Rough	-	waves more than 5 cm in height

N.B. Chemistry tests should not normally be done in rough conditions.

2.3.5.4.2 *Water Temperature Series*

A vertical temperature series in lakes should be recorded at all water chemistry stations. The procedure should be as follows:

1) Measure and record the air temperature by use of a dry bulb thermometer, in the shade over the side of the boat and near the water surface. Don't let the thermometer get wet.

2) Observe and record the water temperature at the surface and 1.5 meters below the surface. Continue at 1.5 metre intervals, until the lake bottom is reached or the water temperature reads 4°C.

3) Water temperature recordings are waived in the 4°C temperature depths - BUT temperatures will be taken and recorded **one** metre above the bottom and **midway** between the bottom and upper 4°C temperature recording.

4) Stations less than 10 m deep should have the temperature recorded at one metre intervals.

5) In addition, water temperatures must be taken and recorded at **all** depths where water chemistry tests are made, e.g. mid-thermocline and the four mg/L dissolved oxygen level.

2.3.5.4.3 Chemistry Measurement Series

A vertical chemistry measurement series shall be developed at each water chemistry station. A Secchi disc reading and the accompanying data are recorded for each sample site.

Samples must be collected between 0.5 m below the surface and 0.5 m above the bottom. They must also be collected at intervals of every 1.5 m or at six equal depth intervals, whichever number of samples is less.

2.3.5.4.4 Total Dissolved Solids

The concentration of total dissolved solids is calculated by measuring specific conductance within a lake. Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, and on the temperature of measurement. Electrolytic conductivity increases with temperature.

2.3.5.5 Equipment

2.3.5.5.1 Water Sampling

Two devices for collecting the water sample for chemistry measurements are recommended. These are the Kemmerer Bottle and the Van Dorn Bottle.

The vertical type Kemmerer bottle is brass or plastic in construction and is available in different sizes. The unit is secured by a graduated braided nylon line not exceeding 5.0 mm in diameter for lowering and/or suspension in water.

The mechanism to close the stoppers and isolate the water at desired depths is controlled by the striking impact of a split or solid brass component called a messenger. It is released by the operator once the bottle is located at the desired depth.

The Van Dorn bottle is a sampler made of non-metallic components. The body and drain valves are constructed of P.C.V. plastic or clear acrylic. Closure of the bottle is by means of a messenger similar to the Kemmerer Bottle. The Van Dorn bottles are available in many sizes and come in two types. One is a vertical sampler, the other is a horizontal type.

2.3.5.5.2 *Conductivity Measuring Bridges*

There are a number of conductivity measuring bridges available with a variety of cell types. It is important that the user becomes familiar with the unit before proceeding to take measurements.

2.3.5.5.3 *Depth Sounder*

Some points to consider when using a depth sounder are:

- chart speed (the faster the better)
- printout - perpendicular printout rather than circular to prevent distortion of recording
- ensure that the scale provides adequate profiles at shallow depths
- portability (including the necessary power supply)
- accuracy
- precision
- durability
- splash proof case

2.3.5.5.4 *Thermometers*

Hydrographic thermometers and maximum/minimum thermometers are used to determine water temperatures. Hydrographic thermometer units consist of a sensitive direct current meter and a calibrated bridge network that contains a temperature sensitive resistor called a thermistor. All thermometers must be standardized.

2.3.6 Waste Assimilation Study Field Procedures for Coastal Waters

2.3.6.1 General Strategies

2.3.6.1.1 *Defining the Problem and Objectives*

Before any field work is carried out on any coastal water, the problem(s) should first be defined, and the objective(s), of the study laid out.

2.3.6.1.2 *Preliminary Office Planning*

Maps and hydrographic charts of the proposed discharge area shall be obtained, as well as any previous reports on the waterbody and any nearby municipal and/or industrial discharges.

All existing data on water quality monitoring, water uses, current speed and direction, receiving water density distribution, and volumes and characteristics of waste discharges should be obtained.

2.3.6.2 *Pre-Design Surveys vs. Monitoring Surveys*

Oceanographic surveys for waste-water disposal systems can be placed in one of two general categories - predesign or monitoring. Each of the two types of surveys has a different objective and possesses unique requirements that demand careful consideration.

Predesign surveys must provide not only the necessary information to determine the proper alignment of the submarine outfall, the location and orientation of the wastewater diffuser system, but also the final design criteria for the outfall and diffuser system which will assure the protection and enhancement of the receiving environment. In addition, accurate bathometric profiles, benthic soil characteristics for outfall placement and foundation, and sediment erosion and deposition behaviour must be determined.

Monitoring surveys are of several types. Predischarge monitoring surveys are conducted to establish the baseline or natural conditions of the receiving water, receiving sediments and adjacent shoreline prior to discharge of waste waters. Post discharge monitoring surveys are conducted for the purpose of determining the effects of the wastewater discharge on the receiving environment or for the purpose of assessing the performance of the disposal system for verification of design criteria and future design improvements.

2.3.6.3 *Pre-Design Waste Assimilation Studies*

2.3.6.3.1 *General Objectives*

Three major objectives must be satisfied in the conduct of a pre-design oceanographic survey. Firstly, a pre-design survey must determine the dispersion or diluting characteristics of the receiving water. Secondly, a pre-design survey must provide sufficient information on the ecosystem in the proposed discharge area to assure that biologically significant or sensitive areas will not be adversely affected by the disposal system, both during construction of the outfall and during the continuing discharge of the wastewater. Thirdly, foundation conditions for outfall and diffuser placement must be determined prior to preparation of engineering plans and specifications on the waste disposal system.

To satisfy all three objectives a general area for placement of the disposal system must be surveyed and potential alternative outfall sites chosen.

Because the rational determination of an outfall length necessary to meet particular receiving environment requirements for a specified level of treatment will be dependent upon the survey results, the predesign oceanographic survey should be designed to provide the greatest practical flexibility in the selection of outfall alignments and lengths.

2.3.6.3.2 *Parameters Requiring Measurement*

Those parameters which are most critical to the design should be most thoroughly measured in the conduct of the oceanographic survey, with less effort expended in assessing perhaps more traditional parameters which have a much lesser effect on design considerations.

a) **Density of Receiving Water**

Density measurements throughout the water column are required in order to estimate the extent of initial dilution occurring over a diffuser. Water density may be determined by calculation from temperature and salinity, conductivity or specific measurements.

b) **Horizontal Ocean Currents**

Horizontal current velocity may be measured by using propeller or cone-type meters suspended at a specific depth.

c) **Horizontal Eddy Dispersion**

Measurement and prediction of the magnitude of horizontal eddy dispersion requires determination of horizontal ocean currents occurring in the horizontally moving wastewater field and of the appropriate eddy diffusivity. Measurements of the diffusivity, or diffusion coefficient, is very difficult and requires sophisticated and complex techniques. The relative dilution effected by eddy dispersion of concern to most wastewater disposal systems, however, is small, permitting a rather gross estimate of the diffusivity without affecting the design substantially. The effect of wave climate on surface and alongshore currents should also be evaluated. The effect of ice accumulation around outfall pipes should also be analyzed.

d) **Decay/Disappearance Rates**

Determination of disappearance rates for specific non-conservative constituents requires, in most cases, special studies wherein a mass of the discharged wastewater containing the constituent is monitored in the receiving environment over a period of time to determine its decay as a function of time. The observed diminution must be corrected for physical dilution that has occurred by eddy dispersion over the period of observation. A tracer material, usually non-toxic fluorescent dye, should be employed in these studies to obtain physical dilution.

e) **Wind Velocity and Direction**

f) **Receiving Water Quality Parameters**

To assure placement of an outfall in an area which will provide the least deleterious effects on the environment and to predict what effects the wastewater discharge will have on the receiving environment, it is necessary to characterize the physical and chemical conditions of the receiving environment and the indigenous flora and fauna in the intertidal zones, in the benthic sediments and in the overlying waters.

Water quality characterization should include dissolved oxygen, pH, temperature, salinity, transparency or turbidity, total and fecal coliforms, BOD, and in some cases, nitrogenous and phosphorous forms. Benthic sediments should be characterized with respect to particle size distribution, organic carbon and nitrogen, dissolved sulfide, heavy metals, and chlorinated hydrocarbons.

Microplankton, macroplankton and nekton populations in the receiving waters may be sampled and their diversity determined. The benthos should be properly examined for specific enumeration, and the extent of biological productivity and diversity should be determined.

g) Benthic Soil

Prior to preparation of engineering plans and specifications the structural characteristics of the benthic soils must be determined. For ease and economics of construction of the outfall, the alignment should not encounter rock outcroppings, and other submerged obstructions, abrupt vertical discontinuities or escarpments. Coring and soil analysis should be performed to determine footing characteristics, and bathometric profiles should be made over a period of time to determine if problems with shoaling and shifting sediments are likely to occur.

2.3.6.3.3 Survey Procedure

Because oceanographic surveys for pollution control facilities are usually restricted by economic and time constraints, it is extremely important to specify a survey program that will provide the most useful and meaningful data within the resources available.

a) Sampling Stations

Sampling station location should be selected to provide an adequate areal coverage of the receiving environment and should be for the most part located at coordinates representing potential diffuser locations and outfall alignments.

Sampling points for certain measurements within the water column should be selected to provide the best representative sample, or samples, of the entire column or of the characteristic under consideration.

b) Current Measurements

Synoptic current measurements throughout the receiving water mass over an extended period of time will provide the best description of the current structure and circulation pattern, but sufficient resources are generally not available for such extensive sampling. A reasonable assessment of a current regime at any particular time can be obtained by taking measurements of current speed and direction near the bottom and top of the water column, and at mid-depth. If the number of current metering points is further limited because of time or other constraints, single-depth current measurements will be most useful at a depth representative of the currents responsible for horizontal movement away from the diffuser following the initial dilution process. In those instances where a pronounced pyenocline exists, the best single depth for measurement would be several meters below the pyenocline. Where there is no such pyeriocline, single-depth measurements at several meters below the surface would usually provide the most useful information.

Coastal currents are affected by lunar tides, major oceanic currents, wind stress, and tributary freshwater discharges, which are all variable in magnitude and effect with respect to time. To obtain a reasonable estimate of the current velocity distribution, therefore, measurements should be taken over a sufficiently long period (preferably one year) to account for the diurnal and seasonal changes.

c) Water Quality Measurements

Water quality characteristics are less variable than current characteristics, but do vary somewhat diurnally and greatly seasonally. Thus, only one or two measurements of water quality characteristics are generally required during a single day several times during a year.

Water quality characteristics can be measured either in situ with direct reading or recording devices or from discrete collected samples. Existing equipment allows in situ simultaneous measurement of DO, pH, transmittance, temperature and conductivity, and easily provides the necessary vertical definition to establish density gradients and pycnoclines. Other measurements, such as nutrient concentrations, must be made from discrete samples collected with an appropriate water sampling device.

d) Biological Parameters

Of the biological parameters, the benthic flora and fauna are the least affected by diurnal and seasonal factors, and thus can be characterized adequately by sampling only several times during a year. Benthic samples can be collected either remotely from a vessel or directly by divers. Remote sampling is performed either with a dredge, which allows for recovery of a disturbed sample, or a coring tool, which provides a relatively undisturbed specimen. Generally, dredges are used for biological characterization of the sediments and corers are employed for physical and chemical assay of the benthic materials.

Several samples are usually taken per time in order to provide an indication of localized sample variation.

A more systematic and specific approach, but also more biased, to benthos characterization is provided by divers who can observe and report on general biological conditions and obtain samples and specimens for later analysis that are highly controlled with respect to size and location.

Because the distributions of the most motile and the floating forms, e.g. microplankton, macroplankton and nekton, are highly time and space dependent, a large number of samples for these organisms must be collected to obtain a statistically significant characterization.

Plankton sampling is usually accomplished by vertical or horizontal tows with appropriately sized netting. Discrete samples collected with conventional water samplers can also be used for plankton enumeration and identification, but this procedure allows for much greater sampling error due to the generally large spatial variations encountered in plankton populations and distributions.

2.3.6.3.4 Equipment

Current Meters

Current meters can be classed either as moored or non-moored, and can be direct reading or recording. Moored recording meters provide an almost continuous record of current velocity, but are restricted because each individual meter is fixed in both the vertical and horizontal plane. Meters operated from a vessel, on the other hand, provide measurements from a variety of depths and locations, but present only an instantaneous sampling of the current regime.

2.3.7 Waste Assimilation Study Field Procedures for Estuaries

2.3.7.1 General Strategies

2.3.7.1.1 Defining Problem and Objectives

An estuary is defined as the tidal mouth of a large river.

Before any field work is carried out on an estuary, the problem(s) should first be defined, and the objectives of the study laid out.

2.3.7.1.2 Preliminary Office Planning

Maps and aerial photographs of the survey area should be obtained, as well as any previous reports on the waterbody and municipal and/or industrial discharges. All discharges to the waterbody should be pinpointed on the map. All existing data on water quality monitoring, water takings and consumption, water uses, flows, and volumes and characteristics of waste discharges should be obtained.

2.3.7.1.3 Preliminary Field Studies

If manpower and time permit, the entire reach of the estuary to be studied should be inspected. Waste discharges, dispersion patterns of effluents, physical characteristics of the estuary, water uses, algal growths, the presence of benthic deposits or organic sludges and any other pertinent characteristics should be noted.

2.3.7.1.4 Boundary Conditions

Boundary condition data are external to the model domain and are driving forces for model simulations. For example, atmospheric temperature, solar radiation and wind speeds are not modelled but are specified to the model as boundary conditions and drive modelled processes such as mixing, heat transfer, algal growth, reaeration, photolysis, volatilization, etc. Nonpoint and point source loadings as well as inflow water volumes are model boundary input. The boundaries at the upstream end of the estuary and the open boundary at the ocean provide major driving forces for change. Models do not make predictions for the boundary conditions but are affected by them.

2.3.7.1.5 Pre-Intensive Survey Planning

In setting limits on wastewater quantity and quality, the following factors affecting estuarine water quality should be assessed: salinity, sediment, bacteria and viruses dissolved oxygen depletion, nutrient enrichment and over-production, aquatic toxicity, toxic pollutants and bioaccumulation and human exposure.

a. **Salinity**

Salinity is important in determining available habitat for estuarine organisms. Large wastewater discharges into relatively small estuaries or embayments can alter the local salinity regime through dilution. Even when the salinity is not affected by the discharge, it is measured and modelled in order to quantify advection and dispersion. These processes help determine how wastewater is assimilated into the estuary.

b. **Sediment**

Sediment enters estuaries from many sources, and can alter the habitat of benthic organisms. Sediment is also an important carrier of such pollutants as hydrophobic organic chemicals, metals, and nutrients. Sediment transport can move pollutants upstream, or between the water column and the underlying bed. Even when wastewater does not introduce excess sediment into an estuary, it is often measured and modelled in order to quantify the transport of sediment-bound pollutants.

c. **Bacteria and Viruses**

Bacteria and viruses may enter estuaries in runoff from farms and feedlots and in effluent from marinas as well as from municipal or industrial wastewater discharges. These pathogens may be transported to bathing beaches and recreational areas, causing direct human exposure and possibly disease. Pathogens also may be transported to shellfish habitat; there they may accumulate in oysters, clams, and mussels and, subsequently, cause disease when eaten by humans.

d. **Dissolved Oxygen Depletion**

Adequate, sustained DO concentrations are a requirement for most aquatic organisms. Seasonal or diurnal depletion of DO, then, disrupts or displaces estuarine communities. Ambient DO levels are affected by many natural processes, such as oxidation of organic material, nitrification, diagenesis of benthic sediments, photosynthesis and respiration by phytoplankton and submerged aquatic vegetation, and reaeration. The natural balance can be disrupted by excessive wastewater loads of organic material, ammonia, and nutrients. Other sources of nutrients, such as runoff from agricultural, residential, and urban lands and atmospheric deposition, can also disrupt the DO balance. Excessive heat input from power plants can aggravate existing problems. Because of its intrinsic importance, and because it is affected by so many natural and man-influenced processes, DO is perhaps the best conventional indicator of water quality problems.

e. **Nutrient Enrichment and Overproduction**

Adequate concentrations of nitrogen and phosphorus are important in maintaining the natural productivity of estuaries. Excessive nutrient loading, however, can stimulate overproduction of some species of phytoplankton, disrupting the natural communities. Periodic phytoplankton "blooms" can cause widely fluctuating DO concentrations, and DO depletion in benthic and downstream areas. Nutrient loads can be introduced in wastewater and runoff and through atmospheric deposition.

f. **Aquatic Toxicity**

High concentrations of ammonia, many organic chemicals, and metals can disable or kill aquatic organisms. Acute toxicity is caused by high exposure to pollutants for short periods of time (less than four days). The toxicity of a chemical can be affected by such environmental factors as pH, temperature, and sediment concentrations. Overall toxicity results from the combined exposure to all chemicals in the effluent and the ambient waters.

g. **Bioaccumulation and Exposure to Humans**

Lower concentrations of organic chemicals and metals that do not cause aquatic toxicity can be taken up and concentrated in the tissues of estuarine organisms. As fish predators consume contaminated prey, bioaccumulation of these chemicals can occur. This food chain contamination can persist long after the original chemical source is eliminated. Humans that regularly consume tainted fish and shellfish can receive harmful doses of the chemical.

Human exposure to harmful levels of organic chemicals and metals can also occur through drinking water withdrawals from fresh water tidal rivers.

2.3.7.1.6 *The Field Survey*

Two general types of surveys may be utilized in estuary modelling. These are described as: those used to identify short-term variations in water quality and those used to estimate trends or mean values.

a. **Intensive Surveys**

Intensive surveys are intended to identify intra-tidal variations or variations that may occur due to a particular event in order to make short-term forecasts. Intensive surveys should encompass at least two full tidal cycles of approximately 25 hours duration. Intensive surveys should usually be conducted regardless of the type of modelling study being conducted.

Wherever possible, all stations and depths should be sampled synoptically. For estuaries that are stationary wave systems (high water slack occurs nearly simultaneously everywhere), this goal may be difficult to achieve due to the logistics and manpower required. Synoptic sampling schemes are constrained by distance between stations, resources in terms of manpower and equipment, and other factors which may limit their applicability. Where it is not possible to sample synoptically, careful attention should be given to the time of collection. For some estuaries, where movement of the tidal wave is progressive up the channel, sampling the estuary at the same stage of the tide may be possible by moving upstream with the tide to obtain a synoptic picture of the water quality variations at a fixed tide stage, that is a lagrangian type of sampling scheme. Sampling should not be conducted during unusual climatic conditions in order to ensure that the data is representative of normal low flow, tidal cycle and ambient conditions.

Boundary conditions must be measured concurrently with monitoring of the estuary. In addition, a record of waste loads during the week prior to the survey may be critical. It is necessary to identify all of the waste discharging facilities prior to the survey so that all waste discharged can be characterized. Estimates of non-point loads are also required.

Where project resources limit the number of samples, an alternative may be to temporally integrate the samples during collection or prior to analysis. This will, however, not provide information on the variability associated with those measurements.

b. **Trend Monitoring**

Trend monitoring is conducted to establish seasonal and long-term trends in water quality. Intensive data is not sufficient to calibrate and validate a model which will be used to make long-term projections, due to differences in the time scales of processes affecting those projections. Trend sampling may take place on a bi-weekly or monthly basis. Stations should be sampled at a consistent phase of the tide and time of day to minimize tidal and diurnal influences on water quality variations. Diurnal variations must still be considered, however, tidal affects may be less important in wind dominated estuarine systems. Care should be exercised to sample during representative conditions and not during unusual climatic events in order to allow comparison between sampling times. Some stations may be selected for more detailed evaluation. Intensive surveys, spaced over the period of monitoring, should also be considered where the trend monitoring will be used to track changes in parameters between intensive surveys.

Boundary data should generally be measured at a greater frequency than estuarine stations used for monitoring trends. Boundary conditions are critical in that they will drive the model used for waste load allocation. The rate at which the boundary conditions are expected to change will indicate the time scale required for boundary sampling. Tiered or stratified sampling programs may be required which include different sampling strategies, such as between low and high flow periods. The more intensive boundary data will provide an estimate of the mean driving forces for the model as well as their associated variability.

2.3.7.2 *Survey Procedures*

2.3.7.2.1 *Spatial Coverage*

An intensive spatial coverage of the estuary for some indicator or surrogate water quality parameter, such as: salinity or turbidity, is generally needed in order to estimate spatial variability, as well as determine the model type and segmentation required.

Generally, the spatial grid for an estuarine model should extend from above the fall line, or zone of tidal influence, to the open boundary of the estuary. The last gauging station is often a good upper boundary since they are typically placed outside of the region of tidal influence. In some cases the ocean boundary will extend beyond the estuary into the ocean to insure a representative boundary condition or to allow use of tidal gauge information collected at some point away from the estuary.

Where simple waste load allocation studies are planned on a portion of an estuary, and it is unrealistic to model the entire estuary, then the spatial grid may be delimited by some natural change in depth or width, such as a restriction in the channel or regions where the velocity and water quality gradients are small. The spatial grid must encompass the discharges of interest in all cases.

Sampling stations should generally be located along the length of the estuary within the region of the model grid, with stations in the main channel margins and subtidal flats for the intensive surveys. Lateral and longitudinal data should be collected, including all major embayments. The spatial coverage required is governed by the gradients in velocities and water quality constituents. Where no gradients exist, then a single sample is sufficient. Some caution should be exercised in the selection of the indicator parameter for this decision. For example, strong vertical dissolved oxygen gradients may occur in the absence of velocity, thermal or salinity gradients. Two areas where cross-channel transects are generally required are the upper and lower boundaries of the system.

The spatial coverage should consider the type of model network to be used. For model networks with few, large segments, several stations (e.g. 3-6) should be located in each model segment in order to estimate spatial variability. For detailed models with many segments, it may not be possible to determine the parameters for each segment. For initial conditions and model evaluation, sufficient samples should be collected to estimate missing data by interpolation.

Where resources are limited, one possible monitoring strategy is to spatially integrate samples, such as over depth or width depending on the modelling approach used. Careful consideration will need to be given to the integration scheme for this type of monitoring. For example, a flow weighted integration would require some prior knowledge of the fraction of the total flows associated with all sampling stations.

2.3.7.2.2 *Estuary Bathometry*

Data are always required to determine model morphometry. Morphometry affects the characterization of the estuary and the type of modelling approach required. Estuarine depth controls propagation of the tidal wave. Shallow channels and sills increase vertical mixing while deep channels are more likely to be stratified with greater upstream intrusion. Deep fjords with shallow sills usually have little circulation and flushing in bottom waters. The length of the estuary determines the type of tidal wave, phase between current velocities and tidal heights. The width effects velocities (narrow constrictions increase vertical mixing and narrow inlets restrict tidal action). Wind-induced circulation is transient and interacts with channel geometry to produce various circulation patterns and affects vertical mixing and sediment transport. Bathometric data are available from the Canadian Hydrographic Service.

For certain estuaries, the affects of tidal marshes can dramatically effect estuarine circulation and water quality. These are generally some of the more difficult systems to model. An initial decision may be whether to measure flows and quality and provide information to the model as boundary conditions or to attempt to model them. Where modelling is required then the corresponding bathometry data must be collected.

2.3.7.2.3 *Transport*

Either description or prediction or transport is essential to all waste load allocation studies. All mechanistic waste load allocation models are based on mass balance principles, and both concentrations and flows are required to compute mass rates of change. For example, a loading to the system is expressed in units of mass/time, not concentration. Essential physical data required for prediction of description of transport are listed as follows:

Morphometry Data:	Channel Geometry, "roughness" or bottom type.
Hydrodynamic Data:	Water surface elevations Velocity and direction Incoming flow Point and distributed flows
Meteorological Data:	Solar radiation Air temperature Precipitation Wind speed and direction Wave height, period and direction Relative humidity Cloud cover
Water Quality Data:	Salinity Water temperatures Suspended sediments Dye studies

The type of data used to quantify transport depends upon the model application and the characteristics of the system.

For complex estuaries, time varying flows, depths, and cross sections will make estimation of flows and dispersion from field data difficult. Then the flows have to be measured, estimated from dye studies, estimated by trial and error methods, or obtained from hydrodynamics studies. However these parameters are determined they must adequately reflect the flushing characteristics of the system. Data requirements for flow measurement and hydrodynamic modelling are discussed below.

Flow Measurement

Flow measurements can be used directly in waste load allocation models or be used to aid in the calibration and validation of hydrodynamic models. Tidal current is determined by placing a network of current meters at selected stations and depths throughout the estuary and measuring velocities over time. A tidal velocity curve can then be constructed. The data measured at different points can be integrated over space (i.e. laterally or vertically) and/or time depending on the needs of the water quality model. Data from the flow measurements should be evaluated when incorporated into models to insure that continuity is maintained and that constituents are properly transported.

Freshwater inflow measurements may be available for major tributaries from Federal or Provincial agencies. The frequency at which data are required must be assessed in the context of how rapidly flows are changing. Generally, hourly and often daily data are sufficient. Flows must be estimated for ungauged tributaries and where the influence of ungauged tributaries is appreciable, a flow monitoring program initiated. Groundwater inflows or flows from direct runoff may be estimated from flow gauges available in the fluvial portion of most large drainage basins. Inflows from point source discharge including municipal and industrial sources and combined sewer overflows are essential input to any model.

Dye Studies

Dye and time of travel studies are often one of the better sources of data for estimating dispersion coefficients, computing transport or for calibration and confirmation data for hydrodynamic models. Dye studies can be conducted with injections toward the mouth of the estuary or in areas where there is the greatest uncertainty in model predictions. For example, dye studies can be used to estimate mixing in the freshwater portion of a tidal river where no salinity gradients occur.

The type of dye study conducted varies with the study objectives. Studies may involve continuous or slug releases of the tracer dye. Continuous discharges are particularly useful in estimating steady-state dilution levels while slug studies are often useful for estimating dispersion coefficients or for calibrating and testing hydrodynamic models.

Continuous tracer studies generally release dye over one or more tidal cycles or discharge periods, which is then monitored within the estuary at selected locations over a series of tidal cycles. Monitoring of continuous dye releases may be continuous or concentrate on initial dilution and successive slack tides to obtain wastewater dilution levels for initial dilution, high and low slack tides or tidally averaged conditions.

Some caution should be exercised in that dyes injected at a point will have different travel times from those mixed over the modeled dimensions. For example, for a one-dimensional (longitudinal) model it may be preferable to distribute the dye as a vertically mixed band across the estuary.

A variety of dye types may have been used. The most common dye presently in use is Rhodamine WT. Generally boat mounted continuous flow fluorometers can be best used to locate and track a dye cloud or to obtain dye concentrations at discrete stations. Some consideration should be given to the toxicity of the dye as well as to its degradation by chlorine in studies of treatment facilities or its absorption onto particulates and macrophytes. Rhodamine WT is also slightly more dense than water and may require adjustment to obtain neutral buoyancy. The background florescence should be determined to aid in determining quantities of dye to be released and subtracted from field measurements. Care should also be exercised to schedule dye studies to avoid non-representative meteorological conditions.

2.3.7.2.4 *Water Quality*

The water quality data required, beyond that needed to quantify transport will vary depending on how the variables will be used and their anticipated impacts on the waste load allocation analysis. In addition, the water quality data required will vary depending on the anticipated response time of the system to changes in the value of the variable. For example, processes that vary over long time scales, in relation to the period of modelling, are often assumed to have a constant effect over the period of simulation. Sediment oxygen demand and sediment release rates are often treated in this way.

Data requirements will vary if the waste load allocation is intended for dissolved oxygen, eutrophication or toxics. Variables critical for an analysis of toxicity, such as pH for ammonia and metals, may not be required if the parameter of interest is DO. If the waste load is not expected to impact particular variables, such as pH, then it may be sufficient to use available data to determine their effects. If however, data are not available for conditions of interest, or if the variable is expected to change, either directly or indirectly, in response to the loading, then modelling may be required as well as collection of additional supporting data.

Without limiting the number of possible water quality parameters, some of the more commonly measured variables include:

Salinity or Conductivity
Temperature
Suspended Solids
Dissolved Oxygen
BOD_5
Total Phosphorus
Total Kjeldahl Nitrogen
Nitrate-Nitrogen
Nitrite-Nitrogen
pH
Toxicity
Coliform Bacteria

Some variables, such as dissolved oxygen (DO) are suggested for all studies. DO can provide general information about the estuaries capacity to assimilate polluting materials and support aquatic life. The specific type of data for a particular application will vary depending on the level of effort required for the study. Concentrations for all pertinent water quality variables should be provided at the model boundaries, as well as at stations within the model system.

Measurements of processes impacting water quality may be required in addition to concentration measurements. For example, strongly sorbed contaminants are strongly affected by sediment interactions, including re-suspension, settling, and sedimentation. Some independent measurement of these processes may be required to reduce model uncertainty.

2.3.7.2.5 *Station Selection*

All stations for data collection should be well described and documented in order to insure that they are re-established during subsequent sampling periods. Stations can be established using an easily determined distance from some permanent structure or landmark. However, care should be exercised to insure that the stations are not located near some structure which would make them unrepresentative. Stations can be relocated using electronic positioning equipment such as range instruments, radar or Loran if they are sufficiently accurate to allow relocation within an acceptable distance. Methods should be established for maintaining positions at stations during sampling. Records of arrival and departure times for each site as well as surface observations should be made during each sampling period.

2.3.8 Waste Load Allocation Modelling

2.3.8.1 General

Because of the wide array of variable elements that must be considered in assessing a receiving water's assimilative capacity, computerized mathematical models are generally employed to make the necessary calculations. In the simplest situations, manual calculations can be performed. In most cases, however, the use of computerized mathematical models will be much more convenient.

2.3.8.2 Model Selection

2.3.8.2.1 *General*

The initial step of any waste load allocation study is to define the nature and the extent of the problem. Once this is done, the preferred approach in model selection is to use the simplest model that can be applied to a particular case. Ideally, the model should include only those phenomena that are operative and important in the receiving water being modeled. The most appropriate procedure for selecting a model is, therefore, to first define the phenomena that are important for the particular site-specific analysis to be performed. Activities that help to define phenomena that should be incorporated include the following:

a) review of existing data on waste loads, and receiving water quality;

b) preliminary mass balance calculations using simple models or equations that provide analytical solutions for various load sources (combined sewer overflows, nonpoint sources, sediment) and reaction phenomena.

It is also desirable to attempt to anticipate the technical issues with respect to control actions (level of treatment, alternate discharge locations, etc.) and determine whether this will influence the types of reactions that will be important. From the foregoing, the analyst will generally be able to establish the phenomena that should be included in the selected model and the time and space scale of the analysis which is most appropriate.

Under ideal circumstances, one would select a formal model or analysis approach that included all the phenomena determined to be important in the study area, and which excluded those reactions that are insignificant in the case in question. While this guidance should be followed as much as possible, in practice a calculation framework or model may be selected because it is available or familiar to the analyst.

In such cases, two criteria are important to apply. First, the model selected must be capable of handling all of the important site-specific phenomena considering the time and space scale of the analysis and using the equations and formulations specified. Secondly, provision should be made, where possible, to eliminate from the calculation framework the effect of any phenomena that are insignificant in the site-specific analysis. In some cases, inclusion of phenomena judged to be unimportant on a site-specific basis can increase the level of uncertainty of the analysis and thus directly affect decisions. In these situations, additional data collection, sensitivity runs, and other aspects of the overall waste load allocation program must be considered, in order that phenomena contained in the calculations are adequately addressed.

Additional evaluation criteria for model selection include completeness of computer program documentation, costs for manpower, and computer time.

2.3.8.2.2 *Model Selection Guidelines*

Guidelines for selection of a model fall under two categories: technical and operational. The technical guidelines ultimately are concerned with matching the model capabilities to the important physical and biochemical processes of the prototypical system. The operational guidelines are concerned with the ease and cost associated with model operation.

The following is the sequence of model selection guidelines, with a brief discussion of the considerations involved.

Technical Guideline #1

Determine Important Features of the Prototypical System That are Required in the Analysis

Site-specific data should be collected and reviewed to understand the system and establish the important factors associated with the identified problem. Valuable information can also be obtained from other experienced professionals, especially those who have modelling experience or site-specific field experience, and from personal site visits.

Technical Guideline #2

Review Available Models and Model Capabilities

There are a wide number of models available capable of performing waste load allocations. It is important to be aware of those capabilities that involve a substantial increase in complexity.

Technical Guideline #3

Match Important Features of the Prototypical System With Model Capabilities

An important step in model selection is comparing the important features of the prototypical system with the model capabilities and selecting, as technically acceptable, those models whose capabilities match the features of the system. A rule of thumb is to select the simplest model(s) that retains all important features in the prototypical system. Choosing a more complex model is not cost effective since data requirements and computer cost tend to increase rapidly. An overly complex program will not usually result in an improved simulation and may increase uncertainty in the analysis.

Technical Guideline #4

Confirm Selection of Technically Acceptable Models

To confirm that the models are indeed technically appropriate, the potential user should consult the user's manual and other support documents, contact and discuss the potential application with members of the support agency, and consult with other experienced professionals.

Operational Guideline #1

Selection of Candidate Models Based on Ease of Application

Once a technically acceptable model has been selected, it is necessary to estimate the ease of applying it. However, it is very difficult to evaluate the adequacy of documentation and support and realistically estimate costs without prior experience with the model. Therefore, it is recommended that the support agency be consulted. It may be possible that special support arrangements (including short courses or informational or personnel exchanges) are available under existing agreements or otherwise could be made available to the potential user. The support agency may also be able to provide the potential user with a list of local users who could be contacted for information regarding their past or current experience with the computer program associated with the model.

Operational Guideline #2

Selection of Candidate Models Based on Cost of Application and Problem Significance

It is difficult to estimate overall costs involved in a model application because each application differs in scope and complexity, and the ability to solve or avoid certain problems is very dependent on the experience and technical background of the analysts involved. However, machine requirements and costs associated with typical runs are usually estimated in the program documentation. As a rule, the simpler the model, the less expensive it is to apply. Again, it is essential that the support agency and other experienced professionals be contacted for information or assistance.

Once an estimate of the costs of application has been made, it should be compared with the benefits of using the program as part of the water quality modelling effort and the overall importance of the problem. In other words, the WLA study costs should be consistent with the economic, social, or environmental values associated with the problem and its solution.

Operational Guideline #3

Selection of Candidate Models Based on Data Availability and Data Acquisition Costs

All models require data for input, calibration, and verification. It is best if model selection is not restricted by availability of data and the decision is made to acquire the specific type of data required for the model. On the other hand, if data availability is a constraint, selection of a less sophisticated model than would be warranted on technical grounds may be appropriate.

SUMMARY:

The first step in model selection is to determine which programs are technically acceptable, based on an understanding of the important physical and biochemical processes in the prototypical system. The second step is to determine the ease and costs of application of those which are technically acceptable. The result of the second step is a list of candidate models which may or may not be ranked according to convenience and cost. The final selection of the preferred model from the list of candidates is based on the overall judgment of the potential user taking into account all of the factors discussed.

2.3.8.3 Modelling Procedures

Figure 2.2 outlines the typical development of a site specific water quality model.

2.3.8.3.1 Initial Assessment

The first three steps in Figure 2.2 contribute to the initial assessment activity. The historical data are reviewed and employed in conjunction with initial model runs, which compare calculated and observed water quality to:

- confirm existing or future water quality problems.
- define the loads, sources, and sinks that control water quality.
- define the important reactions that control water quality.
- define issues in the area of transport that must be resolved.

The initial assessment is the first step of the process aimed at understanding the factors controlling water quality. The initial assessment activity is a first full step in understanding quantitatively the factors controlling water quality. It is not a preliminary analysis; instead, the initial understanding is translated into a field and experimental program whose data output begins to challenge and strengthen the understanding of the system.

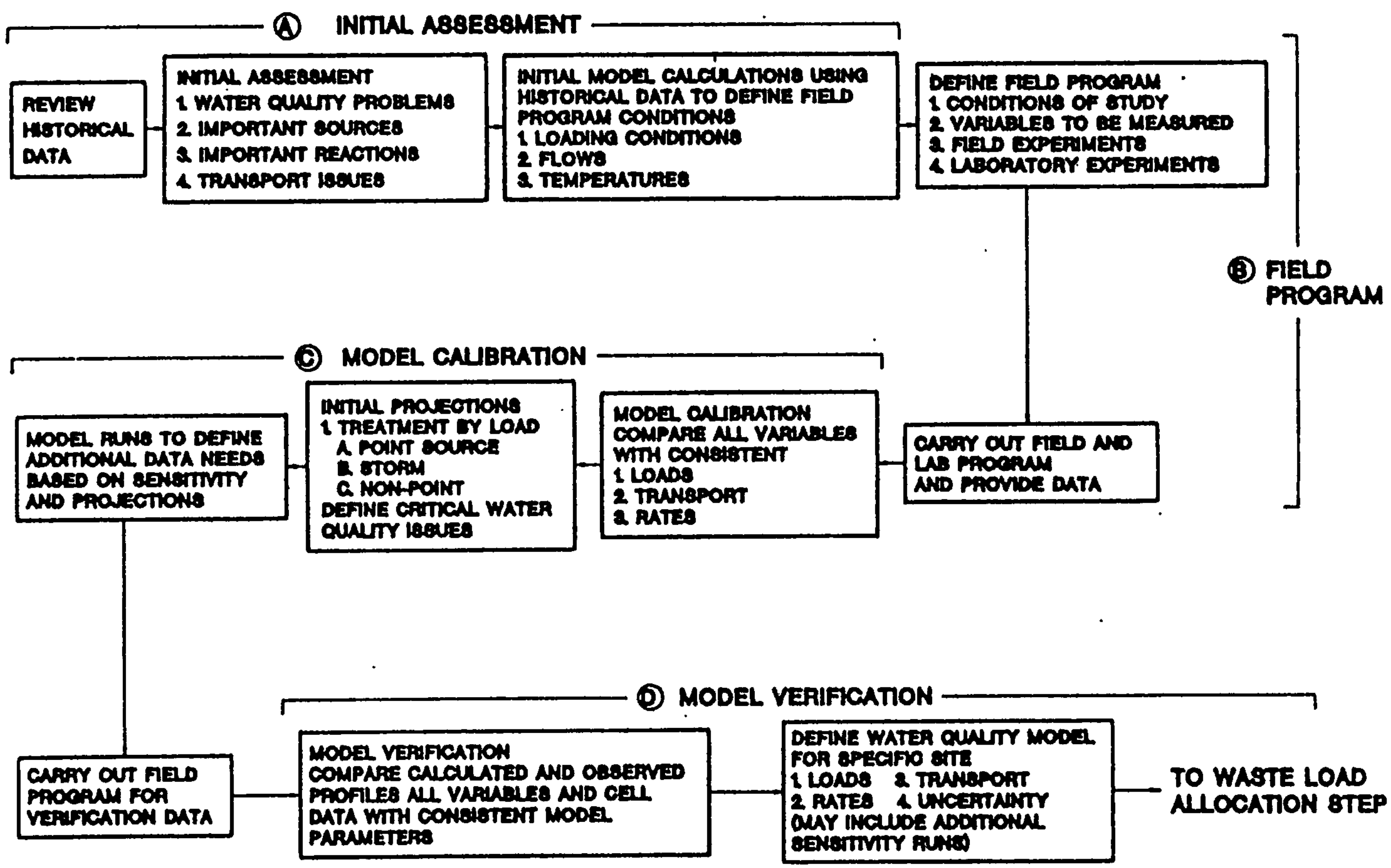
2.3.8.3.2 Field Program

This task translates the results of the initial assessment into a practical field program that can be carried out on the receiving water and in the laboratory using the resources and manpower required and/or available.

2.3.8.3.3 Model Calibration

Following the selection of an appropriate model and the collection of the relevant field data, it is necessary to calibrate the model. Model calibration is necessary because of the semi-empirical nature of present day water quality models.

FIGURE 2.2 - STEPS IN THE DEVELOPMENT OF A SITE SPECIFIC WATER QUALITY MODEL



In model calibration activities, the data from the field program are employed to define model criteria, constants and equations. Water quality calculations using the model are developed for the various conditions associated with each of the water quality data sets. These conditions include those associated with the historical data and the data collected in the field program. Adjustments in the value of model parameters must be made in a consistent fashion for all conditions. The results of these activities are a set of consistent model parameters, which are then employed to develop water quality calculations for the conditions associated with all available data sets. Comparisons of calculated and observed water quality profiles should be developed. The model runs and calculations employed to search for and define the series of consistent coefficients should be retained since they can provide an indication of system sensitivity.

2.3.8.3.4 *Model Verification*

At this stage in the modelling process, a calibrated model has been developed. The next step involves a test of the adequacy of the model in terms of decisions required in the waste load allocation study. Without validation testing, the calibrated model remains a description of the conditions defined by the calibration data set. The uncertainty of any projection or extrapolation of a calibrated model would be unknown unless this is estimated during the validation procedure.

Model verification efforts should contain activities similar to those discussed under model calibration. In general, model parameters should not be altered in the verification analysis. If changes in these model inputs are required, the changes should be entered for all data sets including historical, calibration, and verification data.

Comparison between observed and calculated water quality for all data sets should be developed. Sensitivity analyses should be conducted on model parameters so as to determine which parameters have the greatest impact on model predictions.

The next step in the process is to define a site-specific water quality model that consists of:

- A single set of model parameters that were developed and used in the calibration and verification analysis. These parameters should be uniform in space and time varying only as defined below.

- A set of rules for variation of model parameters in terms of measured information, such as temperature, flow, loads, geometry, etc. The rules for variations of parameters should be those used in the calibration and verification activities.

- A range of values for model parameters that cannot be adequately defined by a single value. The range of parameters, determined from sensitivity analysis, should be used in all projections.

- The quantitative and qualitative measures of model adequacy, including graphs, statistics and appropriate discussions.

2.3.8.3.5 *Allocating Waste Loads*

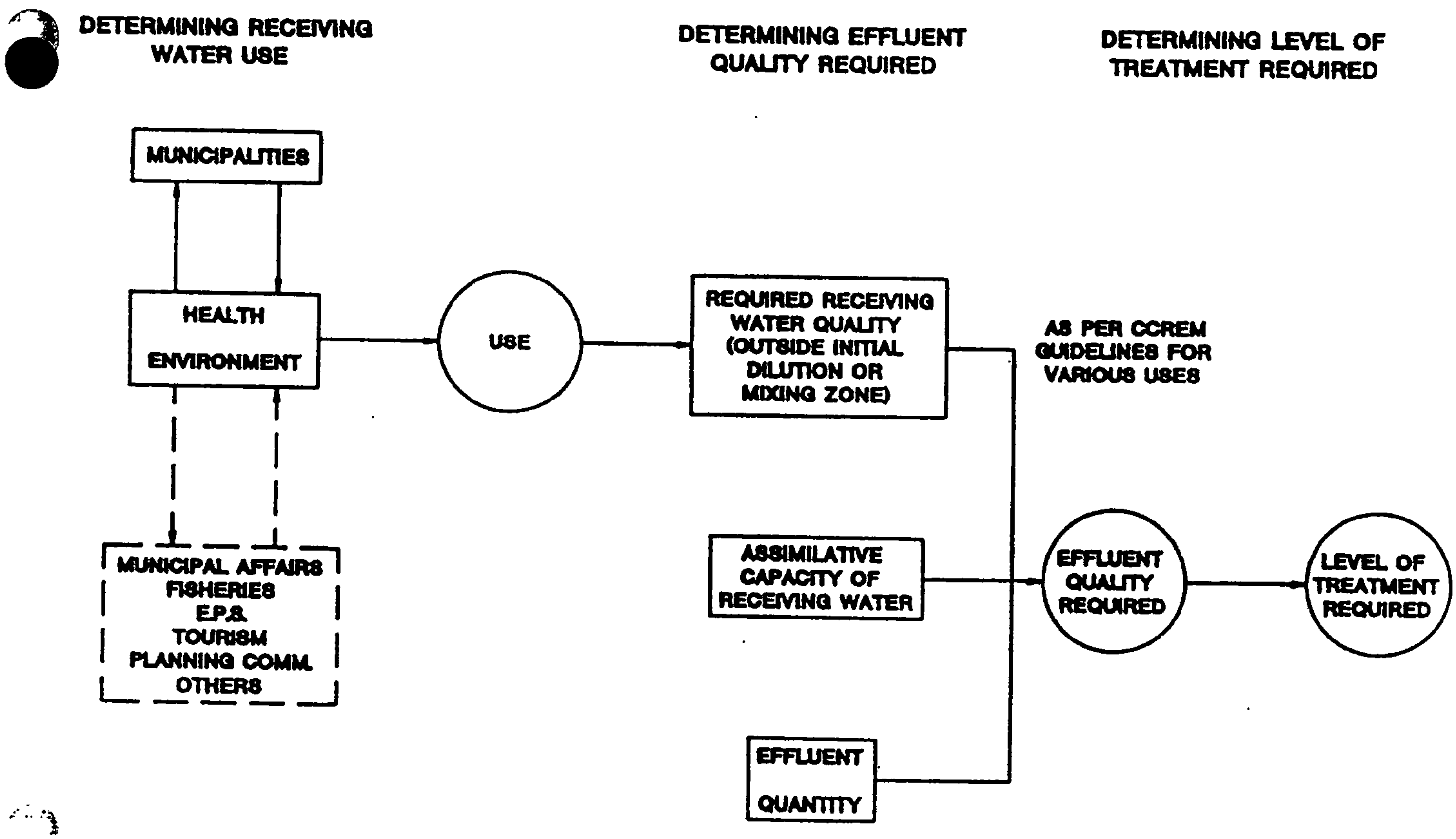
The purpose of the waste load allocation analysis is to define the quantity of waste that may be discharged into a receiving water while meeting the water quality objectives.

The initial requirement is to quantitatively define the critical conditions that will control waste load allocations. There may be one or more critical conditions that should be considered.

Once the critical conditions are established, the calibrated model can be used to predict the water quality response due to various loads. With the model in place, the regulatory agencies shall determine the receiving water use, and thus the required receiving water quality (as outlined in the CCREM guidelines). By varying the loads from the calibrated model, it is then possible to determine required effluent quality and the associated level of treatment required. This procedure is illustrated in Figure 2.3.

FIGURE 2.3

SCHEMATIC REPRESENTATION OF PROCEDURE FOR ESTABLISHING REQUIRED LEVEL OF TREATMENT



3.1 PLANT CLASSIFICATION

3.1.1 General

It is necessary to classify facilities according to their "degree of difficulty to operate". All municipal wastewater facilities within Atlantic Canada be classified by the appropriate regulatory agency. A facility Classification Certificate may then be issued for each facility.

The regulatory agency, upon application of a predesignated form, should classify all wastewater collection systems and treatment plants. The Classification shall take due regard to size, type and character of the wastewater to be treated, and other physical conditions affected by such treatment plants and distribution systems and according to the skill, knowledge, and experience required of an operator.

3.1.2 Classification System

Facilities shall be classified in one of four classes designated as Class I, II, III, or IV according to complexity of operation (with Class IV being the highest). Classification of treatment plants shall be based on a point system in accordance with Table 3.1 and 3.2. Classification of collection and distribution systems shall be based upon population served.

3.1.3 Classification Changes

Classification of any facility may be changed at the discretion of the regulatory agencies by reason of changes in any condition or circumstance upon which the original classification was predated. Due notice of any such change shall be given to the owner of the facility.

3.1.4 Classification Certificate

On satisfactory fulfilment of the requirements provided herein and based on the approval of the appropriate regulatory agency, a suitable certificate to the applicant designating the plant or system classification shall be issued.

Certificates of classification shall be permanent unless revoked for cause or replaced by one of a higher class.

TABLE 3.1 - FACILITY CLASSIFICATION SYSTEM

Facility	Units	I	II	III	IV
Wastewater Collection (WWC*)	Pop Served	1500 or less	1501 - 15,000	15,001 - 50,000	50,000 & greater
Wastewater Treatment (WWT)	Range of Points	30 or less	31 - 55	56 - 75	76 & greater

* Simple "in-line" treatment (such as booster pumping or preventive chlorination or odour control) is considered an integral part of a collection system.

TABLE 3.2 - POINT SYSTEM CLASSIFICATION OF WASTEWATER TREATMENT PLANTS (WWT)

Item	Points
Size	
Maximum population equivalent (PE) served, peak day	1 pt. per 10,000 PE or part (Max 10).
Design flow (avg. day) or peak month's flow (avg. day), whichever is larger	1 pt. per MGD or part (Max 10).
Effluent Discharge	
Receiving stream (sensitivity)	2-6 *
Land disposal-evaporation	2
Subsurface disposal	4
Variation in Raw Wastes (slight to extreme) .	0-6 **
Pretreatment	
Screening, comminution	3
Grit removal	3
Plant pumping of main flow	3
Primary Treatment	
Primary clarifiers	5
Combined sedimentation digestion	5
Chemical addition (except chlor., enz.)	4
Secondary Treatment	
Trickling filter w/sec. clarifiers	10
Activated sludge w/sec. clarifiers (including ext. aeration and oxidation ditches)	15
Stabilization ponds without aeration	5
Aerated lagoon	8
Advanced Water Treatment	
Polishing pond	2
Chemical/physical - without secondary	15
Chemical/physical - following secondary	10
Biological or chemical/biological	12
Ion exchange	10
Reverse osmosis, electrodialysis	15
Chemical recovery, carbon regeneration	4
Oxygen generation on-site	5

Solids Handling	
Thickening	5
Anaerobic digestion	10
Aerobic digestion	6
Evaporative sludge drying	2
Mechanical dewatering	8
Solids reduction(1) Incineration	12
(2) Wet oxidation	12
Disinfection	
Chlorination or comparable	5
On-site generation or disinfection	5
Laboratory Control by Plant Personnel	
Bacteriological (complexity)	3-10 ***
Chemical/physical (complexity)	1-10 ****

* These items are based on judgement and should be given the higher number of points for greater complexity. (See Point System Guidelines (WWT)).

POINT SYSTEM GUIDELINES (WWT)

*** Effluent Discharge**

Receiving stream sensitivity
The key concept is the degree of dilution provided under low flow conditions. Suggested point values are:

"Effluent limited segment in EPA terminology secondary treatment is adequate	2
More than secondary treatment is required	4
"Water quality limited segment" in EPA terminology: stream conditions are very critical (dry run, for example) and a very high degree of treatment is required	6

**** Variation in Raw Wastes (slight to extreme)**

The key concept is frequency and/or intensity of deviation of excessive variation from normal or typical fluctuations; such deviation can be in terms of strength, toxicity, shock loads, I and I, etc. Suggested point values are:

Variations do not exceed those normally or typically expected	0
Recurring deviations or excessive variations of approximately 100% in strength and/or flow	3
Recurring deviations or excessive variations of approximately 200% in strength and/or flow	6

***** Laboratory Control by Plant Personnel**

Bacteriological/biological (complexity).
The key concept is to credit bacti/bio lab work done on-site by plant personnel. Suggested point values are:

Lab work done outside the plant	0
Membrane filter procedures	3
Use of fermentation tubes or any dilution method	5
Biological identification	7
Virus studies or similarly complex work conducted on-site	10

**** **Chemical/Physical (complexity)** The key concept is to credit chemical/physical lab work done on-site by plant personnel. Suggested point values are:	
Lab work done outside the plant	0
Push-button or visual methods for simple tests such as pH, settleable solids - up to	3
Additional procedures such as DO, BOD, titration, solids, volatile content - up to	5
More advanced determinations such as COD, gas analysis, specific constituents - up to	7
Highly sophisticated instrumentation such as atomic absorption and gas chromatography	10

3.2 OPERATOR CERTIFICATION

3.2.1 General

Owners of municipal wastewater facilities may be required to have one or more operators certified at the same level as the facility classification or higher. This requirement will be mandatory in Nova Scotia as of January 1, 1997, for Class I facilities; as of January 1, 1998, for Class II facilities; as of January 1,1999, for Class III facilities; and as of January 1, 2000, for Class IV facilities. In New Brunswick, Newfoundland, and Prince Edward Island, certification requirements are being administered under a voluntary certification program. If and when operator certification becomes mandatory in these provinces, levels achieved under the voluntary program will still be valid.

3.2.2 Operator Pre-Requisites

The minimum prerequisites for operator certification at the various levels are shown in Table 3.3. The specific requirements for education/experience for each of the levels of certification are further defined in the sections following.

TABLE 3.3 - OPERATOR CERTIFICATION PRE-REQUISITES

Operator Class		WTT	WWC
Op-in-trng	Education Experience	12 (a)	12 (a)
I	Education Experience	12 1	12 1
II	Education Experience	12 3	12 3
III	Education Experience DRC	14 4 (2)	14 4
IV	Education Experience DRC	16 4 (2)	16 6

WWT - Wastewater Treatment
WWC - Wastewater Collection
DRC - Direct Responsible Charge

(a) Three (3) months operating experience or completion of an approved basic training course. It is recognized that the position operator-in-training (OIT) is not a legally required position. It is included here to illustrate a method of encouraging new entrants in the field to enter into the certification program.

3.2.3 **Experience Requirements**

"Operating experience" is defined as time spent at a plant or system in satisfactory performance of operation duties.

"Direct responsible charge" (DRC) is defined as follows:

(a) In smaller facilities where shift operation is not required, DRC experience is:

1) Active, daily, on-site charge, and performance of operation duties in the same or next lower certification class.

(b) In large facilities where shift operation is required, DRC experience is defined as both:

1) Active, daily, on-site technical direction, and supervision of operation duties in the same or next lower certification class; and/or

2) Active, daily, on-site charge of an operating shift, or a major segment of a system or facility in the same or next lower certification class.

3.2.4 **DRC Requirements**

"Class I or II" - For Class I or Class II certification, DRC experience is not required.

"Class III - For Class III certification, one-half of the operating experience requirement must be DRC experience gained:

(a) in Class II, if in a top supervisory position, and as specified in the definition of DRC experience, or

or

(b) in Class II or higher, in on-site charge, and as specified in the definition of DRC experience.

"Class IV" - For Class IV certification, one-half of the operating experience requirements must be DRC experience gained:

(a) in Class III, if in a top supervisory position, and as specified in the definition of DRC experience, or

(b) in Class III or higher, in on-site charge, and as specified in the definition of DRC experience.

"Collection and Distribution" - DRC experience is not required for wastewater collection.

3.2.5 **Substitutions**

"Class I" - No substitution for experience requirement for Class I is permitted.

"Class II, III or IV" - Substitutions may be made for required experience in Classes II, III and IV, but with the limitation that 50 percent of any stated experience requirement (both operating and DRC) must be met by actual on-site operating experience in a plant or system.

3.2.6 **Formal Education Substituted for Experience**

"School" - High school education cannot be credited for substitutional value toward any experience requirement, high school education is in itself a basic requirement for certification at any level.

"Post-High School" - Approved relevant formal academic education at the post-high school or college level may be substituted for experience requirement (either operating or DRC) on a year-for-year basis, subject to the 50 percent limitation previously described.

"Note" - Education applied in substitution for an experience requirement cannot also be applied to the education requirement.

3.2.7 **Experience Substituted for Formal Education**

Substitutions may be made for required formal education, subject to the following criteria:

"Grades 1-12" - 1 year of operating experience (operating or DRC) may be substituted for 2 years of grade school, without limitation.

"Class III" - A maximum of 1 year of DRC experience in a Class II (or higher) position may be substituted for 1 year of post-secondary formal education requirement for Class II certification.

"Class IV" - A maximum of 1 year of DRC experience in a Class III (or higher) position may be substituted for 1 year of post-secondary formal education requirement for Class IB certification.

"Note 1" - Experience applied in substitution for an education requirement cannot also be applied to the experience requirement.

3.2.8 **Examinations**

Once qualified under the education and experience requirements, an operator must pass an exam approved by the regulatory agencies in order to be certified.

3.3 MONITORING REQUIREMENTS

A monitoring program, including regular sampling of sewage treatment systems effluent and recording of flows, shall be undertaken by the systems operating authority/owner. This monitoring program should be carried out in compliance with sampling and analysis requirements set by the appropriate regulatory agency.

A typical sampling frequency for compliance is presented in the following table:

Plant Class	Sampling Frequency
I	6/year
II	2/month
III	2/month
IV	1/week

Samples should be 24-hour composite samples, except for those collected at lagoons, which may be grab samples. Samples shall be analyzed for BOD_5, suspended solids and fecal coliforms. Additional parameters requiring sampling shall be listed in the "Approval to Operate" or " Certificate of Approval".

3.3.1 Owner/Operator Responsibility

The owner/operator of any wastewater treatment or collection facility shall be responsible for conducting all compliance sampling. The owner/operator shall ensure that all compliance sampling is conducted in accordance with Policy Section 3.4 and in the stipulations of the "Approval to Operate" or "Certificate of Approval".

3.3.2 Regulators Agencies' Responsibility

The regulatory agency shall be responsible for enforcing compliance requirements, as described in Policy Section 3.4, on any wastewater treatment or collection facility.

3.4 COMPLIANCE REQUIREMENTS

A sewage treatment plant shall be considered in compliance with the effluent limitations if 80 percent of the sample test results, the frequency and number of which are specified by the regulatory authority, meet the required standard for that plant. No single result can be greater than two times the required standard for the plant.

3.5 REPORTING REQUIREMENTS

The operator/authority/owner shall ensure that all monitoring results are submitted to the appropriate regulatory agency.

4.1 APPLICATION FOR APPROVAL

The regulatory authorities require that application for approval shall be made in writing by a person responsible for the construction, modification, or operation of sewage works. The application shall be submitted to the appropriate regulatory agency.

An application for the construction or modification of sewage works shall include engineering reports, plans and specifications and all other information which the regulatory agencies may require.

Approval in principle of preliminary reports and plans (concept approval) shall not constitute official approval. No approval for construction or modification can be issued until final detailed plans and specifications have been submitted to the regulatory agency and found to be satisfactory. Such works shall not be undertaken until an official "Certificate of Approval" bearing the necessary signatures has been issued by the Minister of the appropriate regulatory agency.

All final reports, plans and specifications should be submitted at least 90 days prior to the start of the construction or modification. The reports, plans or specifications shall be stamped with the seal and signature of the designing engineer, licensed to practice in the Province of application.

The application shall include sufficient design information and two complete sets of plans and specifications submitted directly to the appropriate regulatory agency.

Engineering services are performed in four (4) steps:

a) preliminary evaluation;

b) pre-design report;

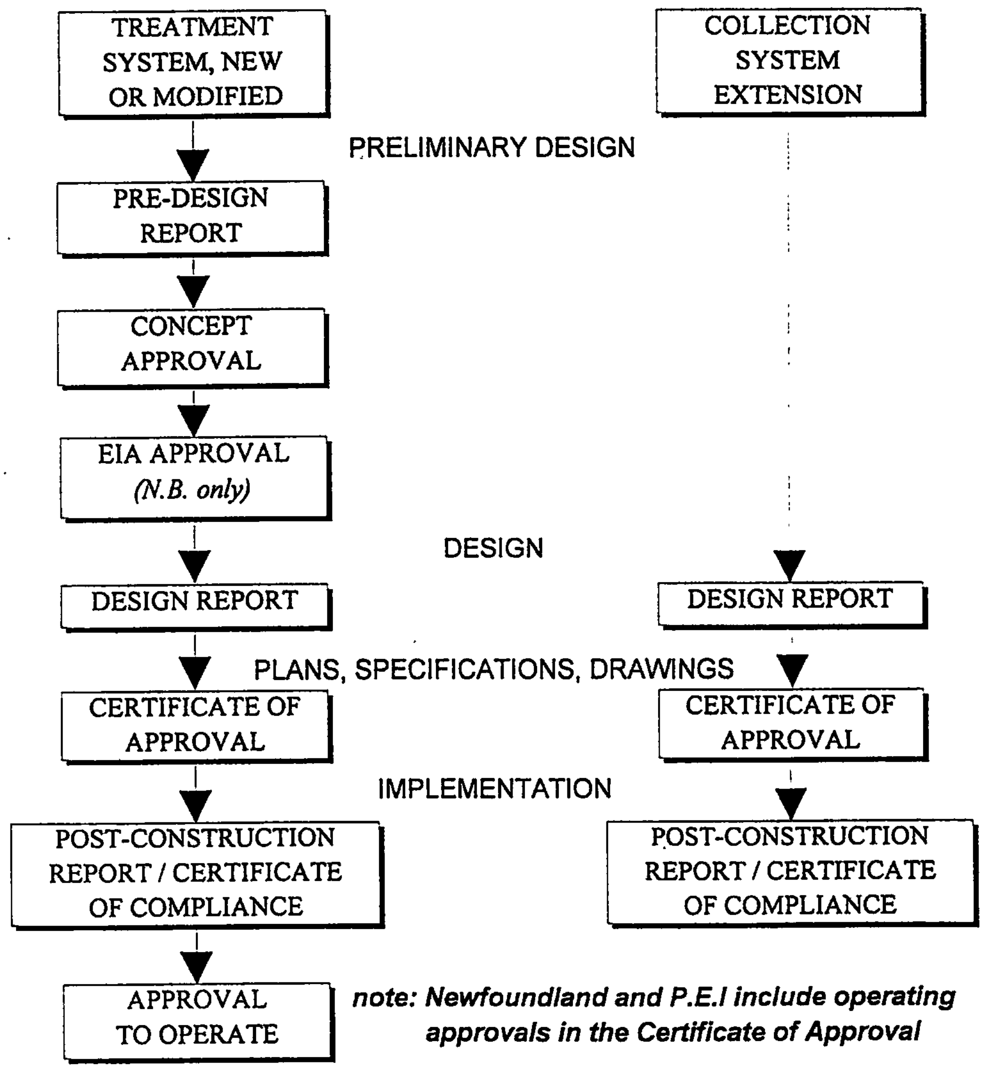
c) preparation of construction plans, specifications, contractual documents and design report; and

d) construction compliance, inspection, administration and acceptance, and submission of a post-construction report.

These services are generally performed by engineering firms in private practice but may be executed by municipal or provincial agencies.

The overall approvals process is outlined in Figure 4.1.

FIGURE 4.1
APPROVALS PROCESS



4.2 PRE-DESIGN EVALUATION

A pre-design evaluation shall broadly:

a) describe existing problems;

b) assess a receiving waters' assimilative capacity;

c) consider methods for alternate solutions including site and/or route selection;

d) estimate capital and annual operating costs; and

e) outline steps for further project implementation including applications for grants-in-aid and approval by regulatory agencies.

4.2.1 Flow Gauging and Wastewater Characterization Studies

Prior to the preparation of a pre-design report on an existing sewerage system, a comprehensive flow gauging and wastewater characterization study should be conducted. This will aid in gaining a better understanding of important design criteria such as flow rates and variations and wastewater composition.

4.2.2 Infiltration/Inflow Investigations

Prior to the preparation of a pre-design report on a existing sewerage system, a comprehensive infiltration/inflow investigation should be conducted. This will give the designers a better indication of extraneous flow contributions, as well as aid in design solutions, (i.e. the potential for reducing flows at an existing plant).

4.3 PRE-DESIGN REPORT

Pre-design reports are necessary in order to obtain a "Concept Approval" from the appropriate regulatory agency. The pre-design report assembles basic information; presents design criteria and assumptions; examines alternate projects with preliminary layouts and cost estimates; describes financing methods giving anticipated charges for users; reviews organizational and staffing requirements; offers a conclusion with a proposed project for client consideration; and outlines official actions and procedures to implement the project.

The concept, factual data and controlling assumptions and considerations for the functional planning of sewage facilities are presented for each process unit and for the whole system. These data form the continuing technical basis for detail design and preparation of construction plans and specifications.

Architectural, structural, mechanical and electrical designs are usually excluded. Sketches may be desirable to aid in presentation of a project. Outline specifications of process units, special equipment, etc., are occasionally included.

4.3.1 **Purpose**

A pre-design report for a proposed project is used:

a) by the municipality for a description, cost estimates, financing requirements, user commitments, findings, conclusions and recommendations, as a guide to adopt a well-defined project;

b) by the regulatory agency for examination of process operation, control, safety and performance directed to maintenance of water quality when facilities are discharging processed sewage;

c) by investment groups and government funding agencies to evaluate the "quality" of the proposed project with reference to authorization and financing; and

d) by news media for telling a story.

4.3.2 **Relation to a Comprehensive Study**

The pre-design report for a specific project should be an "outgrowth" of and consistent with an area wide and drainage basin comprehensive study or master plan.

4.3.3 **Contents**

The pre-design report, to be acceptable for review and approval, must:

a) develop predicted population;

b) establish a specific service area for immediate consideration and indicate possible extensions;

c) present reliable measurements of flow and analyses of wastewater constituents as a basis of process design;

d) estimate costs of immediately proposed facilities;

e) present a reasonable method of financing and show typical financial commitments;

f) suggest an organization and administrative procedure;

g) consider operational requirements with regard to protection of receiving water quality;

h) reflect local bylaws and Federal/Provincial regulations;

i) present summarized findings, conclusions and recommendations for the owner's guidance;

j) include a siting plan. This plan must indicate locations of residences, private and public water supplies, recreational areas, watercourses, zoning, floodplains and other areas of concern when siting sewage collection and treatment facilities;

k) identify existing problems;

l) identify existing and potential receiving water uses; and

m) identify possible treatment plant locations.

4.3.4 Concept and Guidance for Plans and Specifications

The pre-design report should be complete so that plans and specifications may be developed from it without substantial alteration of concept and basis considerations. In short, basic thinking, fundamentals and decisions are spelled out in the pre-design report and carried out in the detailed design plans and specifications.

4.3.5 Format for Content and Presentation

It is urged that the following subsections be utilized as a guideline for content and presentation of the project pre-design report to the Nova Scotia Department of the Environment for review and approval.

4.3.5.1 Title

The Wastewater Facilities Pre-Design Report - collection, conveyance, processing and discharge of wastewater.

4.3.5.2 Letter of Transmittal

A one page letter typed on the firm's letterhead and bound into the report should include:

a) submission of the report to the client;

b) statement of feasibility of the recommended project;

c) acknowledgement to those giving assistance; and

d) reference to the project as outgrowth of approved or "master" plan.

4.3.5.3 Title Page

a) Title of project;

b) municipality, county, etc.;

c) names of officials, managers, superintendents;

d) name and address of firm preparing the report; and

e) seal and signature of professional engineer(s) in charge of the project.

4.3.5.4 ***Table of Contents***

a) Section headings, chapter headings and sub-headings;

b) maps;

c) graphs;

d) illustrations, exhibits;

e) diagrams; and

f) appendices.

4.3.5.5 ***Summary***

Highlight, very briefly, what was found from the study.

4.3.5.5.1 *Findings*

a) population-present, design (when), ultimate;

b) land use and zoning - portion per residential, commercial, industrial, greenbelt, etc.;

c) wastewater characteristics and concentrations - portions of total hydraulic, organic and solid loading attributed to residential commercial and industrial fractions;

d) collection system projects - immediate needs to implement recommended project, deferred needs to complete recommended project and pump stations, force mains, appurtenances, etc.

e) selected process - characteristics of process and characteristics of output.

f) receiving waters - existing water quality and quantity, downstream water uses and impact of project on receiving water;

g) proposed project - total project cost, total annual expense requirement for: debt service; operation, personnel and operation, non-personnel;

h) environmental assessment of selected process;

i) energy requirements - quantities, costs and forms;

j) finances - indicate financing requirements and typical annual charges;

k) organization - administrative control necessary to implement project, carry through to completion and operate and maintain wastewater facility and system; and

l) changes - alert client to situations that could alter recommended project.

4.3.5.5.2 *Conclusions*

Project, or projects, recommended to client for immediate construction, suggested financing program, etc.

4.3.5.5.3 *Recommendations*

Summarized, step-by-step actions, for the client to follow in order to implement conclusions:

a) acceptance of report;

b) adoption of recommended project;

c) submission of report to regulatory agencies for review and approval;

d) authorization of engineering services for approved project (construction plans, specifications, contract documents, etc.);

e) legal services

f) enabling ordinances, resolutions, etc., required;

g) adoption of sewer-use ordinance;

h) adoption of operating rules and regulations;

i) financing program requirements;

j) organization and administration (structure, personnel, employment, etc.);

k) time schedules - implementation, construction, completion dates, reflecting applicable hearings, stipulations, abatement orders.

4.3.5.6 ***Introduction***

4.3.5.6.1 *Purpose*

Reasons for report and circumstances leading up to report.

4.3.5.6.2 *Scope*

Coordination of recommended project with approved comprehensive master plan and guideline for developing the report.

4.3.5.7 ***Background***

Present only appropriate past history.

4.3.5.7.1 *General*

a) existing area, expansion, annexation, inter-municipal service, ultimate area;

b) drainage basin, portion covered;

c) population growth, trends, increase during design life of facility (graph);

d) residential, commercial and industrial land use, zoning, population densities, industrial types and concentrations;

e) topography, general geology and effect on project;

f) meteorology, precipitation, runoff, flooding, etc. and effect on project; and

g) total period of time for which project is to be studied.

4.3.5.7.2 *Economic*

a) Assessed valuation, tax structure, tax rates, portions for residential, commercial, industrial property.

b) employment from within and outside service area;

c) transportation systems, effect on commuter influx;

d) exempt property; churches and agricultural exhibition, properties and effect on project; and

e) costs of present water and wastewater services.

4.3.5.7.3 *Regulations*

a) Existing ordinances, rules and regulations including defects and deficiencies, etc.;

b) recommended amendments, revisions or cancellation and replacement;

c) sewer-use ordinance (toxic, aggressive, volatile, etc., substances);

d) surcharge based on volumes and concentration for industrial wastewaters;

e) existing contracts and agreements (inter-municipal, etc.); and

f) enforcement provisions including inspection, sampling detection, penalties, etc.

4.3.5.8 *Hydraulic Capacity*

The following flows for the design year shall be identified and used as a basis for design for sewers, lift stations, wastewater treatment plants, treatment units, and other wastewater handling facilities. Where any of the terms defined in this Section are used in these design standards, the definition contained in this Section applies.

a. Design Average Flow

The design average flow is the average of the daily volumes to be received for the continuous 12 month period expressed as a volume per unit time. However, the design average flow for facilities having critical seasonal high hydraulic loading periods (e.g., recreational areas, campuses, industrial facilities) shall be based on the daily average flow during the seasonal period.

b. Design Maximum Day Flow

The design maximum day flow is the largest volume of flow to be received during a continuous 24 hour period expressed as a volume per unit time.

c. Design Peak Hourly Flow

The design peak hourly flow is the largest volume of flow to be received during a one hour period expressed as a volume per unit time.

d. Design Peak Instantaneous Flow

The design peak instantaneous flow is the instantaneous maximum flow rate to be received.

e. Design Minimum Day Flow

The design minimum day flow is the smallest volume of flow to be received during a 24 hour period during dry weather when infiltration/inflow are at a minimum, expressed as a volume per unit time.

4.3.5.9 ***Investigative Considerations - Existing Facilities Evaluation***

4.3.5.9.1 *Existing Collection System*

a) Inventory of existing sewers;

b) isolation from water supply wells;

c) adequacy to meet project needs (structural condition, hydraulic capacity tabulation);

d) gauging and infiltration tests (tabulate);

e) overflows and required maintenance, repairs and improvements;

f) outline repair, replacement and storm water separation requirements;

g) evaluation of costs for treating infiltration/inflow versus costs for rehabilitation of system;

h) establish renovation priorities, if selected;

i) present recommended annual program to renovate sewers; and

j) indicate required annual expenditure.

4.3.5.9.2 *Existing Treatment Plant*

a) Area for expansion;

b) surface condition;

c) subsurface conditions;

d) isolation from habitation;

e) isolation from water supply structures;

f) enclosure of units, winter conditions, odour control, landscaping, etc.; and

g) flooding (predict elevation of 25 and 100 year flood stage).

4.3.5.9.3 *Existing Process Facilities*

a) Capacities and adequacy of units (tabulate);

b) relationship and/or applicability to proposed project;

c) age and condition;

d) adaptability to different usages;

e) structures to be retained, modified or demolished; and

f) outfall.

4.3.5.9.4 *Existing Wastewater Characteristics*

a) Water consumption (from records) total, unit, industrial;

b) wastewater flow pattern, peaks, total design flow;

c) physical, chemical and biological characteristics and concentrations; and

d) residential, commercial, industrial, infiltration fractions, considering organic solids, toxic aggressive, etc., substances; tabulate each fraction separately and summarize.

4.3.5.10 Proposed Project

4.3.5.10.1 Collection System

a) Inventory of proposed additions;

b) isolation from water supply well, reservoirs, facilities, etc.;

c) area of services;

d) unusual construction problems;

e) utility interruption and traffic interference;

f) restoration of pavements, lawns, etc.; and

g) basement flooding prevention during power outage.

4.3.5.10.2 Site Requirements

Comparative advantages and disadvantages as to cost, hydraulic requirements, flood control, accessibility, enclosure of units, odour control, landscaping, etc., and isolation with respect to potential nuisances and protection of water supply facilities.

4.3.5.10.3 Wastewater Characteristics

a) Character of wastewater necessary to insure amenability to process selected;

b) need to pretreat industrial wastewater before discharge to sewers;

c) portion of residential, commercial, industrial wastewater fractions to comprise projected growth.

4.3.5.10.4 Receiving Water Considerations and Assimilative Capacity

a) Wastewater discharges upstream;

b) receiving water base flow (utilize critical flow as specified by approving agency);

c) characteristics (concentrations) of receiving waters;

d) downstream water uses including water supply, recreation, agricultural, industrial, etc.;

e) impact of proposed discharge on receiving waters;

f) tabulate assimilative capacity requirements;

g) listing of effluent characteristics; and

h) tabulation and correlation of plant performance versus receiving water requirements.

4.3.5.11 ***Alternatives***

Alternatives should consider such items as regional solution, optimum operation of existing facilities, flow and waste reduction, location of facilities,phased construction, necessary flexibility and reliability, sludge disposal, alternative treatment sites, alternative processes and institutional arrangements.

4.3.5.11.1 *Alternate Process and Site*

a) Describe and delineate (line diagrams);

b) preliminary design for cost estimates;

c) estimates of project cost (total) dated, keyed to construction cost index, escalated, etc.;

d) advantages and disadvantages of each;

e) individual differences, requirements, limitations;

f) characteristics of process output;

g) comparison of process performances;

h) operation and maintenance expenses;

i) annual expense requirements (tabulation of annual operation, maintenance, personnel, debt obligation for each alternate), and

j) environmental assessment of each.

4.3.5.12 ***Selected Process and Site***

a) Identify and justify process and site selected;

b) adaptability to future needs;

c) environmental assessment;

d) outfall location; and

e) describe immediate and deferred construction.

4.3.5.13 *Project Financing*

a) Review applicable financing methods;

b) Effect of Provincial and Federal funding;

c) assessment by front meter, area unit or other benefit;

d) charges by connection, occupancy, readiness-to-serve, water consumption, industrial wastewater discharge, etc.;

e) existing debt service requirements;

f) annual financing and bond retirement schedule;

g) tabulate annual operating expenses;

h) show anticipated typical annual charge to user and non-user; and

i) show how representative properties and users are to be affected.

4.3.5.14 *Legal and Other Considerations*

a) Needed enabling legislation, ordinances, rules and regulations;

b) contractual considerations for inter-municipal cooperation;

c) public information and education; and

d) statutory requirements and limitations.

4.3.5.15 *Appendices: Technical Information and Design Criteria*

4.3.5.15.1 *Collection System*

a) Design tabulations - flow, size, velocities, etc.;

b) regulator or overflow design;

c) pump station calculations, including energy requirements;

d) special appurtenances;

e) stream crossings; and

f) system map (report size).

4.3.5.15.2 *Process Facilities*

a) Criteria selection and basis;

b) hydraulic and organic loadings - minimum, average, maximum and effect;

c) unit dimensions;

d) rates and velocities;

e) detentions;

f) concentrations;

g) recycle;

h) chemical additive control;

i) physical control;

j) removals, effluent concentrations, etc. Include a separate tabulation for each unit to handle solid and liquid fractions;

k) energy requirement; and

l) flexibility.

4.3.5.15.3 *Process Diagrams*

a) Process configuration, interconnecting piping, processing, flexibility, etc.;

b) hydraulic profile;

c) organic loading profile;

d) solids control system;

e) solids profile; and

f) flow diagram with capacities, etc.

4.3.5.15.4 *Space for Personnel, Laboratories and Records*

4.3.5.15.5 *Chemical Control*

a) Processes needing chemical addition;

b) chemicals and feed equipment; and

c) tabulation of amounts and unit and total costs.

4.3.5.15.6 *Support Data*

a) Outline unusual specifications, construction materials and construction methods;

b) maps, photographs, diagrams (report size);

c) other.

4.4 DETAILED DESIGN DOCUMENTATION

4.4.1 General

Upon obtaining a "Concept Approval," the owner or his/her representative must prepare and submit detailed design documentation. This includes a Design Report, plans, specifications and contractual documents, and an application for a "certificate of approval".

4.4.2 Design Report

The Design Report shall contain detailed design calculations for each unit or process of the wastewater treatment or collection facility. The design report shall also address operational and maintenance issues for that particular facility.

4.4.2.1 *Format for Content and Presentation*

It is urged that the following subsection be utilized as a guideline for content and presentation of the project Design Report to the appropriate regulatory agency for review and approval.

4.4.2.1.1 *Title*

The Wastewater Facilities Design Report - collection, conveyance, processing and discharge of wastewater.

4.4.2.1.2 *Letter of Transmittal*

A one page letter typed on the firm's letterhead and bound into the report should include:

a) submission of the report to the client;

b) acknowledgement to those giving assistance; and

c) reference to the project as outgrowth of approved or "master" plan.

4.4.2.1.3 *Title Page*

a) Title of project;

b) municipality, county, etc.;

c) names of officials, managers, superintendents;

d) name and address of firm preparing the report; and

e) seal and signature of professional engineer(s) in charge of the project.

4.4.2.1.4 *Table of Contents*

a) Section headings, chapter headings and sub-headings

b) maps;

c) graphs;

d) illustrations, exhibits;

e) diagrams; and

f) appendices.

4.4.2.1.5 *Collection System*

a) Detailed design tabulations - flow, size, velocities, etc;

b) regulator or overflow design calculations;

c) detailed pump station calculations, including energy requirements;

d) special appurtenances;

e) stream crossings; and

f) system map (report size).

4.4.2.1.6 *Process Facilities*

a) Hydraulic and organic loadings - minimum, average, maximum and effect;

b) detailed calculations used to determine:

- unit dimensions;
- rates and velocities;
- detentions;
- concentrations;
- recycle;
- removals, effluent concentrations, etc. Include a separate tabulation for each unit to handle solid and liquid fractions;
- energy requirement;
- flexibility; and

c) chemical requirements and control.

4.4.2.1.7 *Process Diagrams*

a) Process configuration, interconnecting piping, processing, flexibility, etc;

b) hydraulic profile;

c) organic loading profile;

d) solids control system;

e) solids profile; and

f) flow diagram with capacities, etc.

4.4.2.1.8 *Laboratory*

a) Physical and chemical tests and frequency to control process;

b) time for testing;

c) space and equipment requirements; and

d) personnel requirements - number, type, qualifications, salaries, benefits (tabulate).

4.4.2.1.9 *Operation and Maintenance*

a) Routine and special maintenance duties;

b) time requirements;

c) tools, equipment, vehicles, safety, etc.;

d) personnel requirements - number, type, qualifications, salaries, benefits, (tabulate); and

e) maintenance work space and storage.

4.4.2.1.10 *Office Space for Administrative Personnel and Records*

4.4.2.1.11 *Personnel Service - Locker Room and Lunch Room*

4.4.2.1.12 *Chemical Control*

a) Process needing chemical addition;

b) chemicals and feed equipment; and

c) tabulation of amounts and unit and total costs.

4.4.2.1.13 *Collection System Control*

a) Cleaning and maintenance;

b) regulator and overflow inspection and repair;

c) flow gauging;

d) industrial sampling and surveillance;

e) regulation enforcement;

f) equipment requirements;

g) trouble-call investigation; and

h) personnel requirements - number, type, qualifications, salaries, benefits (tabulate).

4.4.2.1.14 Control Summary

a) Personnel;

b) equipment;

c) chemicals;

d) utilities - list power requirements of major units; and

e) summation.

4.4.2.1.15 Support Data

a) Outline unusual specifications, construction materials and construction methods;

b) maps, photographs, diagrams (report size); and

c) other.

4.4.2.1.16 Appendices

Related data not necessary to an immediate understanding of the design report should be placed in the appendices.

4.4.3 Plans

4.4.3.1 General

All plans for sewage work shall bear a suitable title showing the name of the municipality, sewer district, or institution; and shall show the scale in appropriate units, the north point, date and the name of the engineer, his signature on an imprint of his registration seal.

The plans shall be clear and legible. They shall be drawn to scale which will permit all necessary information to be plainly shown. The size of the plans should be 570 x 817 mm (size A1 (21 x 33 in (size D)). Datum used should be indicated. Locations and logs of test borings, when made, shall be shown on the plans.

Detail plans shall consist of plan views, elevations, sections and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the works. Include dimensions and geodetic elevations of structures, the location and outline form of equipment, location and size of piping, water levels and ground elevations.

4.4.3.2 *Plans of Sewers*

4.4.3.2.1 *General Plans*

A comprehensive plan of the existing and proposed sewers shall be submitted for projects involving new sewer systems or substantial additions to existing systems. This plan shall show the following:

i) **Geographical Features**

a) topography and elevations - existing or proposed streets and all streams or water surfaces shall be clearly shown. Contour lines at suitable intervals should be included;

b) streams -the direction of flow in all streams and high and low water elevations of all water surfaces at sewer outlets and overflows shall be shown.

c) boundaries - the boundary lines of the municipality, the sewer district or area to be sewered shall be shown.

ii) **Sewers**

The plan shall show the location, size and direction of flow of all existing and proposed sanitary and combined sewers draining to the treatment works concerned.

4.4.3.2.2 *Detail Plans*

Detail plans shall be submitted. Profiles should have a horizontal scale of not more than 1:500 (1 in = 40 ft.) and a vertical scale of not more than 1:50 (1 in = 4 ft.). Plans and profiles shall show:

a) location of streets and sewers;

b) line of ground surface, size, material and type of pipe, length between manholes, invert and surface elevation at each manhole and grade of sewer between each two adjacent manholes. All manholes shall be numbered on the plan and correspondingly numbered on the profile.

Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor shall be plotted on the profile of the sewer which is to serve the house in question. The engineer shall state that all sewers are sufficiently deep to serve adjacent basements except where otherwise noted on the plans.

c) locations of all special features such as inverted siphons, concrete encasement, elevated sewers, etc.;

d) all known existing structures both above and below ground which might interfere with the proposed construction, particularly water mains, gas mains, storm drains, etc.;

e) special detail drawings, made to a scale to clearly show the nature of the design, shall be furnished to show the following particulars:

(i) all stream crossings and sewer outlets, with elevations of the stream bed and of normal and extreme high and low water levels;

(ii) details of all special sewer joints and cross-sections; and

(iii) details of all sewer appurtenances such as manholes, lamp holes, inspection chambers, inverted siphons, regulators, tide gates and elevated sewers.

4.4.3.3 *Plans of Sewage Pumping Stations*

4.4.3.3.1 *Location Plan*

A plan shall be submitted for projects involving construction or revision of pumping stations. This plan shall show the following:

a) the location and extent of the tributary area;

b) any municipal boundaries with the tributary area; and

c) the location of the pumping station and force main and pertinent elevations.

4.4.3.3.2 *Detail Plans*

Detail plans shall be submitted showing the following, where applicable:

a) topography of the site;

b) existing pumping station;

c) proposed pumping station, including provisions for installation of future pumps;

d) elevation of high water at the site and maximum elevation of sewage in the collection system upon occasion of power failure;

e) maximum hydraulic gradient in downstream gravity sewers when all installed pumps are in operation; and

f) test borings and groundwater elevations.

4.4.3.4 *Plans of Sewage Treatment Plant*

4.4.3.4.1 *Location Plans*

A plan shall be submitted, showing the sewage treatment plant in relation to the remainder of the system.

Sufficient topographic features shall be included to indicate its location with relation to streams and the point of discharge of treated effluent.

4.4.3.4.2 *General Layout*

Layouts of the proposed sewage treatment plant shall be submitted, showing:

a) topography of the site;

b) size and location of plant structures;

c) schematic flow diagram showing the flow through various plant units;

d) piping, including any arrangements for by-passing individual units. Materials handled and direction of flow through pipes shall be shown;

e) hydraulic profiles, showing the flow of sewage, supernatant, mixed liquor and sludge; and

f) test borings and ground water elevations.

4.4.3.4.3 *Detail Plans*

a) Location, dimensions and elevations of all existing and proposed plant facilities;

b) elevations of high and low water level of the body of water to which the plant effluent is to be discharged;

c) type, size, pertinent features and manufacturer's rated capacity of all pumps, blowers, motors and other mechanical devices;

d) minimum, average and maximum hydraulic flow in profile; and

e) adequate description of any features not otherwise covered by specifications or engineer's report.

4.4.4 **Specifications**

Complete technical specifications for the construction of sewers, sewage pumping stations, sewage treatment plants and all appurtenances, shall accompany the plans.

The specifications accompanying construction drawings shall include, but not be limited to, all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements as to the quality of materials and workmanship and fabrication of the project and the type, size, strength, operating characteristics and rating of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping and jointing of pipe; electrical apparatus, wiring and meters; laboratory fixtures and equipment; operating tools; construction materials; special filter materials such as stone, sand, gravel or slag; miscellaneous appurtenances, chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and operating tests for the completed works and component units. It is suggested that these performance tests be conducted at design load conditions wherever practical.

4.5 REVISIONS TO APPROVED PLANS

Any deviations from approved plans or specifications affecting capacity, flow or operation of units shall be approved in writing before such changes are made. Plans or specifications so revised should, therefore, be submitted well in advance of any construction work which will be affected by such changes, to permit sufficient time for review and approval. Structural revisions or other minor changes not affecting capacities, flows, or operation will be permitted during construction without approval. "As-built" plans clearly showing such alterations shall be submitted to the reviewing agency at the completion of the work.

4.6 CERTIFICATE OF APPROVAL

A "Certificate of Approval" shall be issued by the appropriate regulatory agency to the owner/operator only upon final approval of the Design report, plans, specifications and contract documents. The permit shall provide the owner/operator with the authority to proceed with the construction of that particular project. The "Certificate of Approval" does not provide the owner/operator with the authority to operate the newly constructed system or plant.

4.7 OPERATION DURING CONSTRUCTION

Specifications shall contain a program for keeping existing treatment plant units in operation during construction of plant additions. Should it be necessary to take plant units out of operation, a shut-down schedule which will minimize pollution effects on the receiving stream, shall be reviewed and approved in advance by the appropriate reviewing agency and shall be adhered to.

4.8 OPERATING REQUIREMENTS

4.8.1 General

Any newly constructed sewerage system or treatment plant shall be put into operation only if it meets each of the following criteria:

a) in the case of Nova Scotia and New Brunswick a "Construction Report", and in the case of Prince Edward Island and Newfoundland a "Certificate of Compliance" has been submitted by the engineer to the regulatory agency and has subsequently been reviewed and approved; and

b) in the case of Nova Scotia and New Brunswick an "Approval to Operate" has been issued by the regulatory agency to the owner/operator of the system or plant. In the case of Prince Edward Island and Newfoundland the "Certificate of Approval" issued before construction will address operating issues.

4.8.2 Post-Construction Report / Certificate of Compliance

The "Post-Construction Report / Certificate of Compliance" shall contain all information regarding major changes from the approved plans or specification made during construction. These major changes include any deviations which affect capacity, flow or operation of units. The "Post-Construction Report / Certificate of Compliance" shall also include all commission or start-up of equipment tests and any other tests results produced during construction. The "Post-Construction Report / Certificate of Compliance" must also guarantee that all as-built drawings, operation and maintenance manuals, and any other relevant documentation have been turned over to the owner/operator by the engineer.

4.8.3 Approval To Operate

In the provinces of Nova Scotia and New Brunswick, after the completion of construction and submission of the construction report, the owner/operator or his authorized agent shall apply to the appropriate regulatory agency for an "Approval to Operate".

The purpose of the permit is to clearly outline the operating and reporting requirements for the wastewater treatment facility. The permit shall outline the plant's effluent limitations. The owner or his authorized agent should consult with the regulatory agency to develop the terms and conditions of the licence, followed by the submission of an application for the licence itself. The application should include a letter with enclosed completed application forms and a copy of the operations manual for the facility.

The terms and conditions of any "Permit to Operate" shall only remain in effect for a period of five (5) years. Following this period, the owner/operator shall apply for a renewal of the permit.

In Newfoundland and Prince Edward Island operating issues will be covered in the "Certificate of Approval" issued prior to contruction.

Environment Canada · Environnement Canada

Atlantic Canada Standards and Guidelines Manual

Design Section

New Nouveau Brunswick

1.1 TYPE OF SEWERAGE SYSTEM

In general and except for special reasons, the Minister will approve plans for new systems or extensions only when designed upon a separate sewer basis, in which rain water from roofs, streets and other areas and groundwater from foundation drains are excluded. Overflows from intercepting sewers should not be permitted at points where they will adversely affect a watercourse or the use of water therefrom. Otherwise provision shall be made for treating the overflow.

1.2 DESIGN CAPACITY CONSIDERATIONS

In general, sewer systems should be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc.

In determining the required capacities of sanitary sewers the following factors should be considered:

a. maximum hourly domestic sewage flow;

b. additional maximum sewage or waste from industrial plants;

c. inflow and groundwater infiltration;

d. topography of area;

e. location of waste treatment plant;

f. depth of excavation; and

g. pumping requirements.

The basis of design for all sewer projects shall accompany the documents.

1.3 HYDRAULIC DESIGN

1.3.1 Sewage Flows

Sewage flows are made up of waste discharges from residential, commercial, institutional and industrial establishments, as well as extraneous non-waste flow contributions such as groundwater and surface runoff.

1.3.2 Extraneous Sewage Flows

1.3.2.1 Inflow

When designing sanitary sewer systems, allowances must be made for the leakage of groundwater into the sewers and building sewer connections (infiltration) and for other extraneous water entering the sewers from such sources as leakage through manhole covers, foundation drains, roof down spouts, etc.

Due to the extremely high peak flows that can result from roof down spouts, they should not, in any circumstances, be connected directly, or indirectly via foundation drains, to sanitary sewers. The Departments of Municipal Affairs, The Environment and Health also discourage the connection of foundation drains to sanitary sewers. Studies have shown that flows from this source can result in gross overloading of sewers, pumping stations and sewage treatment plants for extended periods of time. The Departments recommend that foundation drainage be directed either to the surface of the ground or into a storm sewer system, if one exists.

1.3.2.2 Infiltration

The amount of groundwater leakage directly into the sewer system (infiltration) will vary with the quality of construction, type of joints, ground conditions, level of groundwater in relation to pipe, etc. Although such infiltration can be reduced by proper design and construction, it cannot be completely eliminated and an allowance must be made in the design sewage flows to cover these flow contributors. Despite the fact that these allowances are generally referred to as infiltration allowances, they are intended to cover the peak extraneous flows from all sources likely to contribute non-waste flows to the sewer system. The infiltration allowances used for sewer design should not be confused with leakage limits used for acceptance testing following construction. The latter allowance are significantly lower and apply to a sewer system when the system is new and generally without the private property portions of the building sewers constructed.

1.3.3 Domestic Sewage Flows

Unless actual flow measurement has been conducted, the following criteria should be used in determining peak sewage flows from residential areas, including single and multiple housing, mobile home parks, etc.:

a. design population derived from drainage area and expected maximum population over the design period;

b. average daily domestic flow (exclusive of extraneous flows) of 340 L/cap·d;

c. peak extraneous flow (including peak infiltration and peak inflow) of from 0.14 to greater than 0.28 L/s per gross hectare; and

d. peak domestic sewage flows to be calculated by the following equation:

$$Q(d) = \frac{PqM + IA}{86.4}$$

where:

Q(d) = peak domestic sewage flow (including extraneous flow) in L/s.

P = design population, in thousands

q = average daily per capita domestic flow in L/cap.d. (exclusive of extraneous flows)

M = peaking factor (as derived from

Harman Formula **Babbit Formula**

$$M = 1 + \frac{14}{4 + P^{0.5}} \quad \text{or} \quad M = \frac{5}{P^{0.2}} \quad \text{or as}$$

determined from flow studies for similar developments in the same municipality). The minimum permissible peaking factor shall be 2.0.

I = unit of peak extraneous flow, in L/s per hectare.

A = tributary area in gross hectares.

1.3.4 Commercial and Institutional Sewage Flows

1.3.4.1 Flow Variation

The sewage flow from commercial and institutional establishments vary greatly with the type of water-using facilities present in the development, the population using the facilities, the presence of water metering, the extent of extraneous flows entering the sewers, etc.

1.3.4.2 Flow Equivalent

In general, the method of estimating sewage flows for large commercial areas is to estimate a population equivalent for the area covered by the development and then calculate the sewage flows on the same basis in the previous section. A population equivalent of 85 persons per hectare is often used. It is also necessary to calculate an appropriate peaking factor and select a representative unit of peak extraneous flow.

1.3.4.3 Individual Flow Rate

For individual commercial and institutional users the following sewage flow rates are commonly used for design. Where a range is stated the lower figure is the minimum requirement.

Sewage Flows (Average Daily)

Shopping Centres	- 2500-5000 L/1000 m-day (based on total floor area)
School (basic)	- 40 L/student-day
cafeteria	- 60 L/student-day
shower	- 80 L/student-day
Nursing Home	- 375 L/bed-day
Senior Citizen Home	- 650 L/apartment-day
Hospital	- 950 L/bed-day
Restaurant	- 225 L/seat-day + 100 L/employee-day
Motel	- 300 L/room-day (add for restaurant)
Campgrounds	- 500 L/campsite-day

1.3.4.4 Peak Factor

When using the above unit demands, maximum day and peak rate factors must be developed. For establishments in operation for only a portion of the day, such as schools, shopping plazas, etc., the water usage should also be factored accordingly. For instance, with schools operating for 8 hours per day, the water usage rate will be at an average rate of say 70 L/student-day x 24/8 or 210 L/student day over the 8-hour period of operation. The water usage will drop to residual usage rates during the remainder of the day. Schools generally do not exhibit large maximum day to average day ratios and a factor 1.5 will generally cover this variation. For estimation of peak demand rates, an assessment of the water using fixtures is generally necessary and a fixture-unit approach is often used.

The peak water usage rates in campgrounds will vary with the type of facilities provided (showers, flush toilets, clothes washers, etc.) and the ratio of these facilities to the number of campsites. A peak rate factor of 4 will generally be adequate, however, and this factor should be applied to the average expected water usage at full occupancy of the campsite.

1.3.5 Industrial Sewage Flows

1.3.5.1 Flow Variation

Peak sewage flow rates from industrial areas vary greatly depending on such factors as the extent of the area, the types of industries present, the provision of in-plant treatment or regulation of flows, and the presence of cooling waters in the sanitary sewer system.

1.3.5.2 Flow Rate

The calculation of design sewer flow rates for industrial areas is, therefore, difficult. Careful control over the type of industry permitted in new areas is perhaps the most acceptable way to approach the problem. In this way, a reasonable allowance can be made for peak industrial sewage flow for an area and then the industries permitted to locate in the area can be carefully monitored to ensure that all the overall allowances are not exceeded. Industries with the potential to discharge sewage at higher than the accepted rate could either be barred from the area, or be required to provide flow equalization and/or off-peak discharge facilities, or be restricted by a sewer-use by-law.

1.3.5.3 Flow Allowances

Some typical sewage flow allowances for industrial areas are 35 m^3/hectare-day for light industry and 55 m^3/hectare-day for heavy industry.

1.3.6 Combined Sewer Interceptors

In addition to the above requirements, interceptors for combined sewers shall have capacity to receive sufficient quantity of combined wastewater for transport to treatment works to insure attainment of the appropriate provincial and federal water quality standards

1.3.7 Combined Sewer Overflows

The design requirements for sanitary sewers outlined in this manual specify that all new sewer systems be designed as separate sewers. There will, however, still remain many existing combined sewer systems. This will result in the continued existence of combined sewer overflows (CSO's). This being the case, all receiving water quality studies and waste load allocation models must take into account the effect of CSO's. It is the objective of the regulatory agencies to reduce, where possible and practical, the frequency and duration of CSO's so as to minimize their associated impacts on a receiving water.

1.4 DETAILS OF DESIGN AND CONSTRUCTION

1.4.1 Sewer Capacity

Manning's, Kutter's or Hazen-Williams' formula should be used for computing the capacity of sanitary sewers. Sewers shall be designed to handle the peak anticipated sewage flow when flowing full.

Calculations should be presented, in a tabular form, to indicate depths and velocities at minimum, average and maximum daily waste flow for the different sizes of sewers proposed.

1.4.2 Pressure Pipes

Sanitary sewers may be designed as pressure pipes provided that the hydraulic gradient for maximum flow is below basement elevations.

1.4.3 Minimum Pipe Size

No public sewer shall be less than 200 mm in diameter.

1.4.4 Depth

In general, sewers shall be deep enough to prevent freezing and to receive sewage from basements.

Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

1.4.5 Slope

Sewers shall be laid with a uniform slope between manholes.

1.4.5.1 Minimum Slopes

All sewers shall normally be designed and constructed to give mean velocities, when flowing full, of not less than 0.6 meters per second or greater than 4.5 meters per second based on Kutter's or Manning's formula using "n" value of 0.013. Use of other practical "n" values may be permitted by the reviewing agency if deemed justifiable. Velocities above 4.5 m/s may be permitted with high velocity protection.

The following are the minimum slopes which will provide a velocity of 0.6 m/s when sewers are flowing full:

Minimum Slopes for Full-Pipe Velocity of 0.6 m/s	
Sewer Size	Minimum Slope in Metres (ft) per 100 Metres (ft)
200 mm	0.40
250 mm	0.28
300 mm	0.22
350 mm	0.17
375 mm	0.15
400 mm	0.14
450 mm	0.12
525 mm	0.10
600 mm	0.08
675 mm	0.067
750 mm	0.058
900 mm	0.046

Actual pipe slopes should not be less than 0.5 percent (0.5 m/100 m).

1.4.5.2 *Increased Slopes*

To achieve 0.6 m/s flow velocities in sewers which will flow less than 1/3 full, steeper slopes than given above must be used where conditions permit. For instance, the minimum slopes mentioned above would have to be doubled when depth of flow is only 1/5 full and quadrupled when depth of flow is only 1/10 full to achieve 0.6 m/s flow velocity.

1.4.5.3 *Reduced Slopes*

Under special conditions, if full and justifiable reasons are given, slopes slightly less than those required for the 0.6 meter per second velocity when flowing full may be permitted. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. Whenever such decreased slopes are selected, the design engineer must furnish with his report his computations of the anticipated flow velocities of average and daily or weekly peak flow rates. The pipe diameter and slopes shall be selected to obtain the greatest practical velocities to minimize settling problems. The operating authority of the sewer system will give written assurance to the appropriate reviewing agency that any additional sewer maintenance required by reduced slopes will be provided.

1.4.5.4 *High Velocity Protection*

Where velocities greater than 4.5 meters per second are unavoidable, special provisions shall be made to protect against displacement by erosion and shock.

Sewers on 20 percent slopes or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

a. not over 11 meters center to center on grades 20 percent and up to 35 percent.

b. not over 7.3 meters center to center on grades 35 percent and up to 50 percent.

c. not over 5 meters center to center on grades 50 percent and over.

1.4.6 **Alignment**

Sewers 600 mm or less in diameter shall be laid with a straight alignment between manholes.

1.4.7 **Curvi-linear Sewers**

Curvi-linear sewers may be considered for pipe sizes in excess of 600 mm with the following restrictions applicable:

1. The sewer shall be laid as a simple curve of a radius equal to or greater than 60 m.
2. Manholes shall be located at the ends of the curve and at intervals not greater than 90 m along the curve.
3. The curve shall run parallel to the curb or street center line.
4. The minimum grade on curves shall be fifty percent greater than the minimum grade required for straight runs of sewers.
5. Length of pipe shall be such that deflections at each joint shall be less than the allowable maximum recommended by the manufacturer.
6. In general, curved sewers should be used only where savings in costs or the difficulty of avoiding other utilities necessitates their use.
7. A free ball or tethered ball test should be used, such a ball being 10 mm to 25 mm less in diameter than the sewer.

1.4.8 **Changes in Pipe Size**

When a sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method of securing these results is to place the 0.8 depth point of both sewers at the same elevations. Changes in size of sewers less than or equal to 600 mm shall be at manholes only.

1.4.9 Allowance for Hydraulic Losses at Sewer Manholes

Differences in elevation across manholes should be provided to account for hydraulic losses. The elevation drop may be calculated using the head loss formula:

Headloss Across Manholes

$$H = \frac{k\,(V2^2 - V1^2)}{2g}$$

where:

H	=	Headloss	m
k	=	coefficient	dimensionless
V1	=	entrance velocity	m/s
V2	=	exit velocity	m/s
g	=	acceleration due to gravity	m/s/s

Where sewer velocities are less than 2.5 m/s and the velocity change across the manhole is less than 0.6 m/s the invert drop may be determined using the following table.

	Invert Drop
a) straight run	15 mm
b) 45 degree turn	30 mm
c) 90 degree turn	60 mm

1.4.10 Sewer Services

Sewer services shall be consistent with the Local or Provincial Plumbing and Drainage Regulations. It is required that unless Tees or "Wyes" have been installed, that saddles be used in connecting the service to the sewer. Generally these are placed at an angle of 45 degrees above horizontal. Connections shall be made by authorized personnel only.

Pipes with watertight and rootproof joints should be used for house connections. Minimum pipe size should be 150 mm diameter for double connections and 100 mm (4 in) diameter for single connections.

1.4.11 Sulphide Generation

Where sulphide generation is a possibility, the problem shall be minimized by designing sewers to maintain flows at a minimum cleansing velocity of 1.0 m/s.

Where corrosion is anticipated because of either sulphate attack or sulphides, consideration shall be given to the provision of corrosion resistant pipe material or effective protective linings.

1.4.12 Materials

Any generally accepted material for sewers will be given consideration, but the material selected should be adaptable to local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loading, abrasion and similar problems.

All sewers shall be designed to prevent damage from super-imposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of trench. When standard strength sewer pipe is not sufficient, the additional strength needed may be obtained by using extra strength pipe or by special construction.

1.4.13 Metering and Sampling

Where no other measuring devices are provided, one manhole on the outfall line shall be constructed with a suitable removable weir for flow measurements. Easy access for flow measurement and sampling shall be provided. Similar manholes should be constructed on sewer lines from industries to facilitate checking the volume and composition of the waste.

1.4.14 Sewer Extensions

In general, sewer extensions shall be allowed only if the receiving sewage treatment plant is either:

a. Capable of adequately processing the added hydraulic and organic load or

b. Provision of adequate treatment facilities on a time schedule acceptable to the approving agencies is assured.

1.4.15 Installation

1.4.15.1 Standards

Installation specifications shall contain appropriate requirements based on the criteria, standards and requirements established by industry in its technical publications. Requirements shall be set further in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures or ovalation of the pipe, nor seriously impair flow capacity.

1.4.15.2 Trenching

a. The width of the trench shall be ample to allow the pipe to be laid and jointed properly and to allow the backfill to be placed and compacted as needed. The trench sides shall be kept as nearly vertical as possible. When wider trenches are dug, appropriate bedding class and pipe strength shall be used.

b. Ledge rock, boulders and large stones shall be removed to provide a minimum clearance of 150 mm below and on each side of all pipe(s).

1.4.15.3 *Foundation*

The foundation provides the base for the sewer pipe soil system. The project engineer should be concerned primarily with the presence of unsuitable soils, such as peat or other highly organic or compressible soils, and with maintaining a stable trench bottom.

1.4.15.4 *Bedding*

The sewer pipe should be bedded on carefully compacted granular material. The granular material shall have a minimum thickness of 150 mm and cover the full width of the trench.

In general, a well-graded crushed stone is a more suitable material for sewer pipe bedding than a uniformly graded pea gravel. For small sewer pipes, the maximum size should be limited to about 10% of the pipe diameter. Crushed stone or gravel meeting the requirement of ASTM Designation C33, Gradation 67 (19-9.8 mm) will provide the most satisfactory sewer pipe bedding. However, the recommendation of the manufacturer should also be taken into consideration when specifying a particular bedding material. Material removed from the trench shall not be used as bedding material.

1.4.15.5 *Haunching*

The material placed at the sides of a pipe from the bedding up to the spring line is the haunching.

Material used for sewer pipe haunching should be shovel sliced or otherwise placed to provide uniform support for the pipe barrel and to fill completely all voids under the pipe. Haunching material is to be compacted manually. The material used may be similar to the material used for bedding. Material removed from the trench shall not be used as haunching material.

1.4.15.6 *Initial Backfill*

Initial backfill is the material which covers the sewer pipe and extends from the haunching to a minimum of 300 mm above the top of the pipe. Its function is to anchor the sewer pipe, protect the pipe from damage by subsequent backfill and insure the uniform distribution of load over the top of the pipe. It should be placed in 150 mm layers. The material used for initial backfill may be similar to the material used for bedding and haunching, however, it shall be of a material which will develop a uniform and relatively high density with little compactive effort. Material removed from the trench shall not be used as initial backfill.

1.4.15.7 *Final Backfill*

Final backfill is the material which extends from the top of the initial backfill to the top of the trench. It should be placed in 300 mm layers.

The material consists of the excavated material containing no organic matter or rocks having any dimension greater than 200 mm. In most cases, final backfill does not affect the pipe design. Compaction of the final backfill is usually controlled by the location as follows: traffic areas; 95% of modified Proctor density required; general urban areas; 90%

of modified Proctor density may be adequate; undeveloped areas; 85% of modified Proctor density may be required. Trench backfilling should be done in such a way as to prevent dropping of material directly on the top of pipe through any great vertical distance.

1.4.15.8 ***Borrow Materials***

Because the material removed from the trench is not to be used as part of the bedding, haunching, nor initial backfill, material must be imported from another source. Borrow material must meet the specifications for final backfill.

Either cohesive or noncohesive material may be used; however, the project engineer should assess the possible change in groundwater movement if cohesive material is used in rock or if noncohesive material is used in impermeable soil.

1.4.15.9 ***Deflection Test***

a. Deflection testing will not be necessary unless one or more of the following conditions are known to exist:

   - Improper construction practices are evident
   - Questionable embedment materials have been used
   - Severe trench construction conditions were encountered
   - Other inspection or testing methods have indicated unacceptable installation conditions.

b. Measure pipe deflection by pulling a mandrel gauge through each pipe from manhole to manhole after backfilling. Within thirty days after installation, pull a mandrel gauge measuring 5% deflection through the installed section of pipeline. If this test fails, proceed with 7½% deflection test.

c. 7½% deflection test: Thirty days prior to completion of the Period of Maintenance, pull a mandrel gauge measuring 7½% deflection through the installed section of pipeline. If the 7½% deflection test fails, the defects must be located and repaired, and the pipe subsequently retested.

d. If the deflection test is to be run using a rigid ball or mandrel, it shall have a diameter equal to 92.5% of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.

1.4.16 **Joints**

The installation of joints and the materials used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

1.5 MANHOLES

1.5.1 Location

Manholes shall be located at all junctions, changes in grade, size or alignment (except with curvilinear sewers) and termination points of sewers.

1.5.2 Spacing

1.5.2.1 Normal Spacing

The maximum acceptable spacing for manholes is 90 to 120 m for sewers 200 to 450 mm in diameter. Spacings of up to 150 m may be used for sewers 450 mm to 750 mm in diameter. Larger sewers may use greater manhole spacing.

Cleanouts may be used only with approval of the regulatory agencies and shall not be substituted for manholes nor installed at the end of laterals greater than 45 m in length.

1.5.2.2 Extended Spacing

For any particular municipality, the acceptable manhole spacing will vary depending upon the sewer cleaning equipment available. Some municipalities may allow longer spacing intervals. The above limits may, therefore, be exceeded provided the applicant can demonstrate the suitability of equipment available to handle such spacing.

1.5.3 Minimum Diameter

The minimum diameter of a sanitary manhole shall be 1050 mm.

1.5.4 Drop Manholes

A drop pipe should be provided for a sewer entering a manhole at an elevation of 600 mm or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 600 mm the invert should be filleted to prevent solids deposition.

Drop manholes should be constructed with an outside drop connection. Inside drop connections (when necessary) shall be secured to the interior wall of the manhole and provide access for cleaning.

Due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the manhole, the entire outside drop connection shall be encased in concrete.

1.5.5 Manhole Bases

Precast bases may be used for manholes up to 9 m deep.

1.5.6 Pipe Connections

A flexible watertight joint shall be provided on all pipes, within 300 mm of the outside wall of the manhole.

1.5.7 Frost Lugs

Where required, frost lugs shall be provided to hold precast manhole sections together.

1.5.8 Frame and Cover

The manhole frame and cover shall be made of cast iron and designed to meet the following conditions:

a. adequate strength to support superimposed loads;

b. provision of a good fit between cover and frame to eliminate movement in traffic; and

c. a reasonably tight closure.

1.5.9 Watertightness

Manholes shall be of the pre-cast or poured-in-place concrete type, or of another type approved by the regulatory agencies. All manhole joints must be watertight and the manhole shall be waterproofed on the exterior, if required.

Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be desirable in isolated easement locations, or where vandalism may be a problem.

1.5.10 Ladders

Ladders must be provided in all manholes. Cast in place ladders are not permitted unless specifically requested by the owner.

1.5.11 Flow Channel and Benching

The channel should be, as far as possible, a smooth continuation of the pipe. The completed channel should be U-shaped.

1.5.11.1 Small Pipe Channel

For sewer sizes less than 375 mm, the channel height should be at least one half the pipe diameter.

1.5.11.2 *Large Pipe Channel*

For sewer sizes 375 mm and larger, the channel height should not be less than three-fourths of the pipe diameter.

1.5.11.3 *Bench Area*

The bench should provide good footing for a workman and a place for tools and equipment.

1.5.11.4 *Bench Slope*

Benching should be at a slope of at least 1:12 (vertical:horizontal) and not greater than 1:8. Benching should have a wood float finish.

1.5.12 Corrosion Protection

Where corrosion is anticipated because of either sulphate attack or sulphides, consideration shall be given to the provision of corrosion resistant material or effective protective linings.

1.6 TESTING AND INSPECTION

1.6.1 General

Each section of a sanitary sewer shall be tested for exfiltration and/or infiltration. A section is the length of pipe between successive manholes or termination points, including service connections.

Each section of a sewer, and it's related appurtenances, shall be flushed prior to testing.

1.6.2 Exfiltration Test

Each sewer section shall be filled with water and a nominal head shall remain on the section for twenty-four hours immediately prior to testing.

Water shall be added to the section to establish a test head of 1.0 m over either the crown of the pipe, measured at the highest point of the section, or the level of static groundwater, whichever is greater. This may be increased by the inspector in order to satisfy local conditions.

The test head shall be maintained for one hour. The volume of water required to maintain the head during the test period shall be recorded.

1.6.3 Infiltration Test

Infiltration tests shall be conducted in lieu of exfiltration tests where the level of static groundwater is 750 mm or more above the crown of the pipe, measured at the highest point in the section.

A 90 degree V-notch weir shall be placed in the invert of the pipe at the downstream end of the section. The total volume of flow over the weir for one hour shall be measured and recorded.

1.6.4 Allowable Leakage

Allowable leakage shall be determined by the following formula:

$$L = F \times D \times \frac{S}{100}$$

where:

L = allowable leakage in litres per hour
D = diameter in mm
S = Length of section, in metres
F = leakage factor, (litres per hour per mm of diameter per 100 metres of sewer):

Exfiltration Test:

Porous Pipe	F = 0.12 litre
Non-Porous Pipe	F = 0.02 litre

Infiltration Test:

Porous Pipe	F = 0.10 litre
Non-Porous Pipe	F = 0.02 litre

1.6.5 Low Pressure Air Testing

Air testing equipment shall be designed to operate above ground. No personnel will be permitted in the trench during testing. Air testing will not be permitted on pipes with diameter greater than 600 mm.

The test section shall be filled with air until a constant pressure of 28 kPa is reached. After a two minute period the air supply shall be shut off, and the pressure decreased to 24 kPa. The time required for the pressure to reach 17 kPa shall be measured.

1.6.6 Allowable Time for Air Pressure Decrease

Minimum times allowed for air pressure drop is as follows:

Pipe Diameter (mm)	Minimum Time Min: Sec
100	1:53
150	2:50
200	3:47
250	4:43
300	5:40
375	7:05
450	8:30
525	9:55
600	11:20

1.6.7 Sewer Inspection

The specifications shall include a requirement for inspection of manholes and sewers for watertightness, prior to placing into service.

1.6.7.1 Video Inspection

Inspection on 100% of the sewer using the closed circuit television method and recorded on videotape should be specified. This should be conducted within the one-year guarantee period. This inspection should be carried out preferably during the periods of high ground water table in the spring or fall, or at the discretion of the regulatory agencies.

1.6.7.2 Inspection Record

The complete record of the inspection shall be the property of the owner or the municipality. The original videotape and one edited copy of the tape of the sections showing defects shall be turned over to the owner or municipality.

1.6.7.3 Record Content

The maximum speed of the television camera through the pipe shall be 0.30 meters per second with a 5-second minimum stop at each defective location and a 15 - second minimum stop at each lateral showing a flow discharging into the pipe. The audio part shall include the recording of distances at a maximum interval of three meters and a brief description of every defective location and of each service connection.

1.7 INVERTED SIPHONS

Inverted siphons should have not less than two barrels with a minimum pipe size of 150 mm and shall be provided with necessary appurtenances for convenient flushing and maintenance. The manholes shall have adequate clearances for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 0.9

m/s for average flows. The inlet and outlet details shall be so arranged that the normal flow is diverted to one barrel and that either barrel may be cut out of service for cleaning. The vertical alignment should permit cleaning and maintenance.

1.8 PROTECTION OF WATER SUPPLIES

1.8.1 Water-Sewer Cross Connections

There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole, gravity sewer or sewage forcemain.

1.8.2 Relation to Water Works Structures

While no general statement can be made to cover all conditions, it is generally recognized that sewers shall be kept remote from public water supply wells or other water supply sources and structures.

1.8.3 Relation to Water Mains

1.8.3.1 Horizontal and Vertical Separation

Whenever possible, sewers should be laid at least three meters horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of three meters a sewer may be laid closer than three meters to a water main if:

a. it is laid in a separate trench, or if;

b. it is laid in the same trench, with the water main located at one side with a minimum horizontal separation of 300 mm and on a bench of undisturbed earth and if;

c. in either case the elevation of the top (crown) of the sewer is at least 300 mm below the bottom (invert) of the water main. Where a water main must be installed paralleling a gravity sewer and at a lower elevation than the gravity sewer, the water main must be installed in a separate trench. The soil between the trenches must be undisturbed.

1.8.3.2 Crossings

Whenever sewers must cross under the water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 450 mm below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirement, the water main shall be relocated to provide this separation or reconstructed with mechanical - joint pipe for a distance of three meters on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

1.8.3.3 ***Special Conditions***

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe and shall be pressure-tested to assure water-tightness.

1.9 SEWERS IN RELATION TO STREAMS

1.9.1 Location of Sewers on Streams

1.9.1.1 ***Cover Depth***

The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements must be met:

a. 0.3 m of cover is required where the sewer is located in rock;

b. 2 meters of cover is required in other material.

c. in paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.

Less cover will be approved only if the proposed sewer crossing will not interfere with the future improvements to the stream channel. Reasons for requesting less cover should be given in the project proposal.

1.9.1.2 ***Horizontal Location***

Sewers located along streams shall be located outside of the stream bed and sufficiently remote therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.

1.9.1.3 ***Structures***

The sewer outfalls, headwalls, manholes, gate boxes or other structures shall be located so they do not interfere with the free discharge of flood flows of the stream.

1.9.1.4 ***Alignment***

Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible and shall be free from change in grade. Sewer systems shall be designed to minimize the number of stream crossings.

1.9.2 Construction

1.9.2.1 Materials

Sewers entering or crossing streams shall be constructed of cast or ductile iron pipe with mechanical joints; otherwise they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel or other materials which will not cause siltation.

1.9.2.3 Siltation and Erosion

Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams to provide adequate control of siltation and erosion. Specifications shall require that cleanup, grading, seeding and planting or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven days.

1.10 AERIAL CROSSINGS

Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning and settlement.

Precautions against freezing, such as insulation and increased slopes shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers.

For aerial stream crossings the impact of flood waters and debris shall be considered. The bottom of the pipe shall be placed no lower than the elevation of the fifty (50) year flood.

1.11 ALTERNATIVE WASTEWATER COLLECTION SYSTEMS

1.11.1 Applications

Each alternative system has individual characteristics which may dictate proper usage under a certain et of circumstances. Each potential application should be analyzed to determine which system is most cost effective and which will comply with local requirements. The following features of various sewerage alternatives are considered in planning a project.

1.11.1.1 Population Density

Conventional sewers are typically costly on a lineal foot basis. When housing id sparse, resulting in long reaches between services, the cost of providing conventional sewers is often prohibitive. Pressure sewers, small diameter gravity sewers, and vacuum sewers are typically less costly on a lineal foot basis, so often prove to be more cost-effective when serving sparse populations.

1.11.1.2 *Ground Slopes*

Where the ground profile over the main slopes continuously downward in the direction of flow, conventional or small diameter gravity sewers are normally preferred. If intermittent rises in the profile occur, conventional sewers may become cost-prohibitively deep. The variable grade gravity sewer variation of small diameter gravity sewers, by use of inflective gradients and in conjunction with STEP pressure sewer connections, can be economically applied. Vacuum sewers may be particularly adaptable to this topographic condition, so long as head requirements are within the limits of available vacuum.

In flat terrain conventional sewers become deep due to the continuous downward slope of the main, requiring frequent use of lift stations. Both the deep excavation and the lift stations are expensive. SDGS are buried less deep, owing to the flatter gradients permitted. Pressure sewers or vacuum sewers are often found to be practical in flat areas, as ground slope is of little concern. In areas where the treatment facility or interceptor sewer are higher than the service population, pressure sewers and vacuum sewers are generally preferred, but should be evaluated against SDGS systems with lift stations.

1.11.1.3 *Subsurface Obstacles*

Where rock excavation is encountered, the shallow burial depth of alternative sewer mains reduces the amount of rock to be excavated.

Deep excavations required of conventional sewers sometimes encounter groundwater. Depending on severity, dewatering can be expensive and difficult to accomplish.

1.11.2 Pressure Sewer Systems

Pressure sewers are small diameter pipelines, buried just below frost level, which follow the profile of the ground. Each home connected to the pipeline requires either a grinder pump (GP) or a septic tank effluent pump (STEP). Main diameters typically range from 50 - 150 mm with service lateral diameters of 25 - 38 mm. Polyvinyl Chloride (PVC) is the most common piping material.

1.11.2.1 *System Layout*

Pressure sewer systems should be laid out taking the following into consideration:

a. Branched layout rather than gridded or looped.

b. Maintain cleansing velocities especially when grinder pump type pressure sewers are used.

c. Minimize high head pumping and downhill flow conditions.

d. Locate on lot facilities close to the home for ease of maintenance.

e. Provide for each home to have its own tank and pump.

1.11.3 Vacuum Sewer Systems

Vacuum sewer systems consist of a vacuum station, collection piping, wastewater holding tanks, and valve pits. In these systems, wastewater from an individual building flows by gravity to the location of the vacuum ejector valve. The valve seal the line leading to the main in order to maintain required vacuum levels. When a given amount of wastewater accumulates behind the valve, the valve opens and then closes allowing a liquid plug to enter the line. Vacuum pumps in a central location maintain the vacuum in the system.

1.11.3.1 Services

Each home on the system should have its own holding tank and vacuum ejector valve. Holding tank volume is usually 115 L. As the wastewater level rises in the sump, air is compressed in a sensor tube which is connected to the valve controller. At a preset point, the sensor signals for the vacuum valve to open. The valve stays open for an adjustable period of time and then closes. During the open cycle, the holding tank contents are evacuated. The timing cycle is field adjusted between 3 and 30 seconds. This time is usually set to hold the valve open for a total time equal to twice the time required to admit the wastewater. In this manner, air at atmospheric pressure is allowed to enter the system behind the wastewater. The time setting is dependent on the valve location since the vacuum available will vary throughout the system, thereby governing the rate of wastewater flow.

The valve pit is typically located along a property line and may be combined with the holding tank. These pits are usually made of fibreglass, although modified concrete manhole sections have been used. An anti-flotation collar may be required in some cases.

1.11.3.2 Collection Piping

The vacuum collection piping usually consists of 150 mm and 100 mm mains. Smaller 75 mm mains are not recommended as the cost savings of 75 mm verses 100 mm mains are considered to be insignificant.

Rubber gasketed PVC pipe which has been certified by the manufacturer as being suitable for vacuum service is recommended. Solvent welding should be avoided when possible. The mains are generally laid to the same slope as the ground with a minimum slope of 0.2 percent. For uphill transport, lifts are placed to minimize excavation depth. There are no manholes in the system; however, access can be gained at each valve pit or at the end of a line where an access pit may be installed. Installation of the pipe and fittings follows water distribution system practices. Division valves are installed on branches and periodically on the mains to allow for isolation when troubleshooting or when making repairs. Plug valve and resilient wedge gate valves have been used.

1.11.3.3 Vacuum Station

Vacuum stations are typically two-storey concrete and block buildings approximately 7.5 m x 9 m in floor plan. Equipment in the station includes a collection tank, a vacuum reservoir tank, vacuum pumps, wastewater pumps, and pump controls. In addition, an emergency generator is standard equipment, whether it is located within the station, outside the station in an enclosure, or is of the portable, truck mounted variety.

The collection tank is made of either steel or fibreglass. The vacuum reservoir tank is connected directly to the collection tank to prevent droplet carryover and to reduce the frequency of vacuum pump starts. Vacuum pumps can be either liquid ring or sliding vane type and are sized for a 3 - 5 hr/d run-time. The wastewater discharge pumps are non-clog pumps with sufficient net positive suction head to overcome tank vacuum. Level control probes are installed in the collection tank to regulate the wastewater pumps. A fault monitoring system alerts the system operator should a low vacuum or high wastewater level condition occur.

1.11.4 Small Diameter Gravity Sewers

Small diameter gravity sewers (SDGS) require preliminary treatment through the use interceptor or septic tanks upstream of each connection. With the solids removed, the collector mains need not be designed to carry solids as conventional sewers must be. Collector mains are smaller in diameter and laid with variable or inflective gradients. Fewer manholes are used and most are replaced with cleanouts except at major junctions to limit infiltration/inflow and entry of grit. The required size and shape of the mains is dictated primarily by hydraulics rather than solids carrying capabilities.

1.11.4.1 House Connections

House connections are made at the inlet to the interceptor tank.. All household wastewaters enter the system at this point.

1.11.4.2 Interceptor Tanks

Interceptor tanks are buried, watertight tanks with baffled inlets and outlets. They are designed to remove both floating and settleable solids from the waste stream through quiescent settling over a period of 12-24 hours. Ample volume is provided for storage of the solids which must be periodically removed through an access port. Typically, a single-chamber septic tank, vented through the house plumbing stack vent, is used as an interceptor tank.

1.11.4.3 Service Laterals

Service Laterals connect the interceptor tank with the collector main. Typically, they are 75-100 mm in diameter, but should be no larger than the collector main to which they are connected. They may include a check valve or other backflow prevention device near the connection to the main.

1.11.4.4 Collector Mains

Collector mains are small diameter plastic pipes with typical minimum diameters of 75 - 100 mm. The mains are trenched into the ground at a depth sufficient to collect the settled wastewater from most connections by gravity. Unlike conventional gravity sewers, small diameter gravity sewers are not necessarily laid on a uniform gradient with straight alignments between cleanouts or manholes. In places, the mains may be depressed below the hydraulic gradeline. Also, the alignment may be curvilinear between manholes and cleanouts to avoid obstacles in the path of sewers.

1.11.4.5 Cleanouts, Manholes, and Vents

Cleanouts, manholes, and vents provide access to the collector mains for inspection and maintenance. In most circumstances, cleanouts are preferable to manholes because they are less costly and can be more tightly sealed to eliminate most infiltration and grit which commonly enter through manholes. Vents are necessary to maintain free flowing conditions in the mains. Vents in household plumbing are sufficient except where depressed sewer sections exist. In such cases, air release valves or ventilated cleanouts may be necessary at the high points of the main.

1.11.4.6 Lift Stations

Lift stations are necessary where the elevation differences do not permit gravity flow. Either STEP units (see 1.11.1) or mainline lift stations may be used. STEP units are small lift stations installed to pump wastewater from one or a small cluster of connections to the collector main, while a mainline lift station is used to service all connections in a larger drainage basin.

1.11.5 Detailed Design Guidelines

The above are general design considerations only. For detailed design refer to:

Alternative Sewer Systems, Manual of Practice no. FD-12, Facilities Development, Water Pollution Control Federation, Alexandria, VA, 1986.

U.S. Environmental Protection Agency: Manual: *Alternative Wastewater Collection Systems*, EPA-625/1-91/024, Office of Research and Development, Washington, DC, 1991.

2.1 GENERAL

2.1.1 Location

Sewage pumping station structures and electrical and mechanical equipment shall be protected from physical damage from the one hundred (100) year flood. Sewage pumping stations should remain fully operational and accessible during the twenty-five (25) year flood.

During preliminary location planning, consideration should be given to the potential of emergency overflow provisions and as much as practically possible the avoidance of health hazards, nuisances and adverse environmental effects.

2.1.2 Design Capacity

i) Separate Sewer Systems

Sewage pumping stations should be able to pump the expected twenty-five year peak sewage flows, under normal growth conditions, with the largest capacity pump out of operation. See Design Section 1.3 for the recommended approach for the calculation of peak sewage flows. In certain cases, where it can be shown that staging of construction will be economically advantageous, lesser design periods may be used provided it can be demonstrated that the required capacity can be "on-line" when needed. Pumping station overflows shall be permitted under the requirements of Design Section 2.3.

If only two pumps are provided, they should have the same capacity. Each shall be capable of handling the expected peak sewage flow. Where three or more units are provided, they should be designed to fit actual flow conditions and must be of such capacity that with any one unit out of service the remaining units will have capacity to handle maximum sewage flows, taking into account head losses associated with parallel operation.

ii) Combined Sewer Systems

It may be impractical or economical to design a sewage pumping station on a combined sewer system to pump the expected twenty-five year peak sewage flow, with the largest capacity pump out of operation. Under these conditions the following shall be considered in determining the appropriate design capacity:

a) the minimization of combined sewer overflows (see Policy Section 5.2).

b) the minimization of pumping station overflows as outlined in Design Section 2.3.

2.1.3 Accessibility

Sewage pumping stations shall be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys.

2.1.4 Grit

Where it may be necessary to pump sewage prior to grit removal, the design of the wet wells should receive special attention and the discharge piping shall be designed to prevent grit settling in pump discharge lines of pumps not operating.

2.1.5 Sewer Entry

If more than one sewer enters the site of the pumping station, a junction manhole should be provided so that only a single sewer entry to the wet well is required.

2.1.6 Fencing

All above ground pumping stations and associated facilities may require fencing. The fence shall have an opening gate for entry of vehicles and equipment, and the gate shall be kept locked to prevent vandalism.

2.1.7 Heating

Automatic heating may be required at pumping stations, to prevent freezing in cold weather and to maintain a comfortable working temperature (there may be exceptions in the case of small below ground wet well or manhole type lift stations).

2.1.8 Piping System

The design of the pumping and piping systems should account for the potential of surge, water hammer, and special requirements for pump seals associated with wastewater service.

Suction and discharge piping should be sized to accommodate expected peak hourly flows with velocities ranging from 0.8 m/s to 2.0 m/s, where feasible velocities at the low end of the range are preferable. Consideration should be given to providing access ports for such things as sampling, swabbing, and/or flushing discharge pressure gauge(s).

2.1.9 Electrical

All wiring shall be in accordance with the requirements of the Canadian Electrical Code and the Nova Scotia Power Standards.

Dehumidification should be provided to protect electrical control equipment from excess moisture.

2.1.10 Lighting

Adequate light intensity shall be provided for all corridors, stairways, and in areas where machinery or equipment is located.

2.1.11 Safety

The design and construction of all components of wastewater pumping stations shall conform to the safety provisions of the Nova Scotia Occupational Health and Safety Act and The Construction Safety Act.

2.1.12 Construction Materials

Due consideration shall be given to the selection of materials and equipment because of the presence of hydrogen sulphide and other corrosive and inflammable gases, greases, oils and other constituents present in sewage.

2.2 DESIGN

2.2.1 Types of Pumping Systems

The type of sewage pumping station should be selected on the basis of such considerations as reliability and serviceability; operation and maintenance factors; relationship to existing stations/equipment; sewage characteristics; flow patterns and discharge; and long-term capital, operating and maintenance costs.

For large main pumping stations, wet well/dry well type stations are recommended. For smaller stations and in cases for which wet well/dry well types are not feasible, wet well (submersible) pump stations may be used if pumps can be easily removed for replacement or repairs.

2.2.2 Structures

2.2.2.1 Separation

Wet and dry wells including their superstructure shall be completely separated.

2.2.2.2 Equipment Removal

Provision shall be made to facilitate removing pumps, motors and other mechanical and electrical equipment.

2.2.2.3 Access

Suitable and safe means of access shall be provided to dry wells of pump stations and to wet wells or to other parts of the building containing bar screens or mechanical equipment requiring inspection or maintenance. Stairways should be installed, with rest landings not to exceed 3 m vertical intervals.

2.2.3 **Pumps and Pneumatic Injectors**

2.2.3.1 ***Duplicate Units***

At least two pumps or pneumatic ejectors shall be provided. A minimum of three pumps should be provided for stations handling flows greater than 4500 m^3/d.

2.2.3.2 ***Protection Against Clogging***

The need for and the type of screening facilities required for pumping stations varies with the characteristics of the sewage, size of sewers and the requirements of the operating authority. For wet well/dry well stations, it is generally accepted practice to provide screening in the form of a basket screen or a manually or mechanically cleaned bar screen. Although basket screens may be cumbersome to remove and empty, they have the advantage of not requiring entry of operating staff into the wet well for cleaning operations. With basket screens, guide rails should be tubular and similar to submersible pump guide rails. Manually cleaned bar screens should be provided with 38 mm clear openings in the inclined (60°) and horizontal bars. The vertical sides should be solid. The minimum width should be 600 mm. A drain platform should be provided for screenings. Pumps handling separate sanitary sewage from 750 mm or larger diameter sewers shall be protected by bar screens meeting the above requirements.

2.2.3.3 ***Pump Openings***

Pumps shall be capable of passing spheres of at least 75 mm in diameter. Pump suction and discharge openings shall be at least 100 mm in diameter.

2.2.3.4 ***Priming***

The pump shall be so placed that under normal operating conditions it will operate under a positive suction head, except as specified in Design Section 2.2.10.

2.2.3.5 ***Electrical Equipment***

Electrical systems and components (i.e. motors, lights, cables, conduits, switch boxes, control circuits, etc.) in enclosed or partially enclosed spaces where flammable mixtures occasionally may be present (including raw sewage wet wells) shall comply with the Canadian Electrical Code and the Nova Scotia Power Standards. In the interest of the operating authority, provide only three phase power to operate the required equipment.

2.2.3.6 ***Intake***

Each pump should have an individual intake. Wet well design should be such as to avoid turbulence near the intake.

2.2.3.7 ***Constant Speed vs. Variable Speed Pumps***

In certain instances, such as pumping stations discharging directly into mechanical sewage treatment plants or into other pumping stations, some means of flow pacing may be required. This can be provided by various means, depending upon the degree of flow pacing necessary. If even minor pump surges would have serious effects, variable speed pumps should be used. If minor surges can be tolerated, two-speed pumps or multiple constant speed pumps can be used.

2.2.3.8 Controls

Control systems shall be of the air bubbler type or the encapsulated float type. Float-tube control systems on existing stations being upgraded may be approved. Float control should be positioned as per Design Section 2.2.5.5.

2.2.3.9 Alternation

Provisions shall be made to automatically alternate the pumps in use.

2.2.4 Valves

2.2.4.1 Suction Line

Suitable shutoff valves shall be placed on the suction line of each pump except on submersible and vacuum-primed pumps.

2.2.4.2 Discharge Line

Suitable shutoff and check valves shall be placed on the discharge line of each pump. The check valve shall be located between the shutoff valve and the pump. Check valves shall be suitable for the material being handled. Valves shall be capable of withstanding normal pressure and water hammer.

Where limited pump backspin will not damage the pump and low discharge head conditions exist, short individual force mains for each pump may be considered in lieu of discharge valves.

2.2.4.3 Location

Valves shall not be located in the wet well.

2.2.5 Wet Wells

2.2.5.1 Divided Wells

Where continuity of pumping station operation is important, consideration should be given to dividing the wet well into multiple sections, properly interconnected, to facilitate repairs and cleaning. Divided wet wells should also be considered for all pumping stations with capacities in excess of 100 L/s.

2.2.5.2 *Pump Cycle*

For any pumping station, the wet well should be of sufficient size to allow for a minimum of a fifteen minute cycle time for each pump. For a two-pump station, the volume in cubic meters, between pump start and pump stop should be 0.225 times the pumping rate of one pump, expressed in L/s. For other numbers of pumps, the required volume depends upon the operating mode of the pumping units.

2.2.5.3 *Size*

Wet well size and control settings should be based on consideration of the volume required for pump cycling; the design fill time, dimensional requirements to avoid turbulence problems; vertical separation between pump control points; inlet sewer elevation; capacity required between alarm levels and basement flooding and/or overflow elevations; etc. To avoid septicity problems, wet wells should not provide retention times greater than 30 minutes.

2.2.5.4 *Floor Slope*

The wet well floor shall have a minimum slope of 1 to 1 to the hopper bottom. The horizontal area of the hopper bottom shall be no greater than necessary for proper installation and function of the inlet.

2.2.5.5 *Float Controls*

Float controls should be at least 300 mm vertically and 125 mm horizontally apart and positioned against a wall away from turbulent areas.

2.2.5.6 *Pump Start Elevation*

To minimize pumping costs and wet well depth, normal high water level (pump start elevation) may be permitted to be above the invert of the inlet sewer provided basement flooding and/or solids deposition will not occur. Where these problems cannot be avoided, the high water level (pump start elevation) should be approximately 300 mm below the invert of the inlet sewer.

2.2.5.7 *Pump Stop Elevation*

Low water level (pump shut-down) should be at least 300 mm or twice the pump suction diameter, whichever is greater, above the center line of the pump volute.

2.2.5.8 *Bottom Elevation*

The bottom of the wet well should be no more than D/2, nor less than D/3 below the mouth of the flared intake where turned-down, bell-mouth inlets are used. "D" being the diameter of the mouth of the flared intake.

2.2.5.9 *Air Displacement*

Covered wet wells shall have provisions for air displacement such as an inverted "j" tube or other means which vents to the outside.

2.2.6 Dry Wells

2.2.6.1 *Dry Well Dewatering*

A separate sump pump equipped with dual check valves shall be provided in the dry wells to remove leakage or drainage, with the discharge above the overflow level of the wet well. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump.

2.2.6.2 *Maintenance*

The dry well should be equipped with a lifting beam to facilitate removal of pump motors. A roof hatch is recommended to provide access for removal of the entire pump and motor.

2.2.7 Ventilation

2.2.7.1 *General*

Adequate ventilation shall be provided for all pump stations. Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well. There shall be no interconnection between the wet well and dry well ventilation systems. Ventilation must avoid dispensing contaminants throughout other parts of the pumping station, and vents shall not open into a building or connect with a building ventilation system.

2.2.7.2 *Air Inlets and Outlets*

In dry wells over 4.6 m deep multiple inlets and outlets are desirable. Dampers should not be used on exhaust or fresh air ducts and fine screens or other obstructions in air ducts should be avoided to prevent clogging.

2.2.7.3 *Electrical Controls*

Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilation equipment shall be interconnected with the respective pit lighting system. Consideration should be given also to automatic controls where intermittent operations is used. The manual lighting ventilation switch shall override the automatic controls.

2.2.7.4 *Fans, Heating, and Dehumidification*

The fan wheels shall be fabricated from non-sparking material. Automatic heating and dehumidification equipment shall be provided in all dry wells. The electrical equipment and components shall meet the requirements in Design Section 2.2.3.5.

2.2.7.5 *Wet Wells*

Ventilation may be either continuous or intermittent. Ventilation, if continuous, should provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Fresh air shall be forced into the wet well, by mechanical means, at a point 300 mm above the expected high liquid level. There shall be a provision for automatic blow-by to elsewhere in the well, should the fresh air outlet become submerged. Portable ventilation equipment shall be provided for use at submersible pump stations.

2.2.7.6 *Dry Wells*

Ventilation may be either continuous or intermittent. Ventilation, if continuous, should provide at least six complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Ventilation shall be forced into the dry well at a point 150 mm above the pump floor, and allowed to escape through vents in the roof superstructure. A system of two speed ventilation with a initial ventilation rate of 30 changes per hour for 10 minutes and automatic change over to 6 changes per hour may be used to conserve heat.

2.2.8 Flow Measurement

Suitable devices for measuring wastewater flow shall be provided at all pumping stations. Indicating, totalizing, and recording flow measurement shall be provided at pumping stations with a 75 L/s or greater design peak hourly flow. Elapsed time meters used in conjunction with pumping rate tests may be acceptable for pumping stations with a design peak hourly flow up to 75 L/s.

2.2.9 Water Supply

There shall be no physical connection between any potable water supply and a sewage pumping station which under any conditions might cause contamination of the potable water supply. If a potable water supply is brought to the station it shall be protected with a suitable backflow prevention device (see Design Section 3.7.2).

2.2.10 Suction Lift Pumps

2.2.10.1 *General*

Suction lift pumps shall be of the self-priming or vacuum-priming type and shall meet the applicable requirements of Design Section 2.2. Suction lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved by the appropriate reviewing agency upon submission of factory certification of pump performance and detailed calculations indicating satisfactory performance under the proposed operating conditions. Such detailed calculations must include static suction lift as measured from "lead pump off" elevation to center line of pump suction, friction and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head and a safety factor of at least 1.8 meters.

The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent the humid and corrosive sewer atmosphere from entering the equipment compartment. Wet well access shall not be through the equipment compartment. Valving shall not be located in the wet well.

2.2.10.2 *Self-Priming Pumps*

Self-priming pumps shall be capable of rapid priming and re-priming at the "lead pump on" elevation. Such self-priming and re-priming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed 7.6 m in total length. Priming lift at the "lead pump on" elevation shall include a safety factor of at least 1.2 m from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed 6.7 m.

2.2.10.3 *Vacuum-Priming Pumps*

Vacuum-priming pump stations shall be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction lift pump. The vacuum pumps shall be adequately protected from damage due to sewage. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed 6.7 m.

2.2.11 Submersible Pump Stations

2.2.11.1 *General*

Submersible pump stations shall meet the applicable requirements under Design Sections 2.2.1 to 2.2.9 except as modified in this section.

2.2.11.2 *Construction*

Submersible pumps and motors shall be designed specifically for raw sewage use, including totally submerged operation during a portion of each pumping cycle. An effective method to detect shaft seal failure or potential seal failure shall be provided and the motor shall be of squirrel-cage type design without brushes or other arc-producing mechanisms.

2.2.11.3 *Pump Removal*

Submersible pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.

2.2.11.4 ***Power Supply***

Electrical supply, control and alarm circuits shall be designed to provide strain relief and to allow disconnection from outside the wet well. Terminals and connectors shall be protected from corrosion by location outside the wet well or through use of water-tight seals. If located outside, weatherproof equipment shall be used.

2.2.11.5 ***Controls***

The motor control center shall be located outside the wet well and be protected by a conduit seal or other appropriate measures meeting the requirements of the Canadian Electrical Code, to prevent the atmosphere of the wet well from gaining access to the control center. The seal shall be so located that the motor may be removed and electrically disconnected without disturbing the seal.

2.2.11.6 ***Power Cord***

Pump motor power cords shall be designed for flexibility and serviceability under conditions of extra hard usage and shall meet the requirements of the Canadian Electrical Code. The ground fault system shall be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable. They shall also be provided with strain relief appurtenances and shall be designed to facilitate field connecting.

2.2.11.7 ***Valves***

Valves required under Design Section 2.2.4 shall be located in a separate valve pit. Accumulated water shall be drained to the wet well or to the soil. If the valve pit is drained to the wet well, an effective method shall be provided to prevent sewage from entering the pit during surcharged wet well conditions.

2.2.11.8 ***Ventilation***

Gravity ventilation may be acceptable provided that maintenance crews carry suitable portable ventilation equipment when visiting the site.

2.2.12 Cathodic Protection

Steel fabricated pumping stations shall require cathodic protection for corrosion control. Impressed current or magnesium anode packs are generally used for this purpose in conjunction with a suitable protective coating on underground surfaces, applied in accordance with the manufacturer's directions. The unit should be electrically isolated by dielectric fittings placed on inlet and outlet pipes, anchor bolts and electrical conduit boxes.

Upon completion of the installation, the capability of the anti-corrosion system should be verified by instrumentation. Such inspection should be carried out by a person approved by the reviewing agencies.

2.2.13 Alarm Systems

Alarm systems shall be provided for pumping stations. The alarm shall be activated in cases of power failure, pump failure, use of the lag pump, unauthorized entry, or any cause of pump station malfunction. Pumping station alarms shall be telemetered, including identification of the alarm condition, to a municipal facility that is manned 24 hours a day. If such a facility is not available and 24 hour holding capacity is not provided, the alarm may be telemetered to municipal offices during normal working hours or to the home of the person(s) in charge of the pumping station during off-duty hours. Audio visual alarm systems with a self-contained power supply may be acceptable in some cases in lieu of the telemetering system outlined above, depending upon location, station holding capacity and inspection frequency.

2.3 EMERGENCY OPERATION

Pumping stations and collection systems shall be designed to prevent or minimize bypassing of raw sewage. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrolled storm events, consideration should be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency power generation in order to prevent backup of sewage into basements, or other discharges which may cause severe adverse impacts on public interests, including public health and property damage. Where a high level overflow is utilized, consideration shall also be given to the installation of storage/detention tanks, or basins, which shall be made to drain to the station wet well. Storage capacity should be related to frequency and length of power outages for the area. Where public water supplies, shellfish production, or waters used for culinary or food processing purposes exist, overflows shall not be permitted.

2.3.1 Overflow Prevention Methods

A satisfactory method shall be provided to prevent or minimize overflows. The following methods should be evaluated on a case by case basis:

a. storage capacity, including trunk sewers, for retention of wet weather flows (storage basins must be designed to drain back into the wet well or collection system after the flow recedes); and

b. an in-place or portable pump, driven by an internal combustion engine meeting the requirements of Design Section 2.3.3 below, capable of pumping from the wet well to the discharge side of the station.

2.3.2 Overflows

If the avoidance of overflows is not possible, provision shall be made for chlorination of the overflow raw sewage unless waived by the regulatory agencies. The overflow facilities should be alarmed and equipped to indicate frequency and duration of overflows, and provided with facilities to permit manual flow measurement. Overflows should be recorded and reported to the regulatory agencies.

2.3.3 **Equipment Requirements**

The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives, or electrical generating equipment.

2.3.3.1 ***Engine Protection***

The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment shall be capable of shutting down the engine and activating an alarm on site and as provided in Design Section 2.2.13. Protective equipment shall monitor for conditions of low oil pressure and overheating, except that oil pressure monitoring will not be required for engines with splash lubrication.

2.3.3.2 ***Size***

The engine shall have adequate rated power to start and continuously operate all connected loads.

2.3.3.3 ***Fuel Type***

Reliability and ease of starting, especially during cold weather conditions, should be considered in the selection of the type of fuel.

2.3.3.4 ***Engine Ventilation***

The engine shall be located above grade with adequate ventilation of fuel vapours and exhaust gases.

2.3.3.5 ***Routine Start-up***

All emergency equipment shall be provided with instructions indicating the need for regular starting and running of such units at full loads.

2.3.3.6 ***Protection of Equipment***

Emergency equipment shall be protected from damage at the restoration of regular electrical power.

2.3.4 **Engine-Driven Pumping Equipment**

Where permanently-installed or portable engine-driven pumps are used, the following requirements in addition to general requirements shall apply.

2.3.4.1 Pumping Capacity

Engine-driven pumps shall meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable.

2.3.4.2 Operation

The engine and pump shall be equipped to provide automatic start-up and operation of pumping equipment. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity and alarm systems must meet the requirements of Design Section 2.3.4.3.

2.3.4.3 Portable Pumping Equipment

Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity to allow time for detection of pump station failure and transportation and hookup of the portable equipment shall be provided. A riser from the force main with quick-connect coupling and appropriate valving shall be provided to hook up portable pumps.

2.3.5 Engine-Driven Generating Equipment

Where permanently-installed or portable engine-driven generating equipment is used, the following requirements in addition to general requirements shall apply.

2.3.5.1 Generating Capacity

Generating unit size shall be adequate to provide power for pump motor starting current and for lighting, ventilation and other auxiliary equipment necessary for safety and proper operation of the pumping station. The operation of only one pump during periods of auxiliary power supply must be justified. Such justification may be made on the basis of maximum anticipated flows relative to single-pump capacity, anticipated length of power outage and storage capacity. Special sequencing controls shall be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating.

2.3.5.2 Operation

Provisions shall be made for automatic and manual start-up and load transfer. The generator must be protected from operating conditions that would result in damage to equipment. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity and alarm systems must meet requirements of Design Section 2.3.5.3

2.3.5.3 Portable Generating Equipment

Where portable generating equipment or manual transfer is provided, sufficient storage capacity to allow time for detection of pump station failure and transportation and connection of generating equipment shall be provided. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

2.4 INSTRUCTIONS AND EQUIPMENT

The operating authority of sewage pumping stations shall be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, tools and such spare parts as may be necessary.

2.5 FORCE MAINS

2.5.1 Velocity

At design average flow, a cleansing velocity of at least 0.6 meters per second shall be maintained.

2.5.2 Air Relief Valve and Blowoff

An automatic air relief valve shall be placed at high points in the force main to prevent air locking. Blowoffs should be provided at all low points in pressure sewers.

2.5.3 Termination

Force mains should enter the gravity sewer system at a point not more than 0.6 m above the flow line of the receiving manhole. A 45° bend may be considered to direct the flow downward.

2.5.4 Design Pressure

The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

2.5.5 Size

Force mains shall be sized to provide sufficient flow velocity, required capacity at the available head and to withstand operating pressures as outlined in Design Sections 2.5.1 and 2.5.4.

2.5.6 Slope and Depth

Force main slope does not significantly affect the hydraulic design or capacity of the pipeline itself. Under no circumstance, however, shall any force main be installed at zero slope. Zero slope installation makes line filling and pressure testing difficult, and promotes accumulation of air and wastewater gases.

A forcemain should have a minimum cover of 1.8 m.

2.5.7 **Special Construction**

Force main construction near watercourses or used for aerial crossing shall meet applicable requirements of Design Sections 1.9 and 1.10.

2.5.8 **Design Friction Losses**

Friction losses through force mains shall be based on the Hazen Williams formula or another acceptable method. When the Hazen Williams formula is used, the following values for "C" shall be used for design.

Unlined iron or steel	-	100
All other	-	120

When initially installed, force mains will have a significantly higher "C" factor. The "C" factor of 120 should be considered in calculating maximum power requirements for smooth pipe.

2.5.9 **Separation from Water Mains**

Water mains and sewage force mains are to be installed in separate trenches. The soil between the trenches shall be undisturbed. Force mains crossing water mains shall be laid to provide a minimum vertical distance of 450 mm between the outside of the force main and the outside of the water main. The water main shall be above the force main. At crossings, one full length of water pipe shall be located so both joints will be as far from the force main as possible. Special structural support for the water main and the force main may be required.

2.5.10 **Identification**

Where force mains are constructed of material which might cause the force main to be confused with potable water mains, the force main should be appropriately identified.

2.6 TESTING

2.6.1 **General**

The entire length of a force main shall be tested for leakage. If the length of a force main exceeds 400 m, the allowable leakage must not exceed the allowable leakage for a similar force main 400 m in length. All valves in the force main must be opened immediately prior to testing.

2.6.2 **Leakage Test**

The force main shall be filled with water, and a test pressure of 1035 kPa or equal to 1.5 times the working pressure shall be applied, measured at the lowest point in the test section. The pressure shall be maintained by pumping water from a suitable container of known volume. The amount of water used for a period of two hours shall be recorded.

2.6.3 Allowable Leakage

Allowable leakage for a force main shall be determined by the following formula:

$$L = \frac{(SD) \times P^{0.5}}{727{,}500}$$

where:

L = allowable leakage in litres/hour
S = length of pipe in metres
D = nominal diameter of pipe in mm
P = test pressure in kPa

Allowable leakage for closed metal seated valves is 1.2 ml per mm of nominal valve diameter per hour.

3.1 PERFORMANCE EXPECTATIONS

Treatment, the extent of which will depend upon local conditions, shall be provided in connection with all sewer installations. The engineer should confer with the regulatory agencies before proceeding with the design of detailed plans.

3.1.1 Preliminary Treatment

Coarse screens, bar screens and comminutors are generally provided so as to protect downstream pumps and other equipment from damage caused by the movement of large solids and trash.

Usually, grit chambers remove all particles that have settling velocities (in a quiescent settling column) greater than 1.5 to 3 cm/sec at 20°C. Sand particles of specific gravity 2.65 and size 0.2 mm (retained on a 65-mesh screen) are known to have a settling velocity of approximately 3 cm/sec and grit chambers are designed to remove all sand (and gravel) particles of size greater than 0.2 mm. However, particles of specific gravity lower than 2.65 can also have settling velocity greater than 3 cm/sec when they are of very coarse size, and such solids are also removed in a grit chamber whether they are inorganic or organic. Design engineers have no control over this. The only controlling factor is the settling (or subsiding) velocity of a solid particle and this depends on particle size as well as specific gravity (at a given temperature). Consequently, particles collected even in properly designed and operated grit chambers have been known to have wide ranges of specific gravity, size, shape, character and organic content.

Pre-aeration of wastewater can be used to achieve the following objectives:

a. odour control;
b. grease separation and increased grit removal;
c. prevention of septicity;
d. grit separation;
e. flocculation of solids;
f. maintenance of dissolved oxygen (D.O.) in primary treatment tanks at low flows;
g. increased removal of BOD and SS in primary units (see Figure 3.1); and
h. to minimize solids deposits on side walls and bottom of wetwells.

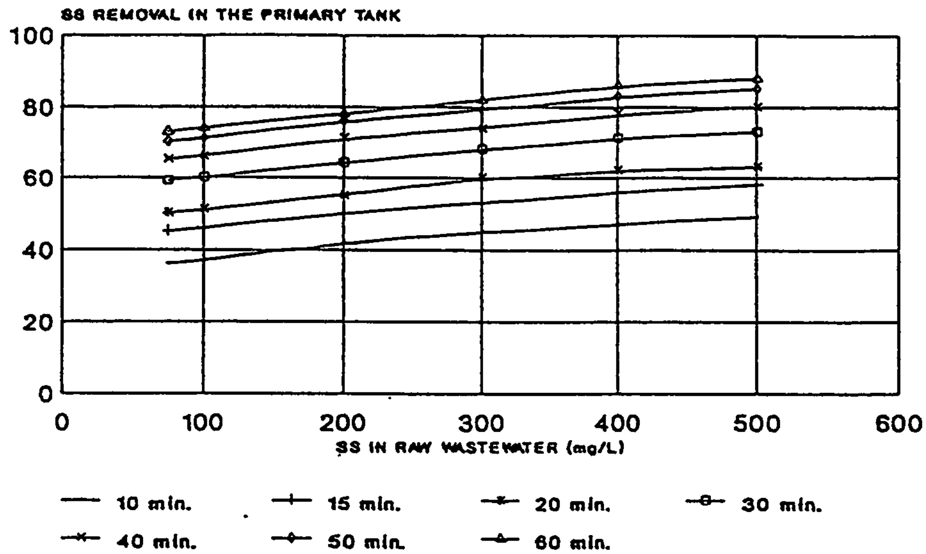
The flocculation process in preliminary wastewater treatment is used for the following purposes and benefits:

1. Increased removal of SS in the primary settling basin by mechanically or physically induced agglomeration of the finer particles.

2. Increased removal of BOD, SS, and phosphorus by treating raw wastewater with chemicals ahead of primary sedimentation.

Pre-chlorination (the practice of applying chlorine at the plant headworks) is used principally to control odour, corrosion and septicity, and to aid in grease removal. The provision to pre-chlorinate influent wastewater should be provided for all wastewater treatment plants.

FIGURE 3.1
EFFECT OF PREAERATION ON REMOVAL OF
SS IN A PRIMARY SETTLING TANK



NOTE : REMOVAL BASED ON A 2 HR DETENTION TIME IN THE SETTLING BASINS

3.1.2 Primary, Secondary and Tertiary Treatment

Table 3.1 lists expected effluent quality produced by well operated treatment facilities treating typical municipal sanitary sewage. The table can be used to illustrate potential effluent quality for selected processes, and as a guide for performance comparisons. Specific facilities may have different treatment objectives and quality requirements.

3.2 SITE CONSIDERATIONS

3.2.1 Plant Location

The following items shall be considered when selecting a plant site:

a. proximity to residential areas;
b. direction of prevailing winds;
c. accessibility;

TABLE 3.1 - SEWAGE TREATMENT PROCESSES TYPICAL EFFLUENT QUALITY

PROCESS	BOD_5 mg/L	TSS mg/L	Total P, mg/L	Total N, mg/L
Primary (including anaerobic lagoons)	75-150	50-110	5-5	25-45
- With P Removal	45-85	25-50	1-2	20-40
Secondary				
- Biological (Mech.)	10-25	10-25	3.5-6.5	15-35
- Aerated Lagoons	15-30	20-35	4-7	20-40
- Faculative Lagoons - Winter to Late Spring - Summer to Late Fall	 25-70 10-30	 20-60 10-40	 3.5-7 2-5	 20-35 5-10
Advanced				
- Secondary with chemical treatment (P control)	5-15	10-30	0.5-1.5	15-35

d. area available for expansion;
e. local zoning requirements;
f. local soil characteristics, geology, hydrology and topography available to minimize pumping;
g. access to receiving stream;
h. downstream uses of the receiving stream; and
i. compatibility of treatment process with the present and planned future land use, including noise, potential odors, air quality and anticipated sludge processing and disposal techniques.
j. proximity to surface water supplies and water wells.

Where a site must be used which is critical with respect to these items, appropriate measures shall be taken to minimize adverse impacts.

3.2.2 Separation Distances

Separation distances should be designed to prevent the occurrence of objectionable odours in subdivisions and surface water and groundwater contamination, when sewage treatment plants are operated normally and within designed capacities. They should not be designed to accommodate unusual upset conditions that may occur from time to time.

Separation distances will be measured from the proposed odour producing source to the nearest neighbouring lot line. Specific separation distances are as follows:

a. Mechanical plants shall be located a minimum of 150 m from residences, 30 m from commercial-industrial developments and 30 m from any other adjacent property boundaries. Under special circumstances a lesser separation distance to residences may be adopted, provided provision for odour control equipment is provided at the plant; and

b. Waste stabilization lagoons shall be located at least 150 m from isolated human habitation and 300 m from built-up areas.

3.2.3 Flood Protection

The treatment works structures, electrical and mechanical equipment shall be protected from physical damage from the one hundred (100) year flood. Treatment works should remain fully operational and accessible during the twenty-five (25) year flood. This applies to new construction and to existing facilities undergoing major modifications. The designer should consult the Canada - Nova Scotia Agreement regarding flood protection and designated flood areas.

3.2.4 General Plant Layout

The general arrangement of the plant within the site should take into account the subsurface conditions and natural grades to provide the necessary facilities at minimum cost.

In the layout of the plant, the designer should orient the buildings to provide adequate allowances for future linear expansions of the various treatment sections and orient the plant so that the best advantage can be taken of the prevailing wind and weather conditions to minimize odour, misting and freezing problems and energy consumption. The plant layout should also allow for the probability of snow drifting, with entrances, roadways and open tankage located so that the effect of snow drifting on operations will be minimized.

It is not recommended that construction of any of the facilities be in close proximity to a shore line, except where this is unavoidable. Suitable measures must be taken to adequately protect the structures from the effects of wave action and shore erosion.

Within the constraints mentioned above, the designer should work towards a plant layout where the various processing units are arranged in a logical progression to avoid the necessity for major pipelines or conduits to transmit wastewater, sludges, or chemicals from one module to the next, and also to arrange the plant layout to provide for convenience of operation and ease of flow splitting for proposed and future treatment units.

Where site roadways are provided for truck access, the road design should be sufficient to withstand the largest anticipated delivery or disposal vehicles with due allowance for vehicle turning and forward exit from the site.

In order to avoid the dangers of high voltage lines crossing the site, it is suggested that a high voltage pole be located at the property line. Depending on the distance from the terminal pole to the control building, the step-down transformer would be located at the terminal pole or adjacent to the control building. If the distance between the terminal pole and the building is excessive, the transformer should be located adjacent to the building. Then the high voltage connections should be brought by underground cable to the pothead at the transformer. In this way, the primary and secondary terminals of the transformer are fully enclosed and no fence is required around the transformer.

Sewage treatment works sites must be adequately fenced and posted to prevent persons from obtaining unauthorized access.

3.2.5 Provision For Future Expansion

In addition to the general site considerations outlined in Design Section 3.2.4, there are a number of allowances needed to provide for economical and practical expansion of the wastewater treatment facilities. Key provisions include:

a. Design of on-site pumping stations such that their capacity can be increased and/or parallel facilities constructed without the need for major disruption of the plant's operation;

b. Layout and sizing of channels and plant piping such that additional treatment units can be added or increases in loading rates accommodated. Similarly, the layout of buildings and tankage should accommodate the location of the future stages of expansion;

c. Space provision within buildings to provide for replacement of equipment with larger capacity units. This is particularly important with equipment such as pumps, blowers, boilers, heat exchanges, etc. Adequate working space shall be provided around equipment, and provision made for the removal of equipment; and,

d. Sizing of inlet and outlet sewers to account for the ultimate plant capacity. Provided that problems will not occur with excessive sedimentation in the sewers, these sewers should be sized for the ultimate condition. With diffused outfalls, satisfactory port velocities can often be obtained by blocking off ports which will not be required until subsequent expansion stages.

3.3 QUALITY OF EFFLUENT

The required degree of treatment for sewage treatment plants shall be based on the Provincial Water Quality objectives (reference chapter P2) for the receiving waters as established by the regulatory agencies.

3.4 GENERAL DESIGN REQUIREMENTS

3.4.1 Type of Treatment

A process should be capable of providing the necessary treatment and effluent discharge control to protect the adjacent and receiving environment.

As a minimum, the following items shall be considered in the selection of the type of treatment:

a. present and future effluent requirements;
b. location of and local topography of the plant site;
c. space available for future plant construction;
d. the effects of industrial wastes likely to be encountered;
e. ultimate disposal of sludge;
f. system capital costs;
g. system operating and maintenance costs, including basic energy requirements;
h. process complexity governing operating personnel requirements;
i. environmental impact on present and future adjacent land use;
j. sewage characteristics and the results of any treatability or pilot plant studies; and
k. reliability of the process and the potential for malfunctions or bypassing needs.

3.4.2 Engineering Data for New Process Evaluation

The policy of the reviewing authority is to encourage rather than obstruct the development of any methods or equipment for the treatment of wastewater. The lack of inclusion in these standards of some types of wastewater treatment processes or equipment should not be construed as precluding their use. The reviewing authority may approve other types of wastewater treatment processes and equipment under the condition that the operational reliability and effectiveness of the process or device shall have been demonstrated with a suitably-sized prototype unit operating at its design load conditions, to the extent required.

The reviewing authority may require the following:

a. monitoring observations, including tests results and engineering evaluations, demonstrating the efficiency of such processes;

b. detailed description of the test methods;

c. testing, including appropriately composite samples, under various ranges of strength and flow rates (including diurnal variations) and waste temperatures over a sufficient length of time to demonstrate performance under climatic and other conditions which may be encountered in the area of the proposed installations; and

d. other appropriate information.

The reviewing authority may require that appropriate testing be conducted and evaluations be made under the supervision of a competent process engineer other than those employed by the manufacturer or developer.

3.4.3 Design Loads

3.4.3.1 Design Period

Factors which will have an influence on the design period of sewage treatment works include the following:

- population growth rates;
- prevailing financing interest rates;
- inflation rates;
- ease of expansion of facilities; and
- time requirements for design and construction or expansion.

Wherever possible, sewage treatment plants should be designed for the flows expected to be received 20 years hence, under normal growth conditions. In certain cases, where it can be shown that staging of construction will be economically advantageous, lesser design periods may be used provided it can be demonstrated that the required capacity can be "on line" when needed.

3.4.3.2 Hydraulic Design

Flow conditions critical to the design of the treatment plant are described in Policy section 4.5.5.8.

Initial low flow conditions must be evaluated in the design to minimize operational problems with freezing, septicity, flow measurements and solids dropout. The design peak hourly flows must be considered in evaluating unit processes, pumping, piping, etc.

The treatment plant design flow selected shall meet the appropriate effluent and water quality standards that are set forth in the permit to operate. The design of treatment units that are not subject to peak hourly flow requirements shall be based on the design average flow. For plants subject to high wet weather flows or overflow detention pumpback flows, the design maximum day flows that the plant is to treat on a sustained basis should be specified.

3.4.3.2.1 *New Systems*

Hydraulic Capacity for Wastewater Facilities to serve New Collection Systems.

i) The sizing of wastewater facilities receiving flows from new wastewater collection systems shall be based on an average daily flow of 340 L per capita plus wastewater flow from industrial plants and major institutional and commercial facilities unless water use data or other justification upon which to better estimate flow is provided.

ii) The 340 L/cap·d figure shall be used, in conjunction with an extraneous flow allowances (see Design Section 1.3) intended to cover infiltration.

iii) If the new collection system is to serve existing development the likelihood of I/I contributions from existing service lines and non-wastewater connections to those service lines shall be evaluated and wastewater facilities designed accordingly.

3.4.3.2.2 *Existing Systems*

Hydraulic Capacity for Wastewater Facilities to serve existing Collection Systems:

i) Projections shall be made from actual flow data to the extent possible.

ii) The probable degree of accuracy of data and projections shall be evaluated. This reliability estimation should include an evaluation of the accuracy of existing data, as well as an evaluation of the reliability of estimates of flow reduction anticipated due to infiltration/inflow (I/I) reduction or flow increases due to elimination of sewer bypasses and backups.

iii) Critical data and methodology used shall be included. It is recommended that graphical displays of critical peak wet weather flow data (refer to Policy Section 4.5.5.8) be included for a sustained wet weather flow period of significance to the project.

iv) At least one year's flow data should be taken as the basis for determining the various critical flow conditions.

3.4.3.2.3 *Wet Weather Flows*

If unusually high flows are encountered during wet weather periods, a thorough investigation of the collection system should be made and a program for corrective action initiated.

3.4.3.2.4 *Flow Equalization*

Facilities for the equalization of flows and organic shock loads shall be considered at all plants which are critically affected by surge loadings. The sizing of the flow equalization facilities should be based on data obtained herein and from Design Section 1.3.

3.4.3.3 ***Organic Design Loads***

3.4.3.3.1 *Organic Load Definitions and Identification*

The following organic loads for the design year shall be identified and used as a basis for design of wastewater treatment facilities. Where any of the terms defined in this Section are used in these design standards, the definition contained in this Section applies.

a. **Biochemical Oxygen Demand Defined**

The 5-day Biochemical Oxygen Demand (BOD_5) is defined as the amount of oxygen required to stabilize biodegradable organic matter under aerobic conditions within a five day period in accordance with **Standard Methods**, 19th Edition. Total 5-day Biochemical Oxygen demand ($TBOD_5$) is equivalent to BOD_5 and is sometimes used in order to differentiate carbonaceous plus nitrogenous oxygen demand from strictly carbonaceous oxygen demand.

The carbonaceous 5-day Biochemical Oxygen Demand ($CBOD_5$) is defined as BOD_5 less the nitrogenous oxygen demand of the wastewater. See **Standard Methods**, 19th Edition.

b. **Design Average BOD_5**

The design average BOD_5 is generally the average of the organic load received for a continuous 12 month period for the design year expressed as weight per day. However, the design average BOD_5 for facilities having critical seasonal high loading periods (e.g., recreational areas, campuses, industrial facilities) shall be based on the daily average BOD_5 during the seasonal period.

c. **Design Maximum Day BOD_5**

The design maximum day BOD_5 is the largest amount of organic load to be received during a continuous 24 hour period expressed as weight per day.

d. **Design Peak Hourly BOD_5**

The design peak hourly BOD_5 is the largest amount of organic load to be received during a one hour period expressed as weight per day.

3.4.3.3.2 *New Systems*

Organic Capacity of Wastewater Treatment Facilities to Serve New Collection Systems.

a. Domestic waste treatment design shall be on the basis of at least 0.08 kg of BOD_5 per capita per day and 0.09 kg of suspended solids per capita per day, unless information is submitted to justify alternate designs.

b. When garbage grinders are used in areas tributary to a domestic treatment plant, the design basis should be increased to 0.10 kg of BOD_5 per capita per day and 0.11 kg pounds of suspended solids per capita per day.

c. Where appreciable amounts of industrial waste are included, consideration shall be given to the character of wastes in the design of the plant.

d. Data from similar municipalities may be utilized in the case of new systems. However, thorough investigation that is adequately documented shall be provided to the reviewing authority to establish the reliability and applicability of such data.

3.4.3.3.3 *Existing Systems*

Design of Organic Capacity of Wastewater Treatment Facilities to Serve Existing Collection Systems:

a. Projections shall be made from actual wasteload data to the extent possible. Laboratory analyses shall be made on composite samples taken over 24 hour periods. This data shall include composite samples for the maximum significant period of sewage and industrial waste discharge, and shall cover a significant period of time to be representative of actual conditions. It is recommended that the designing engineer confer with the reviewing agency for details concerning the collection and analysis of samples. Recognition should be given to flow patterns for institutions, schools, motels, etc.

b. Projections shall be compared to Design Section 3.4.3.3.2 and an accounting made for significant variations from those values.

c. Impact of industrial sources shall be documented. For projects with significant industrial contributions, pretreatment may be required.

3.4.3.4 ***Shock Effects***

The shock effects of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants, shall be considered.

3.4.3.5 *Design by Analogy*

Data from similar municipalities may be utilized in the case of new systems; however, a thorough investigation that is adequately documented shall be provided to the reviewing authority to establish the reliability and applicability of such data.

3.4.3.6 *Design Capacity of Various Plant Components (Without Flow Equalization)*

In general, all components of mechanical sewage treatment plants should be hydraulically capable of handling the anticipated peak sewage flow rates without overtopping channels and/or tankage. From a process point-of-view, however, the design of various sections of sewage treatment plants should be based upon the following hydraulic, organic and inorganic loading rates:

Sewage Pumping Stations

- peak hourly flow rate.

Screening

- peak flow rate.

Grit Removal

- peak flow rate, peak grit loading rate.

Primary Sedimentation

- peak flow rate, peak suspended solids loading rate.

Aeration (without nitrification)

- average diurnal BOD_5 loading rate is usually sufficient with predominantly domestic wastes, but the presence of significant industrial waste loadings may create sufficient diurnal variations to warrant consideration. Daily or seasonal variations in domestic and/or industrial BOD loading rates should be taken into consideration. Except for short detention treatment systems, such as contact stabilization or high rate processes, hydraulic detention time is seldom critical.

Aeration (with nitrification)

- average diurnal BOD_5 loading rate is usually sufficient with predominantly domestic wastes, but the presence of significant industrial waste loadings may create sufficient BOD diurnal variations to warrant consideration. Diurnal peak flow rate and diurnal peak ammonia (total Kjeldahl nitrogen with extended aeration) loading rates must be designed for. Daily or seasonal variations in BOD_5, ammonia, total Kjeldahl (with extended aeration) and peak flow rates should also be taken into consideration.

Secondary Sedimentation

- peak hourly flow rate or peak solids loading rate, whichever governs.

Sludge Return

- capacity requirements will vary with the treatment system (see Design Section 10).

Disinfection Systems

- peak flow rate.

Chemical Feed Systems

- peak flow rate.

Effluent Filtration

- peak flow rate, peak solids loading rate.

Outfall Sewer

- peak flow rate.

Sludge Treatment (digestion, thickening, dewatering, incineration, etc.)

- average loading rates (hydraulic, total solids, volatile solids) unless sustained peaks are of significance to the individual treatment process.

3.4.4 Conduits

All piping and channels should be designed to carry the maximum expected flows. The incoming sewer should be designed for unrestricted flow. Bottom corners of the channels must be filtered. Conduits shall be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates should be placed in channels to seal off unused sections which might accumulate solids. The use of shear gates or stop planks is permitted where they can be used in place of gate valves or sluice gates. Non-corrodible materials shall be used for these control gates.

3.4.5 Flow Division Control

Flow division control facilities shall be provided as necessary to insure organic and hydraulic loading control to plant process units and shall be designed for easy operator access, change, observation and maintenance. Appropriate flow measurement shall be incorporated in the flow division control design.

3.4.6 **Wastewater Flow Measurement**

Facilities for measuring and recording all wastewater flows through the treatment works shall be provided. All plant and process unit bypasses should also be equipped with flow measuring devices, such that hydraulic balances around each treatment process unit and the total plant are possible. Flow measuring devices should be located so that the flows measured are meaningful and recordable.

3.4.6.1 ***Location***

Flow measurement facilities shall be provided to measure the following flows:

a. Plant influent or effluent flow;

b. Plant influent flow: If influent flow is significantly different from effluent flow, both shall be measured. This would apply for installations such as lagoons, and plants with excess flow storage or flow equalization;

c. Excess flow treatment facility discharges;

d. Other flows required to be monitored under the provisions of the permit to operate; and

e. Other flows such as returned activated sludge, waste activated sludge, recirculation, and recycle required for plant operational control.

3.4.6.2 ***Facilities***

Indicating, totalizing, and recording flow measurement devices shall be provided for all mechanical plants. Flow measurement facilities for lagoon systems shall not be less than elapsed time meters used in conjunction with pumping rate tests or shall be calibrated weirs. All flow measurement equipment must be sized to function effectively over the full range of flows expected and shall be protected against freezing.

3.4.6.3 ***Hydraulic Conditions***

Flow measurement equipment including entrance and discharge conduit configuration and critical control elevations shall be designed to ensure that the required hydraulic conditions necessary for accurate measurement are provided. Conditions that must be avoided include turbulence, eddy currants, air entrainment, etc., that upset the normal hydraulic conditions that are necessary for accurate flow measurement.

3.4.7 **Component Back-up Requirements**

The components of sewage treatment plants should be designed in such a way that equipment breakdown and normal maintenance operations can be accommodated without causing serious deterioration of effluent quality.

To achieve this, critical treatment processes should be provided in multiple units so that with the larger unit out of operation, the hydraulic capacity (not necessarily the design rated capacity) of the remaining units shall be sufficient to handle the peak wastewater flow. There should also be sufficient flexibility in capability of operation so that the normal flow into a unit out of operation can be distributed to all the remaining units. Similarly, it should be possible to distribute the flow of all of the units in the treatment process downstream of the affected process. In addition, where feasible, it should be possible to operate the sections of treatment plants as completely separate process trains to allow full-scale loading tests to be carried out.

3.4.8 Sampling Equipment

Effluent composite sampling equipment shall be provided at all mechanical plants with a design average flow of 380m^3/day or greater and at other facilities where necessary to meet "permit to operate" monitoring requirements. Composite sampling equipment shall also be provided as needed for influent sampling and for monitoring plant operations.

3.4.9 Plant Hydraulic Gradient

The hydraulic gradient of all gravity flow and pumped waste streams within the sewage treatment plant, including by-pass channels, should be prepared to ensure that adequate provision has been made for all head losses. In calculating the hydraulic gradient, changes in head caused by all factors should be considered, including the following:

a. head losses due to channel and pipe wall friction;

b. head losses due to sudden enlargement or sudden contraction in flow cross section;

c. head losses due to sudden changes in direction, such as at bends, elbows, Wye branches and tees;

d. head losses due to sudden changes in slope, or drops;

e. head losses due to obstructions in conduits;

f. head required to allow flow over weirs, through flumes, orifices and other measuring, controlling, or flow division devices;

g. head losses caused by flow through comminutors, bar screens, tankage, filters and other treatment units;

h. head losses caused by air entrainment or air binding;

i. head losses incurred due to flow splitting along the side of a channel;

j. head increases caused by pumping;

k. head allowances for expansion requirements and/or process changes; and

l. head allowances due to maximum water levels in receiving waters.

3.4.10 Arrangement of Units

Component parts of the plant should be arranged for greatest operating and maintenance convenience, flexibility, economy, continuity of maximum effluent quality and ease of installation of future units.

3.5 PLANT DETAILS

3.5.1 Installation of Mechanical Equipment

The specifications should be so written that the installation and initial operation of major items of mechanical equipment will be supervised by a representative of the manufacturer.

3.5.2 By-Passes

3.5.2.1 General

Except where duplicate units are available, properly located and arranged by-pass structures shall be provided so that each unit of the plant can be removed from service independently. The by-pass design shall facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode. By-pass systems should also be constructed so that each unit process can be separately by-passed.

3.5.2.2 Unit By-Pass During Construction

Final plan documents shall include construction requirements as deemed necessary by the reviewing agency to avoid unacceptable temporary water quality degradation.

3.5.3 Overflows

If sewage entering the treatment plant must be pumped into the treatment units, an emergency overflow for the pumping station should be provided, if it is physically possible (reference to chapter D2). The purpose of this overflow is to prevent basement flooding by back-ups in the sewer system in the event of pumping station failure. Wherever possible, this overflow should be routed through the chlorine contact chamber and plant outfall sewer. If this is not possible, provision should be made for chlorination of such overflows.

The overflow elevation and the method of activation should ensure that the maximum feasible storage of the wet well will be utilized before the controlled overflow takes place. The overflow facilities should at least be alarmed and equipped to indicate frequency and duration of overflows and provided with facilities to permit manual flow measurement. Automatic flow measurement and recording systems may be required in certain cases where effluent quality requirements dictate.

3.5.4 **Drains**

Means shall be provided to dewater each unit to an appropriate point in the process. Due consideration shall be given to the possible need for hydrostatic pressure relief devices to prevent flotation of structures. Pipes subject to clogging shall be provided with means for mechanical cleaning or flushing.

3.5.5 **Construction Materials**

Due consideration should be given to the selection of materials which are to be used in sewage treatment works because of the possible presence of hydrogen sulphide and other corrosive gases, greases, oils and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Dissimilar metals should be avoided to minimize galvanic action.

3.5.6 **Painting**

The use of paints containing lead or mercury should be avoided. In order to facilitate identification of piping, particularly in the large plants, it is suggested that the different lines be color-coded. The following color scheme is recommended for purposes of standardization.

Raw sludge line - brown with black bands
Sludge recirculation suction line - brown with yellow bands
Sludge draw off line - brown with orange bands
Sludge recirculation discharge line - brown
Sludge gas line - orange (or red)
Natural gas line - orange (or red) with black bands
Nonpotable water line - blue with black bands
Potable water line - blue
Chlorine line - yellow
Sulfur Dioxide - yellow with red bands
Sewage (wastewater) line - grey
Compressed air line - green
Water lines for heating digesters or buildings - blue with a 150 mm red band spaced 760 mm apart

The contents and direction of flow shall be stencilled on the piping in a contrasting color.

3.5.7 **Operating Equipment**

A complete outfit of tools and accessories and spare parts necessary for the plant operator's use shall be provided. A portable pump is desirable. Readily accessible storage space and work bench facilities shall be provided and consideration given to provision of a garage area which would also provide space for large equipment, maintenance and repair.

3.5.8 Grading and Landscaping

Upon completion of the plant, the ground should be graded. Concrete or gravel walkways should be provided for access to all units. Where possible, steep slopes should be avoided to prevent erosion. Surface water shall not be permitted to drain into any unit. Particular care shall be taken to protect trickling filter beds, sludge beds and intermittent sand filters, from surface wash. Provision should be made for landscaping, particularly when a plant is located near residential areas.

3.5.9 Erosion Control During Construction

Effective site erosion control shall be provided during construction as outlined in the Nova Scotia Department of the Environment publication, "Erosion and Sedimentation Control Handbook for Construction Sites". An approved erosion control plan is required before construction begins.

3.5.10 Cathodic Protection

Steel fabricated sewage treatment plants shall require cathodic protection for corrosion control as specified in Design Section 2.2.12.

3.6 PLANT OUTFALLS

3.6.1 Dilution

Outfall sewers shall consist of a completely piped system conforming to the requirements of Design Section 1 of these guidelines and shall not discharge into any ditch or watercourse in which adequate assimilative capacity is not available. In assessing the available assimilative capacity the proximity of other outfalls must be taken into consideration. The outfall sewer shall be designed to discharge to the receiving water in a manner acceptable to the reviewing authority. Consideration should be given to each of the following: a) utilization of cascade aeration of effluent discharge to increase dissolved oxygen levels and b) limited or complete across-stream dispersion as needed to protect aquatic life movement and growth in the immediate reaches of the receiving stream.

3.6.2 Outlet

The outfall sewer, where practicable, shall be extended to the low water level of the receiving body of water in such a manner to insure the satisfactory dispersion of the effluent thereto and insofar as practicable, it shall have its outlet submerged. Where greater depths are available, three (3) feet should be the achieved depth of submergence.

3.6.3 Protection and Maintenance

The outfall sewer shall be so constructed and protected against the effects of flood water, tides, ice or other hazards as to reasonably insure its structural stability and freedom from stoppage.

A manhole should be provided at the shore end of all gravity sewers extending into the receiving waters, complete with a flow measuring device.

Hazards to navigation must be considered in designing outfall sewers.

3.6.4 Dispersion of Flow

Where conditions exist that a point discharge of effluent could have deleterious effects on the receiving body of water, consideration shall be given to providing a means of effective submerged dispersion of the effluent into the water course.

3.6.5 Sampling Provisions

All outfalls shall be designed so that a sample of the effluent can be obtained at a point after the final treatment process and before discharge to or mixing with the receiving water.

3.7 ESSENTIAL FACILITIES

3.7.1 Emergency Power Facilities

The need for standby power and the extent of equipment requiring operation by standby power must be individually assessed for each sewage treatment plant. Some of the factors which will require consideration in making the decisions regarding standby power and the processes to be operated by the standby power equipment are as follows:

- reliability of primary power source;
- number of power feeder lines supplying grid system, number of alternate routes within the grid system, and the number of alternate transformers through which power could be directed to the sewage treatment plant;
- whether sewage enters the plant by gravity or is pumped;
- type of treatment provided;
- pieces of equipment which may become damaged or overloaded following prolonged power failure;
- assimilation capacity of the receiving waters and ability to withstand higher pollution loadings over short time periods; and
- other uses of the receiving water.

Each specific installation should provide for the following considerations:

- means for illuminating working areas to ensure safe working conditions; and

- standby power source or equivalent to power pumps, motorized valves and control panels that are necessary to maintain the sewage flow through the treatment plant.

Standby generating capacity normally is not required for aeration equipment used in the activated sludge process. In cases where a history of long-term (4 hours or more) power outages have occurred, auxiliary power for minimum aeration of the activated sludge will be required. Full power generating capacity may be required by the reviewing authority on certain critical stream segments.

3.7.2 Water Supply

3.7.2.1 *General*

An adequate supply of potable water under pressure shall be provided for use in the laboratory, chlorination equipment and general cleanliness around the plant. The chemical quality should be checked for suitability for its intended uses such as heat exchangers, chlorinators, etc.

No piping or other connections shall exist in any part of the treatment works, which, under any conditions, might cause the contamination of a potable water supply. If a potable water supply is brought to the plant, it shall be protected with a suitable backflow prevention device.

3.7.2.2 *Direct Connections*

Potable water from a municipal or separate supply may be used directly at points above grade for the following hot and cold supplies:

a. lavatory sink;
b. water closet;
c. laboratory sink;
d. shower;
e. drinking fountain;
f. eye wash fountain; and
g. safety shower.

Hot water for any of the above units shall not be taken directly from a boiler used for supplying hot water to a sludge heat exchanger or digester heating coils.

3.7.2.3 *Indirect Connections*

Where a potable water supply is to be used for any purpose in a plant other than those listed in Design Section 3.7.2.2, a break tank, pressure pump and pressure tank shall be provided. Water shall be discharged to the break tank through an air-gap at least 150 mm above the maximum flood line or the spill line of the tank, whichever is higher.

A sign shall be permanently posted at every hose bib, faucet or sill cock located on the water system beyond the break tank to indicate that the water is not safe for drinking.

Consideration will also be given to backflow devices consisting of a system of check valves and relief valves which provide protection against backflow.

3.7.2.4 ***Separate Potable Water Supply***

Where it is not possible to provide potable water from a public water supply, a separate well may be provided as long as sufficient pressure is available. Location and construction of the well should comply with requirements of the regulatory authorities. Requirements governing the use of the supply are those contained in Design Sections 3.7.2.2 and 3.7.2.3.

3.7.2.5 ***Separate Non-Potable Water Supply***

Where a separate non-potable water supply is to be provided, a break tank will not be necessary but all sill cocks and hose bibs shall be posted with a permanent sign indicating the water is not safe for drinking.

3.7.3 Sanitary Facilities

Toilet, shower, lavatory and locker facilities should be provided in sufficient numbers and convenient locations to serve the expected plant personnel.

3.7.4 Floor Slope

Floor surfaces shall be sloped adequately to a point of drainage.

3.7.5 Stairways

Stairways should be installed with a slope of 30 to 35 degrees from the horizontal to facilitate carrying samples, tools, etc. All risers in a stairway should be of equal height. Minimum tread run shall not be less than 200 mm. The sum of the tread run and riser shall not be less than 430 mm nor more than 460 mm. A flight of stairs shall consist of not more than 3 m continuous rise without a platform. Stairways shall be installed wherever possible in lieu of ladders.

3.8 SAFETY

3.8.1 General

Adequate provision shall be made to effectively protect the operator and visitors from hazards. The following shall be provided to fulfil the particular needs of each plant:

a. Enclosure of the plant site with a fence and signs designed to discourage the entrance of unauthorized persons and animals;

b. Hand rails and guards around tanks, trenches, pits, stairwells, and other hazardous structures with the tops of walls less that 1 m above the surrounding ground level;

c. Gratings over appropriate areas of treatment units where access for maintenance is required;

d. First aid equipment;

e. "No Smoking" signs in hazardous areas;

f. Protective clothing and equipment, such as self-contained breathing apparatus, gas detection equipment, goggles, gloves, hard hats, safety harnesses, etc.;

g. Portable blower and sufficient hose;

h. Portable lighting equipment complying with the National and Provincial Electrical Code requirements;

i. Gas detectors;

j. Appropriately-placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manholes, hazardous chemical storage areas, flammable fuel storage areas, etc.;

k. Adequate ventilation in pump station areas in accordance with Design Section 2.2.7.

l. Provisions for local lockout on stop motor controls; and

m. Provisions for confined space entry in accordance with regulatory agency requirements.

3.8.2 Hazardous Chemical Handling

Reference should be made to Federal "Transportation of Dangerous Goods Act" and the Provincial "Dangerous Goods and Hazardous - Wastes Management Act".

3.8.2.1 Contaminant Materials

The materials utilized for storage, piping, valves, pumping, metering, splash guards, etc., shall be specially selected considering the physical and chemical characteristics of each hazardous or corrosive chemical.

3.8.2.2 Primary Containment

Structures, rooms, and areas accommodating chemical storage and feed equipment should be arranged to provide convenient access for chemical deliveries, equipment servicing and repair, and observation of operation. It is recommended that wherever possible the storage area be separated from the main plant, and that segregated storage be provided for each chemical. Where two, or more, chemicals could react with undesirable effects, the drainage piping (if provided) from the separate chemical handling areas should not be interconnected. For dangerous materials such as gaseous chlorine, either floor drains in the storage and scale rooms should be omitted entirely, with the floors sloped towards the doors, or floor drains installed, but kept totally separated from the drainage systems for the rest of the building.

3.8.2.3 *Secondary Containment*

Chemical storage areas shall be enclosed in dykes or curbs which are capable of containing 110% of the stored volume until it can be safely transferred to alternate storage or released to the wastewater at controlled rates which will not damage facilities, inhibit the treatment processes or contribute to stream pollution. Liquid polymer should be similarly contained to reduce areas with slippery floors, especially to protect travel-ways. Non-slip floor surfaces are desirable in polymer handling areas.

3.8.2.4 *Underground Storage*

Underground storage and piping facilities for fuels or for chemicals such as alum or ferric chloride shall be constructed in accordance with applicable provincial and federal regulations on underground storage tanks for both fuels and hazardous materials.

3.8.2.5 *Liquified Gas Chemicals*

Properly designed isolated areas shall be provided for storage and handling of chlorine and sulfur dioxide and other hazardous gases. Gas detection kits, alarms, controls, safety devices, and emergency repair kits shall also be provided.

3.8.2.6 *Eye Wash Fountains and Safety Showers*

Eye wash fountains and safety showers utilizing potable water shall be provided in the laboratory and on each floor level or work location involving hazardous or corrosive chemical storage, mixing (or shaking), pumping, metering, or transportation unloading. These facilities are to be as close as practical to possible chemical exposure sites and are to be fully useful during all weather conditions.

The eye wash fountains shall be supplied with water of moderate temperature (10 to 30°C), separate from the hot water supply, suitable to provide 15 to 30 minutes of continuous irrigation of the eyes.

The emergency showers shall be capable of discharging 2 to 4 litres per second of water at moderate temperature at pressures of 140 to 350 kPa. The eye wash fountains and showers shall be not more than 7.0 m from points of hazardous chemical exposure.

3.8.2.7 *Splash Guards*

All pumps or feeders for hazardous or corrosive chemicals shall have guards which will effectively prevent spray of chemicals into space occupied by personnel. The Splash Guards are in addition to guards to prevent injury from moving or rotating machinery parts.

3.8.2.8 *Piping, Labelling, Coupling Guards, Location*

All piping containing or transporting corrosive or hazardous chemicals shall be identified with labels every 3 m and with at least two labels in each room, closet or pipe chase. Colour coding may also be used but is not an adequate substitute for labelling. All connections (flanged or other type), except adjacent to storage or feeder areas, shall have guards which will direct any leakage away from space occupied by personnel. Pipes containing hazardous or corrosive chemicals should not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate chemical spray or dripping on to personnel.

3.8.2.9 *Protective Clothing or Equipment*

The following items of protective clothing or equipment shall be available and utilized for all operations or procedures where their use will minimize injury hazard to personnel:

a. self-contained air supply system recommended for protection against chlorine;

b. chemical worker's goggles or other suitable goggles (safety glasses are insufficient);

c. face masks or shields for use over goggles;

d. rubber gloves;

e. rubber aprons with leg straps;

f. rubber boots (leather and wool clothing should be avoided near caustics); and

g. safety harness and line.

h. dust mask to protect the lungs in dry chemical areas.

3.8.2.10 *Warning Systems and Signs*

Facilities shall be provided for automatic shut-down of pumps and sounding of alarms when failure occurs in a pressurized chemical discharge line.

Warning signs requiring use of goggles shall be located near chemical unloading stations, pumps and other points of frequent hazard.

3.8.2.11 *Dust Collection*

Dust collection equipment shall be provided to protect personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways. The latter is to minimize slick floors which result when a polymer covered floor becomes wet.

3.8.2.12 *Container Identification*

The identification and hazard warning data included on shipping containers, when received, shall appear on all containers (regardless of size or type) used to store, carry or use a hazardous substance. Sewage and sludge sample containers should be adequately labelled. Below is a suitable label for sewage sample:

RAW SEWAGE Sample point no. ________ Contains Harmful Bacteria. **May contain hazardous or toxic material.** **Do not drink or swallow.** **Avoid contact with openings or breaks in the skin.**

3.9 LABORATORY

3.9.1 General

All treatment works shall include a laboratory for making the necessary analytical determinations and operating control tests, except in individual situations where the omission of a laboratory is approved by the reviewing agency. The laboratory shall have sufficient size, bench space, equipment and supplies to perform all self-monitoring analytical work required by the Permit to Operate and to perform the process control tests necessary for good management of each treatment process included in the design.

The facilities and supplies necessary to perform analytical work to support industrial waste control programs will normally be included in the same laboratory. The laboratory size and arrangement must be sufficiently flexible and adaptable to accomplish these assignments. The layout should consider future needs for expansion in the event that more analytical work is needed. Laboratory instrumentation and size should reflect treatment plant size, staffing requirements, and process complexity. Experience and training of plant operators should also be assessed in determining treatment plant laboratory needs.

Treatment plant laboratory needs may be divided into the following three general categories:

I. Plants performing only basic operational testing; this typically includes pH, temperature, and dissolved oxygen;

II. Plants performing more complex operational and permit laboratory tests including biochemical oxygen demand, suspended solids, and fecal coliform analysis, and;

III. Plants performing more complex operational, permit, industrial pretreatment, and multiple plant laboratory testing.

Expected minimum laboratory needs for these three plant classifications are outlined in this section. However, in specific cases laboratory needs may have to be modified or increased due to the industrial monitoring needs or special process control requirements.

3.9.2 Category I: Plants performing only basic operational testing.

3.9.2.1. *Location and Space*

A floor area up to 14 m^2 should be adequate. It is recommended that this be at the treatment site. Another location in the community utilizing space in an existing structure owned by the involved sewer authority may be acceptable.

3.9.2.2. *Design and Materials*

The facility shall provide for electricity, water, heat, sufficient storage space, a sink, and a bench top. The lab components need not be of industrial grade materials. Laboratory equipment and glassware shall be of types recommended by Standard Methods for the Examination of Water and Wastewater and the reviewing authority.

3.9.3 Category II: Plants performing more complex operational and permit laboratory tests including biochemical oxygen demand, suspended solids, and fecal coliform analysis.

3.9.3.1 *Location and Space*

The laboratory size should be based on providing adequate room for the equipment to be used. In general, the laboratories for this category of plant should provide a minimum of approximately 28 m^2 of floor space. The laboratory should be located at the treatment site on ground level. It shall be isolated away from vibrating, noisy, high-temperature machinery or equipment which might have adverse effects on the performance of laboratory staff or instruments.

3.9.3.2 *Floors*

Floor surfaces should be fire resistant, and highly resistant to acids, alkalies, solvents, and salts.

3.9.3.3 *Cabinets and Bench Tops*

Laboratories in this category usually perform both the permit testing and operational control monitoring utilizing "acids" and "bases" in small quantities, such that laboratory grade metal cabinets and shelves are not mandatory. The cabinets and shelves selected may be of wood or other durable materials. Bench tops should be of acid resistant laboratory grade materials for protection of the non-acid proof cabinets. Glass doors on wall-hung cabinets are not required. One or more cupboard style base cabinets should be provided. Cabinets with drawers should have stops to prevent accidental removal.

Cabinets for Category II laboratories are not required to have gas, air, vacuum, and electrical service fixtures. Built-in shelves should be adjustable.

3.9.3.4 *Fume Hoods, Sinks, and Ventilation*

3.9.3.4.1 *Fume Hoods*

Fume hoods shall be provided for laboratories in which required analytical works results in the production of noxious fumes.

3.9.3.4.2 *Sinks*

A laboratory grade sink and drain trap shall be provided.

3.9.3.4.3 *Ventilation*

Laboratories should be air conditioned. In addition, separate exhaust ventilation should be provided.

3.9.3.5 *Balance and Table*

An analytical balance of the automated digital readout, single pan 0.1 mg sensitivity type shall be provided. A heavy special-design balance table which will minimize vibration of the balance is recommended. It shall be located as far as possible from windows, doors, or other sources of drafts or air movements, so as to minimize undesirable impacts from these sources upon the balance.

3.9.3.6 *Equipment, Supplies, and Reagents*

The laboratory shall be provided with all of the equipment, supplies, and reagents that are needed to carry out all of the facility's analytical testing requirements. If any required analytical testing produces malodorous or noxious fumes, the engineer should verify that the in-house analysis is more cost-effective than use of an independent off-site laboratory. Composite samples may be required to satisfy permit sampling requirements. Permit to operate, process control, and industrial waste monitoring requirements should be considered when specifying equipment needs. References such as Standard Methods for the Examination of Water and Wastewater and the U.S.E.P.A. Analytical Procedures Manual should be consulted prior to specifying equipment items.

3.9.3.7 *Utilities*

3.9.3.7.1 *Power Supply*

Consideration should be given to providing line voltage regulation for power supplied to laboratories using delicate instruments.

3.9.3.7.2 *Laboratory Water*

Reagent water of a purity suitable for analytical requirements shall be supplied to the laboratory. In general, reagent water prepared using an all glass distillation system is adequate. However, some analyses require deionization of the distilled water. Consideration should be given to softening the feed water to the still.

3.9.3.8 *Safety*

3.9.3.8.1 *Equipment*

Laboratories shall provide as a minimum the following: first aid equipment; protective clothing including goggles, gloves, lab aprons, etc.; and a fire extinguisher.

3.9.3.8.2 *Eyewash Fountains and Safety Showers*

Eyewash fountains and safety showers utilizing potable water shall be provided in the laboratory and should be as close as practical and shall be no more than 7.0 m from points of hazardous chemical exposure.

The eyewash fountains shall be supplied with water of moderate temperature 10° to 30° C (50° to 90° F) suitable to provide 15 minutes to 30 minutes of continuous irrigation of the eyes. The emergency showers shall be capable of discharging 2 to 4 L/s of water at a moderate temperature and at pressure of 140 to 350 Kpa.

3.9.4 **Category III: Plants performing more complex operational, permit, industrial pretreatment and multiple plant laboratory testing.**

3.9.4.1 *Location and Space*

The laboratory should be located at the treatment site on ground level, with environmental control as an important consideration. It shall be located away from vibrating, noisy, high temperature machinery or equipment which might have adverse effects on the performance of laboratory staff or instruments.

The laboratory facility needs for Category III plants should be described in the engineering design report or facilities plan. The laboratory floor space and facility layout should be based on an evaluation of complexity, volume, and variety of sample analyses expected during the design life of the plant including testing for process control, industrial pretreatment control, user charge monitoring, and the permit to operate monitoring requirements.

Consideration should be given to the necessity to provide separate (and possibly isolated) areas for some special laboratory equipment, glassware, and chemical storage. At large plants, office and administrative space needs should be considered.

For less complicated laboratory needs bench-top working surface should occupy at least 35 percent of the total laboratory floor space. Additional floor and bench space should be provided to facilitate performance of analysis of industrial wastes, as required by the permit to operate and the utility's industrial waste pretreatment program. Ceiling height should be adequate to provide for the installation of wall mounted water stills, deionizers, distillation racks, hoods, and other equipment with extended height requirements.

3.9.4.2 Floor and Doors

3.9.4.2.1 Floors

Floor surfaces should be fire resistant, and highly resistant to acids, alkalies, solvents, and salts.

3.9.4.2.2 Doors

Two exit doors should be located to permit a straight egress from the laboratory, preferable at lease one to outside the building. Panic hardware should be used. They should have large glass windows for easy visibility of approaching or departing personnel.

Automatic door closers should be installed; swinging doors should not be used.

Flush hardware should be provided on doors if cart traffic is anticipated. Kick plates are also recommended.

3.9.4.3 Cabinets and Bench Tops

3.9.4.3.1 Cabinets

Wall-hung cabinets are useful for dust-free storage of instruments and glassware. Units with sliding glass doors are preferable. A reasonable proportion of cupboard style base cabinets and drawer units should be provided.

Drawers should slide out so that entire contents are easily visible. They should be provided with rubber bumpers and with stops which prevent accidental removal. Drawers should be supported on ball bearings or nylon rollers which pull easily in adjustable steel channels. All metals drawer fronts should be double-wall construction.

All cabinet shelving should be acid resistant and adjustable. The laboratory furniture shall be supplied with adequate water, gas, air, and vacuum service fixtures, traps, strainers, plugs, and tailpieces, and all electrical service fixtures.

3.9.4.3.2 Bench Tops

Bench tops should be constructed of materials resistant to attacks from normally used laboratory reagents. Generally, bench-top height should be 900 mm. However, areas to be used exclusively for sit-down type operations should be 760 mm high and include kneehole space. Twenty-five millimetre overhangs and drip grooves should be provided to keep liquid spills from running along the face of the cabinet. Tops should be furnished in large sections, 32 mm thick. They should be field-jointed into a continuous surface with acid, alkali, and solvent-resistant cements which are at least as strong as the material of which the top is made.

3.9.4.4 *Hoods*

3.9.4.4.1 *General*

Fume hoods to promote safety and canopy hoods over heat-releasing equipment shall be provided.

3.9.4.4.2 *Fume Hoods*

a. **Location**

Fume hoods should be located where air disturbance at the face of the hood is minimal. Air disturbance may be created by persons walking past the hood; by heating, ventilating, or air-conditioning systems; by drafts from opening or closing a door, etc.

Safety factors should be considered in locating a hood. If a hood is situated near a doorway, a secondary means or egress must be provided. Bench surfaces should be available next to the hood so that chemicals need not be carried long distances.

b. **Design and Material**

The selection, design, and materials of construction of fume hoods and their appropriate safety alarms must be made by considering the variety of analytical work to be performed. The characteristics of the fumes, chemicals, gases, or vapours that will or may be released by the activities therein should be considered. Special design and construction is necessary if perchloric acid use is anticipated. Consideration should be given to providing more than one fume hood to minimize potential hazardous conditions throughout the laboratory.

Fume hoods are not appropriate for operation of heat-releasing equipment that does not contribute to hazards, unless they are provided in addition to those needed to perform hazardous tasks.

c. **Fixtures**

One sink should be provided inside each fume hood. A cup sink is usually adequate.

All switches, electrical outlets, and utility and baffle adjustment handles should be located outside the hood. Light fixtures should be explosion-proof.

d. **Exhaust**

Twenty-four hour continuous exhaust capability should be provided. Exhaust fans should be explosion-proof. Exhaust velocities should be checked when fume hoods are installed.

3.9.4.4.3 *Canopy Hoods*

Canopy hoods should be installed over the bench-top areas where hot plate, steam bath, or other heating equipment or heat-releasing instruments are used. The canopy should be constructed of heat and corrosion resistant material.

3.9.4.5 ***Sinks, Ventilation, and Lighting***

3.9.4.5.1. *Sinks*

The laboratory should have a minimum of two sinks (not including cup sinks). At least one of them should be a double-well sink with drainboards. Additional sinks should be provided in separate work areas as needed, and identified for the use intended.

Sinks should be made of epoxy resin or plastic materials highly resistant to acids, alkalies, solvents, and salts, and should be abrasion and heat resistant, non-absorbent, and light in weight. Traps should be made of glass, plastic, or lead and easily accessible for cleaning. Waste openings should be located toward the back so that a standing overflow will not interfere.

All water fixtures on which hoses may be used should be provided with reduced zone pressure backflow preventers to prevent contamination of water lines.

3.9.4.5.2 *Ventilation*

Laboratories should be separately air conditioned, with external air supplied for one hundred percent make-up volume. In addition, separate exhaust ventilation should be provided. Ventilation outlet locations should be remote from ventilation inlets. Consideration should be given to providing dehumidifiers.

3.9.4.5.3 *Lighting*

Good lighting, free from shadows, must be provided for reading dials, meniscuses, etc., throughout the laboratory.

3.9.4.6 ***Balance and Table***

An analytical balance of the automatic, digital readout, single pan, 0.1 mg sensitivity type shall be provided. A heavy special-design balance table which will minimize vibration of the balance is needed. It shall be located as far as practical from windows, doors, or other sources of drafts or air movements, so as to minimize undesirable impacts from these sources upon the balance.

3.9.4.7 ***Equipment, Supplies, and Reagents***

The laboratory shall be provided with all of the equipment, supplies, and reagents that are needed to carry out all of the facility's analytical testing requirements. Composite samplers may be required to satisfy permit sampling requirements. Permit to operate, process control, and industrial waste monitoring requirements should be considered when specifying equipment needs. Reference such as Standard Methods for the Examination of Water and Wastewater and the U.S.E.P.A. Analytical Procedures Manual should be consulted prior to specifying equipment items.

3.9.4.8 *Utilities and Services*

3.9.4.8.1 *Power Supply*

Consideration should be given to providing line voltage regulation for power supplied to laboratories using delicate instruments.

3.9.4.8.2 *Laboratory Water*

Reagent water of a purity suitable for analytical requirements shall be supplied to the laboratory. In general, reagent water prepared using an all glass distillation system is adequate. However, some analyses require deionization of the distilled water. Consideration should be given to softening water to the still.

3.9.4.8.3 *Gas and Vacuum*

Natural or LP gas should be supplied to the laboratory. Digester gas should not be used.

An adequately-sized line source of vacuum should be provided with outlets available throughout the laboratory.

3.9.4.9 *Safety*

3.9.4.9.1 *Equipment*

Laboratories shall be provide the following: first aid equipment; protective clothing and equipment such as goggles, safety glasses, full face shields, gloves, etc.; fire extinguishers; chemical spill kits; posting of "No Smoking" signs in hazardous area; and appropriately placed warning signs for slippery areas, non-potable water fixtures, hazardous chemical storage areas, flammable fuel storage areas, etc.

3.9.4.9.2 *Eyewash Fountains and Safety Showers*

Eyewash fountains and safety showers utilizing potable water shall be provided in the laboratory. These facilities are to be as close as practical and shall be no more than 7.0 m from points of hazardous chemical exposure.

The eyewash fountains shall be supplied with water of moderate temperature 10° to 30° C, suitable to provide 15 minutes to 30 minutes of continuous irrigation of the eyes. The emergency showers shall be capable of discharging 2 to 4 L/s of water at moderate temperature and at pressures of 140 to 350 kPa.

4.1 SCREENING DEVICES

4.1.1 Bar Racks and Screens

4.1.1.1 Where Required

Coarse bar racks or screens shall be provided as the first treatment stage for the protection of plant equipment against reduced operating efficiency, blockage, or physical damage.

4.1.1.2 Selection Considerations

When considering which types of screening devices should be used, the following factors should be considered:

- effect on downstream treatment and sludge disposal operations;
- possible damage to comminutor or barminutor devices caused by stones or coarse grit particles;
- head losses of the various alternative screening devices;
- maintenance requirements;
- screenings disposal requirements, and quantities of screenings; and
- requirements for a standby unit.

4.1.1.3 Location

4.1.1.3.1 Outdoors

Screening devices installed outside shall be protected from freezing.

4.1.1.3.2 Indoors

Screening devices installed in a building where other equipment or offices are located should be separated from the rest of the building, provided with separate outside entrances and provided with adequate means of ventilation.

4.1.1.3.3 Access

Screens located in pits more than 1.2 m deep shall be provided with stairway access. Access ladders are acceptable for pits less than 1.2 m deep, in lieu of stairways.

4.1.1.3.4 Ventilation

Fresh air shall be forced into enclosed screening device areas or into open pits more than 1.2 m deep. Dampers should not be used on exhaust or fresh air ducts and fine screens or other obstructions should be avoided to prevent clogging. Where continuous ventilation is required, at least 12 complete air changes per hour shall be provided. Where continuous ventilation would cause excessive heat loss, intermittent ventilation of at least 30 complete air changes per hour shall be provided when workmen enter the area.

Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilation equipment shall be interconnected with the respective pit lighting system. The fan wheel should be fabricated from non-sparking material. Gas detectors shall be provided in accordance with Design Section 3.8.

4.1.1.4 *Design and Installation*

4.1.1.4.1 *Bar Spacing*

a) Manually Cleaned Screens

Clear openings between bars should be from 25 mm to 45 mm. Design and installation shall be such that they can be conveniently cleaned.

b) Mechanical Screens

Clear openings for mechanically cleaned screens may be as small as 15 mm.

Mechanical screens are recommended where the installation is not regularly supervised or where an increase in head results in plant bypass.

4.1.1.4.2 *Velocities*

At the design average rate of flow, the screen chamber should be designed to provide a velocity through the screen of approximately 0.3 meters per second to prevent settling, and a maximum velocity during wet weather periods no greater than 0.75 meters per second to prevent forcing material through the openings. The velocity shall be calculated from a vertical projection of the screen openings on the cross-sectional area between the invert of the channel and the flow line.

4.1.1.4.3 *Invert*

The screen channel invert should be 75 to 150 mm below the invert of the incoming sewers. To prevent jetting action, the length and/or construction of the screen channel shall be adequate to re-establish hydraulic flow pattern following the drop in elevation.

4.1.1.4.4 *Slope*

Manually cleaned screens, except those for emergency use, should be placed on a slope of 30 to 45 degrees with the horizontal.

4.1.1.4.5 *Channels*

The channel preceding and following the screen shall be shaped to eliminate stranding and settling of solids and should be designed to provide equal and uniform distribution of flow to the screens. Dual channels shall be provided and equipped with the necessary gates to isolate flow from any screening unit. Provisions shall also be made to facilitate dewatering each unit.

4.1.1.4.6 *Flow Measurement*

Flow measurement devices should be provided at each screen channel. They should be selected based on reliability and accuracy. The effect of changes in backwater elevations, due to intermittent cleaning of screens, should be considered in locating of flow measurement equipment.

4.1.1.5 *Safety*

4.1.1.5.1 *Railings and Gratings*

Manually cleaned screen channels shall be protected by guard railings and deck gratings, with adequate provisions for removal or opening to facilitate raking.

Mechanically cleaned screen channels shall be protected by guard railings and deck gratings. Consideration should also be given to temporary access arrangements to facilitate maintenance and repair.

4.1.1.5.2 *Mechanical Devices*

Mechanical screening equipment shall have adequate removal enclosures to protect personnel against accidental contact with moving parts and to prevent dripping in multi-level installations.

A positive means of locking out each mechanical device and temporary access for use during maintenance shall be provided.

4.1.1.5.3 *Drainage*

Floor design and drainage shall be provided to prevent slippery areas.

4.1.1.5.4 *Lighting*

Suitable lighting shall be provided in all work and access areas. Refer to Design Section 4.1.1.6.2.

4.1.1.6 *Control Systems*

4.1.1.6.1 *Timing Devices*

All mechanical units which are operated by timing devices should be provided with auxiliary controls which will set the cleaning mechanism in operation at preset high water elevation. If the cleaning mechanism fails to lower the high water, a warning should be signalled.

4.1.1.6.2 *Electrical Systems and Components*

Electrical systems and components (i.e. motors, lights, cables, conduits, switchboxes, control circuits, etc.) in enclosed or partially enclosed spaces where flammable mixtures occasionally may be present (including all space above raw or partially treated wastewater) shall comply with the Canadian Electrical Code, Part 1 and the regulations under the Nova Scotia Power Standards. All electrical components in the headworks room must be explosion proof.

4.1.1.6.3 *Manual Override*

Automatic controls shall be supplemented by a manual override.

4.1.1.7 *Screenings Removal and Disposal*

A convenient and adequate means for removing screenings shall be provided. Hoisting or lifting equipment may be necessary depending on the depth of pit and amount of screenings or equipment to be lifted.

Facilities must be provided for handling, storage, and disposal of screenings in a manner acceptable to the regulatory agency. Separate grinding of screenings and return to the sewage flow is unacceptable.

Manually cleaned screening facilities shall include an accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities shall be provided for both the platform and storage area.

4.1.1.8 *Auxiliary Screens*

Where mechanically operated screening or comminuting devices are used, auxiliary manually cleaned screens shall be provided. Where two or more mechanically cleaned screens are used, the design shall provide for taking any unit out of service without sacrificing the capability to handle the peak design flow.

4.1.2 Fine Screens

4.1.2.1 *General*

Fine screens may be used in lieu of primary sedimentation providing that subsequent treatment units are designed on the basis of anticipated screen performance. Fine screens should not be considered equivalent to primary sedimentation. Where fine screens are used, additional provision for the removal of floatable oils and greases shall be considered. Selection of screen capacity should consider flow restriction due to retained solids, gummy material, frequency of cleaning and extent of cleaning.

4.1.2.2 *Design*

Tests should be conducted to determine BOD_5 and suspended solids removal efficiencies at the design maximum day flow and design maximum day BOD_5 loadings. Pilot testing for an extended time is preferred.

A minimum of two fine screens shall be provided, each unit being capable of independent operation. Capacity shall be provided to treat design peak instantaneous flow with one unit out of service.

Fine screens shall be preceded by a mechanically cleaned bar screen or other protective device. Comminuting devices shall not be used ahead of fine screens. Fine screens shall be protected from freezing and located to facilitate maintenance.

4.1.2.3. *Electrical Fixtures and Control*

Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall comply with the Canadian Electrical Code and the regulations under the Nova Scotia Power Standards.

4.1.2.4 *Servicing*

Hosing equipment (with hot and cold water) shall be provided to facilitate cleaning. Provision shall be made for isolating or removing units from their location for servicing.

4.2 COMMINUTORS

4.2.1 General

Provisions for location shall be in accordance with those for screening devices, Design Section 4.1.1.3.

4.2.2 When Required

Comminutors shall be used in plants that do not have primary sedimentation or fine screens and should be provided in cases where mechanically cleaned bar screens will not be used.

4.2.3 Design Considerations

4.2.3.1 *Location*

Comminutors should be located downstream of any grit removal equipment and be protected by a coarse screening device. Consideration for a different sequence may be given to suit individual cases.

4.2.3.2 *Size*

Comminutor capacity shall be adequate to handle the design peak hourly flow.

4.2.3.3 *Installation*

A screened bypass channel shall be provided. The use of the bypass channel should be automatic at depths of flows exceeding the design capacity of the comminutor.

Each comminutor that is not preceded by grit removal equipment should be protected by a 150 mm deep gravel trap.

Gates shall be provided in accordance with Design Section 4.1.1.4.5.

4.2.3.4 *Servicing*

Provision shall be made to facilitate servicing units in place and removing units from their location for servicing.

4.2.3.5 *Electrical Controls and Motors*

Electrical equipment in comminutor chambers where hazardous gases may accumulate shall comply with the Canadian Electrical Code and the regulations under the Nova Scotia Power Standards.

Motors in areas not governed by this requirement may need protection against accidental submergence.

4.3 GRIT REMOVAL FACILITIES

4.3.1 When Required

Grit removal is required in advance of treatment units to prevent the undue wear of machinery and the unwanted accumulation of solids in channels, settling tanks and digesters.

Grit removal facilities should be provided for all sewage treatment plants and are required for plants receiving sewage from combined sewers or from sewer systems receiving substantial amounts of grit. If a plant, serving a separate sewer system, is designed without grit facilities, the design shall include provisions for future installation. Consideration shall be given to possible damaging effects on pumps, comminutors and other preceding equipment and the need for additional storage capacity in treatment units where grit is likely to accumulate.

4.3.2 Location

Grit removal facilities should be located ahead of pumps and comminuting devices. Coarse bar racks should be placed ahead of grit removal facilities.

4.3.3 Accessibility

Consideration should be given in the design of grit chambers to provide safe access to the chamber and, where mechanical equipment is involved, to all functioning parts.

4.3.4 Ventilation

Where installed indoor, uncontaminated air shall be introduced continuously at a rate of 12 air changes per hour, or intermittently at a rate of 30 air changes per hour. Odor control facilities may also be warranted.

4.3.5 Electrical

Electrical equipment in grit removal areas where hazardous gases may accumulate shall comply with the Canadian Electrical Code and the regulations under the Nova Scotia Power Standards.

4.3.6 Outside Facilities

Grit removal facilities located outside shall be protected from freezing.

4.3.7 Design Factors

4.3.7.1 Inlet

Inlet turbulence shall be minimized.

4.3.7.2 Type and Number of Units

Grit removal facilities (channel type) should have at least two hand-cleaned units, or a mechanically cleaned unit with bypass. A single manually cleaned or mechanically cleaned grit chamber with bypass is acceptable for small sewage treatment plants serving separate sanitary sewer systems. Minimum facilities for larger plants serving separate sanitary sewers should be at least one mechanically cleaned unit with a bypass. Facilities other than channel-types are desirable if provided with adequate and flexible controls for agitation and/or air supply devices and with grit collection and removal equipment.

4.3.7.3 Grit Channels

4.3.7.3.1 Velocity

Channel-type chambers shall be designed to provide controlled velocities as close as possible to 0.30 meters per second for normal variation in flow.

4.3.7.3.2 Control Sections

Flow control sections shall be of the proportional or Sutro Weir type.

4.3.7.3.3 *Channel Dimensions*

The minimum channel width shall be 380 mm. The minimum channel length shall be that required to settle a 0.2 mm particle with a specific gravity of 2.65, plus a fifty (50) per cent allowance for inlet and outlet turbulence.

4.3.7.3.4 *Grit Storage*

With permanently positioned weirs, the weir crest should be kept 150 to 300 mm above the grit channel invert to provide for storage of settled grit (weir plates that are capable of vertical adjustment are preferred since they can be moved to prevent the sedimentation of organic solids following grit cleaning). Grit storage is also a function of the frequency of grit removal.

4.3.7.4 *Detritus Tanks*

Detritus tanks should be designed with sufficient surface area to remove a 0.2 mm, or smaller, particle with a specific gravity of 2.65 at the expected peak flow rate. Detritus tanks, since they are mechanically-cleaned and do not need dewatering for cleaning, do not require multiple units, unless economically justifiable.

Separation of the organics from the grit before, during, or after the removal of the settled contents of the tank can be accomplished in one of the following ways:

- the removed detritus can be washed in a grit washer with the organic laden wash water being returned to the head of the detritus tank;
- a classifying-type conveyor can be used to remove the grit and return the organics to the detritus tank;
- the removed detritus can be passed through a centrifugal-type separator.

4.3.7.5 *Aerated Grit Tanks*

Aerated grit tanks for the removal of 0.2 mm, or larger, particles with specific gravity of 2.65, should be designed in accordance with the following parameters:

4.3.7.5.1 *Detention Time*

Detention time shall be 2 to 5 minutes at the peak sewage flow rate.

4.3.7.5.2 *Air Supply*

Air supply rates should be in the range of 4.5 to 12.4 L/s per linear meter of tank. The higher rates should be used with tanks of large cross-section (i.e. greater than 3.6 m deep). Air supply should be via air diffusers (wide band diffusion header) positioned lengthwise along one wall of the tank, 600 to 900 mm above the tank bottom. Air supply should be variable.

4.3.7.5.3 *Inlet Conditions*

Inlet flow should be parallel to induced roll in tank. There shall be a smooth transition from inlet to circulation flow.

4.3.7.5.4 *Baffling*

A minimum of one transverse baffle near the outlet weir shall be provided. Additional transverse baffles in long tanks and longitudinal baffles in wide tanks should be considered.

4.3.7.5.5 *Outlet Conditions*

The outlet weir shall be oriented parallel to the direction of induced roll (i.e. at a right angle to the inlet).

4.3.7.5.6 *Tank Dimensions*

The lower limit of the above aeration rates are generally suitable for tanks up to 3.7 m deep and 4.3 m wide. Wider or deeper tanks require aeration rates in the upper end of the above range. Long, narrow aerated grit tanks are generally more efficient than short tanks and produce a cleaner grit. A length to width ratio of 2:5 to 5:1 is desirable. Depth to width ratios of 1:1.5 to 1:2 are acceptable.

4.3.7.5.7 *Velocity*

The surface velocity in the direction of roll in tanks should be 0.45 to 0.6 m/s (tank floor velocities will be approximately 75 per cent of above). The velocity across the floor of the tank shall not be less than 0.3 m/s.

4.3.7.5.8 *Tank Geometry*

"Dead spaces" in aerated grit tanks are to be avoided. Tank geometry is critical with respect to the location of the air diffusion header, sloping tank bottom, grit hopper and fitting of the grit collector mechanism into the tank structure. Consultation with Equipment Suppliers is advisable.

4.3.7.5.9 *Multiple Units*

Multiple units are generally not required unless economically justifiable, or where the grit removal method requires bypassing of the tank (as with clam shell bucket).

4.3.7.6 ***Mechanical Grit Chambers***

Specific design parameters for mechanical grit chambers will be evaluated on a case-by-case basis.

4.3.7.7 Grit Washing

The need for grit washing should be determined by the method of final grit disposal.

4.3.7.8 Dewatering

Provision shall be made for isolating and dewatering each unit. The design shall provide for complete draining and cleaning by means of a sloped bottom equipped with a drain sump.

4.3.7.9 Water

An adequate supply of water under pressure shall be provided for cleanup.

4.3.8 Grit Removal

Grit facilities located in deep pits should be provided with mechanical equipment for pumping or hoisting grit to ground level. Such pits should have a stairway, approved-type elevator or manlift, adequate ventilation and adequate lighting.

4.3.9 Grit Handling

Grit removal facilities located in deep pits should be provided with mechanical equipment for hoisting or transporting grit to ground level. Impervious, non-slip, working surfaces with adequate drainage shall be provided for grit handling areas. Grit transporting facilities shall be provided with protection against freezing and loss of material.

4.3.10 Grit Disposal

Disposal of grit in sanitary landfills or lagoons, as well as grit incineration shall be considered acceptable disposal methods. Whatever method of disposal is employed, the full spectrum of environmental considerations must be embodied in the final design.

4.4 PRE-AERATION AND FLOCCULATION

4.4.1 General

Pre-aeration of raw wastewater, may be used to achieve one or more of the following objectives:

a. Odor control;
b. Grease separation and increased grit removal;
c. Prevention of septicity;
d. Grit separation;
e. Flocculation of solids;
f. Maintenance of DO in primary treatment tanks at low flows;
g. Increased removals of BOD and SS in primary units; and
h. Minimizes solids deposits on side walls and bottom of wetwells.

Flocculation of sewage with or without coagulating aids, is worthy of consideration when it is desired to reduce the strength of sewage prior to subsequent treatment. Also, flocculation may be beneficial in pre-treating sewage containing certain industrial wastes.

4.4.2 Arrangement

The units should be designed so that removal from service will not interfere with normal operation of the remainder of the plant.

4.4.3 Pre-aeration

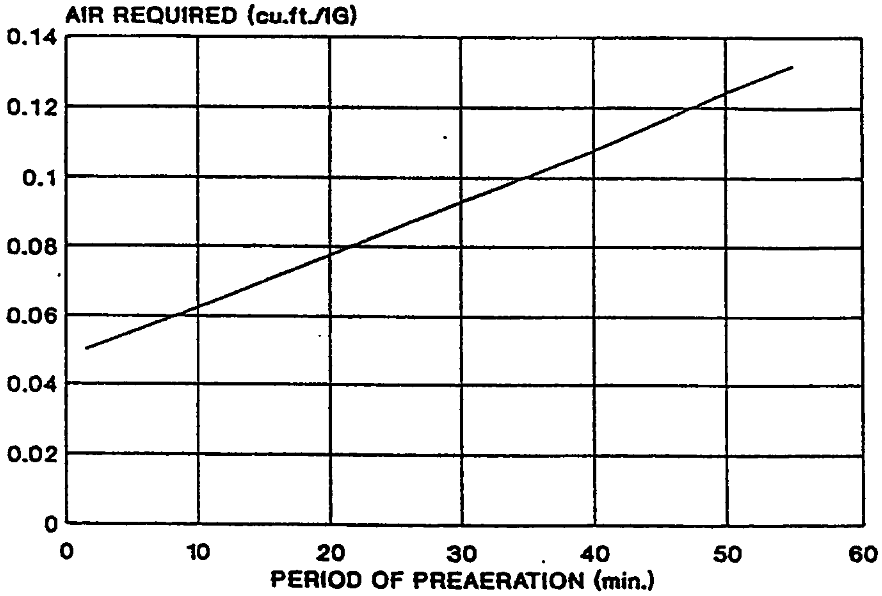
4.4.3.1 Air Flow Measurements

Figure 4.1 represents air flow requirements for different periods of pre-aeration.

Pre-aeration periods should be 10 to 15 minutes if odor control and prevention of septicity are the prime objectives.

FIGURE 4.1

AIR FLOW REQUIRED FOR DIFFERENT PERIODS OF PREAERATION



4.4.4 Flocculation

4.4.4.1 *Detention Period*

When air or mechanical agitation is used in conjunction with chemicals to coagulate or flocculate the sewage, the detention period should be about 30 minutes at the design flow. However, if polymers are used this may be varied.

4.4.4.2 *Stirring Devices*

4.4.4.2.1 *Paddles*

Paddles should have a peripheral speed of 0.50 to 0.75 meters per second to prevent deposition of solids.

4.4.4.2.2 *Aerators*

Any of the types of equipment used for aerating activated sludge may be utilized. It shall be possible to control agitation, to obtain good mixing and maintain self-cleaning velocities across the tank floor.

4.4.4.3 *Details*

Inlet and outlet devices should be designed to insure proper distribution and to prevent short-circuiting. Convenient means should be provided for removing grit.

4.4.4.4 *Quick Mix*

At plants where there are two or more flocculation basins utilizing chemicals, provision shall be made for a quick mix of the sewage with the chemical so that the sewage passing to the flocculation basins will be of uniform composition. The detention period provided in the quick-mix chamber should be very short, one-half to three minutes.

4.5 FLOW EQUALIZATION

4.5.1 General

Flow equalization can reduce the dry-weather variations in organic and hydraulic loadings at any wastewater treatment plant. It should be provided where large diurnal variations are expected.

4.5.2 Location

Equalization basins should be located downstream of pre-treatment facilities such as bar screens, comminutors and grit chambers.

4.5.3 Type

Flow equalization can be provided by using separate basins or on-line treatment units, such as aeration tanks. Equalization basins may be designed as either in-line or side-line units. Unused treatment units, such as sedimentation or aeration tanks, may be utilized as equalization basins during the early period of design life.

4.5.4 Size

Equalization basin capacity should be sufficient to effectively reduce expected flow and load variations to the extent deemed to be economically advantageous. With a diurnal flow pattern, the volume required to achieve the desired degree of equalization can be determined from a cumulative flow plot, or mass diagram, over a representative 24-hour period. To obtain the volume required to equalize the 24-hour flow:

1. Draw a line between the points representing the accumulated volume at the beginning and end of the 24-hr period. The slope of this line represents the average rate of flow.

2. Draw parallel lines to the first line through the points on the curve farthest from the first line.

3. Draw a vertical line between the lines drawn in No. 2. The length of this line represents the minimum required volume.

4.5.5 Operation

4.5.5.1 *Mixing*

Where applicable, aeration or mechanical equipment shall be provided to maintain adequate mixing. Corner fillets and hopper bottoms with draw-offs should be provided to alleviate the accumulation of sludge and grit.

4.5.5.2 *Aeration*

Where applicable, aeration equipment shall be sufficient to maintain a minimum of 1.0 mg/l of dissolved oxygen in the mixed basin contents at all times. Air supply rates should be a minimum of 0.15 litres per second per cubic meter storage capacity. The air supply should be isolated from other treatment plant aeration requirements to facilitate process aeration control, although process air supply equipment may be utilized as a source of standby aeration.

4.5.5.3 *Controls*

Inlets and outlets for all basin compartments shall be suitably equipped with accessible external valves, stop plates, weirs or other devices to permit flow control and the removal of an individual unit from service. Facilities shall also be provided to measure and indicate liquid levels and flow rates.

4.5.6 Electrical

All electrical work in housed equalization basins shall comply with the Canadian Electrical Code and the regulations under the Nova Scotia Power Standards.

4.5.7 Access

Suitable access shall be provided to facilitate cleaning and the maintenance of equipment.

5.1 GENERAL DESIGN REQUIREMENTS

The need for and the design of primary sedimentation tanks will be influenced by various factors, including the following:

- the characteristics of the raw wastewater; the type of sludge digestion systems, either available or proposed (aerobic digestion should not be used with raw primary sludges);
- the presence, or absence, of secondary treatment following primary treatment;
- the need for handling of waste activated sludge in the primary settling tank;
- the need for, or possible economic benefits through, phosphorus removal in the primary settling tank(s).

5.1.1 Number of Units

Multiple units capable of independent operation are desirable and shall be provided in all plants where design flows exceed 500 cubic meters per day. Plants not having multiple units shall include other provisions to assure continuity of treatment.

5.1.2 Arrangement of Units

Settling tanks shall be arranged in accordance with Design Section 3.4.10.

5.1.3 Interaction with Other Processes

a. Pumping directly to any clarifier is prohibited, unless special provision is included in the design of pump controls. Attention should be focused so that pumps deliver smooth flow transmissions at all times, with a minimal energy gradient.

b. For activated sludge plants employing high energy aeration, provisions should be made for floc to be reformed before settling.

c. For primary clarifiers, tanks and equipment must be sized to not only accommodate raw waste solids but also those solids introduced by thickener overflows, anaerobic digester overflow and sometimes waste activated sludge.

5.1.4 Flow Distribution and Control

Effective flow measurement devices and control appurtenances (i,e., valves, gates, splitter boxes, etc.) shall be provided to permit proper proportion of flow to each unit. Parallel basins should be of the same size, otherwise flow shall be distributed in proportion to surface area.

5.1.5 Tank Configuration and Proportions

Consideration should be given to the probable flow pattern in the selection of tank size and shape, and inlet and outlet type and location. Generally rectangular clarifiers are designed with length-to-width ratios of at least 4:1, and width to depth ratios of 1:1 and 2.25:1.

5.1.6 Site Constraints

The selection of feasible clarifier alternatives should include the following site considerations:

a. Wind direction;
b. Proximity to residents;
c. Soil conditions;
d. Groundwater conditions; and
e. Available space.

5.1.7 Size Limitations

Rectangular clarifiers shall have a maximum length of 90 m. Circular clarifiers shall have a maximum diameter of 60 m. The minimum length of flow from inlet to outlet shall be 3 m, unless special provisions are made to prevent short circuiting. The vertical sidewater depth shall be designed to provide an adequate separation zone between the sludge blanket and the overflow weirs.

5.1.8 Inlet Structures

Inlet structures should be designed to dissipate the inlet velocity, to distribute the flow equally and to prevent short-circuiting. Channels should be designed to maintain a velocity of at least 0.3 meters per second at one-half design average flow. Corner pockets and dead ends should be eliminated and corner fillets or channelling used where necessary. Provisions shall be made for elimination or removal of floating materials in inlet structures.

5.1.9 Outlet Arrangements

5.1.9.1 General

Overflow weirs shall be adjustable for levelling, and sufficiently long to avoid high heads which result in updraft currents.

5.1.9.2 Location

Overflow weirs shall be located to optimize actual hydraulic detention time and minimize short circuiting. Peripheral weirs shall be placed at least 0.3 m from the wall.

5.1.9.3 *Weir Troughs*

Weir troughs shall be designed to prevent submergence at maximum design flow and to maintain a velocity of at least 0.3 meters per second at one-half design average flow.

5.1.10 **Submerged Surfaces**

The tops of troughs, beams and similar submerged construction elements shall have a minimum slope of 1.4 vertical to 1 horizontal; the underside of such elements should have a slope of 1 to 1 to prevent the accumulation of scum and solids.

5.1.11 **Unit Dewatering**

Unit dewatering features shall conform to the provisions outlined in Design Section 3.5.4. The bypass design should also provide for redistribution of the plant flow to the remaining units.

5.1.12 **Freeboard**

Walls of settling tanks shall extend at least 150 mm above the surrounding ground surface and shall provide not less than 300 mm freeboard. Additional freeboard or the use of wind screens is recommended where larger settling tanks are subject to high velocity wind currents that would cause tank surface waves and inhibit effective scum removal.

5.1.13 **Clarifier Covers**

Clarifiers may be required to be covered for winter operation. The structure should be constructed with adequate head room for easy access. The structure must include adequate lighting, ventilation and heating. Humidity and condensation shall be controlled inside the structure.

5.2 TYPES OF SETTLING

5.2.1 Type I Settling (Discrete Settling)

Type I settling is assumed to occur in gravity grit chambers handling wastewater and in basins used for preliminary settling (silt removal) of surface waters. A determination of the settling velocity of the smallest particle to be 100% removed is fundamental to the design of Type I clarifiers. Because each particle is assumed to settle independently and with a constant velocity, a mathematical development is possible, based on Newton's Law and Stoke's Law.

5.2.2 Type II Settling (Flocculant Settling)

Type II settling occurs when particles initially settle independently but flocculate as they proceed the depth of the tank. As a result of flocculation, the settling velocities of the aggregates formed change with time, and a strict mathematical solution is not possible. Laboratory testing is required to determine appropriate values for design parameters.

Type II settling can occur during clarification following fixed-film processes, primary clarification of wastewater, and clarification of potable water treated with coagulants.

Type II settling can also occur above the sludge blanket in clarifiers following activated sludge treatment; however design procedures based on Type III settling are normally used to design these units.

5.2.3 Type III Settling (Hindered or Zone Settling)

Type III settling occurs in clarifiers following activated sludge processes and gravity thickeners. While Type II processes may occur to a limited extent in such units, it is Type III that governs design. In suspensions undergoing hindered settling, the solids concentration is usually much higher than in discrete or flocculant processes. As a result, the contacting particles tend to settle as a zone or blanket, and maintain the same position relative to each other.

5.3 DESIGN CRITERIA

Table 5.1 outlines design parameters for settling tanks based upon their associated settling type.

5.4 SLUDGE AND SCUM REMOVAL

5.4.1 Scum Removal

Effective scum collection and removal facilities, including baffling, shall be provided for all settling tanks. Scum baffles are to be placed ahead of the outlet weirs and extend 300 mm below the water surface. The unusual characteristics of scum which may adversely affect pumping, piping, sludge handling and disposal, should be recognized in design. Provisions may be made for the discharge of scum with the sludge; however, other special provisions for disposal may be necessary.

5.4.2 SLUDGE REMOVAL

5.4.2.1 Sludge Removal

Sludge collection and withdrawal facilities shall be designed to assure rapid removal of the sludge and minimization of density currents. Suction withdrawal should be provided for activated sludge plants designed for reduction of the nitrogenous oxygen demand and is encouraged for those plants designed for carbonaceous oxygen demand reduction. Each settling tank shall have its own sludge withdrawal lines to insure adequate control of the sludge wasting rate for each tank.

TABLE 5.1 SEDIMENTATION BASINS DESIGN PARAMETERS

TYPE OF SETTLING	SIDEWATER DEPTH (m)	SURFACE OVERFLOW (1) RATE ($m^3/m^2.d$)	WEIR LOADING RATE $m^3/m.d$ (2) (3)	SOLIDS LOADING (kg/m^2d)
Type I and Type II	3.0 - 4.6 (10 - 15 ft)	≤ 40 at design average flow (800 $IG/ft^2.d$) ≤ 60 at peak hourly flow (1200 $IG/ft^2.d$)	125 - 370 (8400 - 25000 IG/ft.d)	N/A
Type III	3.5 - 4.6 (11.5 - 15 ft)	1) Settling following activated sludge: ≤ 30 at design average flow (600 $IG/ft^2.d$) ≤ 50 at peak hourly flow (1000 $IG/ft^2.d$) 2) Settling following extended aeration: ≤ 15 at design average flow (300 $IG/ft^2.d$) ≤ 35 at peak hourly flow (700 $IG/ft^2.d$) 3) Settling following trickling filtration: ≤ 25 at design average flow (500 $IG/ft^2.d$) ≤ 45 at peak hourly flow (900 $IG/ft^2.d$) 4) Settling following separate nitrification: ≤ 35 at peak hourly flow (700 $IG/ft^2.d$)	< 250 (4) (<16500 IG/ft.d)	49 (at an SVI of 300) (10 $lb/ft^2.d$) - 290 (at an SVI of 100) (59 $lb/ft^2.d$)

1. When several different overflow criteria are given (design average flow, peak hourly flow) the clarifier area to be used in the design is the larger of those computed in each case.
2. At design average flow.
3. If pumping is required, weir loading rate should be related to pump delivery rates to avoid short-circuiting.
4. Where weirs are located so that density currents upturn below them, the rate should not exceed 186 $m^3/m.d$.

5.4.2.2 *Sludge Collection*

Sludge collection mechanisms shall remain in operation during sludge withdrawal. Mechanism speeds shall be such as to avoid undue agitation while still producing desired collection results.

5.4.2.3 *Sludge Hopper*

The minimum slope of the side walls shall be 1.7 vertical to 1 horizontal. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. Hopper bottoms shall have a maximum dimension of 0.6 meters. Extra depth sludge hoppers for sludge thickening are not acceptable. The hoppers are to be accessible for sounding and cleaning.

5.4.2.4 *Cross-Collectors*

Cross-collectors serving one or more settling tanks may be useful in place of multiple sludge hoppers.

5.4.2.5 *Sludge Removal Piping*

Each hopper shall have an individually valved sludge withdrawal line at least 150 mm in diameter. The static head available for withdrawal of sludge shall be 750 mm or greater, as necessary to maintain a 1.0 meter per second velocity in the withdrawal line. Clearance between the end of the withdrawal line and the hopper walls shall be sufficient to prevent "bridging" of the sludge. Adequate provisions shall be made for rodding or back-flushing individual pipe runs. Piping shall also be provided to return waste sludge to primary clarifiers.

5.4.2.6 *Sludge Removal Control*

Sludge wells equipped with telescoping valves or other appropriate equipment shall be provided for viewing, sampling and controlling the rate of sludge withdrawal from each tank hopper. The use of easily maintained sight glass and sampling valves may be appropriate. A means of measuring the sludge removal rate from each hopper shall be provided. Air lift type of sludge removal will not be approved for removal of primary sludges. Sludge pump motor control systems shall include time clocks and valve activators for regulating the duration and sequencing of sludge removal.

5.5 PROTECTIVE AND SERVICE FACILITIES

5.5.1 Operator Protection

All settling tanks shall be equipped to enhance safety for operators. Such features shall appropriately include machinery covers, life lines, stairways, walkways, handrails and slip-resistant surfaces.

5.5.2 **Mechanical Maintenance Access**

The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanisms, baffles, weirs, inlet stilling baffle area and effluent channels.

5.5.3 **Electrical Fixtures and Controls**

Electrical fixtures and controls in enclosed settling basins shall comply with the Canadian Electrical Code and the Nova Scotia Power Standards. The fixtures and controls shall be located so as to provide convenient and safe access for operation and maintenance. Adequate area lighting shall be provided.

6.1 ACTIVATED SLUDGE

6.1.1 General

6.1.1.1 Applicability

The activated sludge process and its various modifications, may be used where sewage is amenable to biological treatment. This process requires close attention and competent operating supervision, including routine laboratory control. These requirements should be considered when proposing this type of treatment.

6.1.1.2 Specific Process Selection

The activated sludge process and its several modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of five day BOD. Choice of the process most applicable will be influenced by the proposed plant size, type of waste to be treated, degree and consistency of treatment required, anticipated degree of operation and maintenance and operating and capital costs. All designs shall provide for flexibility in operation.

6.1.1.3 Aeration Equipment Selection

Evaluation of aeration equipment alternatives should include the following considerations:

The size of the aeration tank for any particular adaptation of the process shall be determined by full scale experience, pilot plant studies, or rational calculations based mainly on food to microorganism ratio and mixed liquor suspended solids levels. Other factors, such as size of treatment plant, diurnal load variations, and degree of treatment required, shall also be considered. In addition, temperature, pH, and reactor dissolved oxygen shall be considered when designing for nitrification.

- Costs - capital, maintenance and operating;
- Oxygen transfer efficiency;
- Mixing capabilities;
- Diffuser clogging problems;
- Air pre-treatment requirements;
- Total power requirements;
- Aerator tip speed of mechanical aerators used with activated sludge systems;
- Icing problems;
- Misting problems; and
- Cooling effects on aeration tank contents.

6.1.1.4 Energy Requirements

This process requires major energy usage to meet aeration demands. Energy costs in relation to critical water quality conditions must be carefully evaluated. Capability of energy usage phase-down while still maintaining process viability, both under normal and emergency energy availability conditions, must be included in the activated sludge design.

6.1.1.5 ***Winter Protection***

Protection against freezing shall be provided to ensure continuity of operation and performance.

6.1.1.6 ***Pretreatment***

Where primary settling tanks are not used, effective removal or exclusion of grit, debris, excessive oil or grease, and comminution or screening of solids shall be accomplished prior to the activated sludge process.

Where primary settling is used, provision shall be made for discharging raw sewage directly to the aeration tanks to facilitate plant start-up and operation during the initial stages of the plant's design life.

6.1.1.7 ***Waste Activated Sludge Concentration***

In the absence of primary settling tanks, other effective means of waste sludge concentration shall be provided.

6.1.2 **Process Definitions**

The following are brief descriptions of a number of modifications of the activated sludge process.

6.1.2.1 ***Conventional Activated Sludge***

The plug flow activated sludge process is a biological mechanism capable of removing 85 to 95% BOD from typical municipal wastewater. The flow pattern is plug-flow-type. The process is characterized by 20 to 45% sludge return. This is the original activated sludge process and was later modified to suit various applications, situations and treatment requirements. One characteristic of the plug flow configuration is a very high organic loading on the mixed liquor suspended solids (MLSS) in the initial part of the task. Plug flow configurations are often preferred when high effluent DO's are sought.

6.1.2.2 ***Complete Mix Activated Sludge***

In a complete mix activated sludge process, the characteristics of the mixed liquor are similar throughout the aeration tank. That is, the influent waste is rapidly distributed throughout the tank and the operating characteristics measured in terms of solids, oxygen uptake rate (OUR), MLSS, and soluble BOD_5 concentration are identical throughout the tank. Because the entire tank contents are the same quality as the tank effluent, there is a very low level of food available at any time to a large mass of microorganisms. This is the major reason why the complete mix modification can handle surges in the organic loading without producing a change in effluent quality.

6.1.2.3 *Step Aeration*

Step feed is a modification of the plug flow configuration in which the secondary influent is fed at two or more points along the length of the aeration tank. With this arrangement, oxygen uptake requirements are relatively even, resulting in better utilization of the oxygen supplied. Step feed configurations generally use diffused aeration equipment. Secondary influent flow is usually added in the first 50 to 75% of the aeration tank's length.

6.1.2.4 *Contact Stabilization*

Contact stabilization activated sludge is both a process and a specific tankage configuration. Contact stabilization encompasses a short-term contact tank, secondary clarifier, and a sludge stabilization tank with about six times the detention time used in the contact tank.

This unit operation was developed to take advantage of the fact that BOD removal occurs in two stages. The first is the absorptive phase and the second is the stabilization of the absorbed organics.

Contact stabilization is best for smaller flows in which the mean cell residence time (MCRT) desired is quite long. Therefore, aerating return sludge can reduce tank requirements by as much as 30 to 40% versus that required in an extended aeration system.

6.1.2.5 *Extended Aeration*

The extended aeration process used the same flow scheme as the complete mix or plug flow processes but retains the wastewater in the aeration tank for long periods of time. This process operates at a high MCRT (low F/M) resulting in a condition where there is not enough food in the system to support all the microorganisms present. The microorganisms therefore compete very actively for the remaining food and even use their own cell structure for food. This highly competitive situation results in a highly treated effluent with low sludge production. However, extended aeration plant effluents generally have significant concentrations of "pin floc" resulting in BOD_5 and SS removals of about 85%. Many extended aeration systems do not have primary clarifiers. Also, many are package plants used by small communities.

The main disadvantages of this system are the large oxygen requirements per unit of waste entering the plant and the large tank volume needed to hold the wastes for the extended period.

6.1.2.6 *Oxidation Ditch*

The oxidation ditch is a variation of the extended aeration process. The wastewater is pumped around a circular or oval pathway by a mechanical aerator/pumping device at one or more points along the flow pathway. In the aeration tank, the mixed liquor velocity is maintained between 0.2 to 0.37 m/s in the channel to prevent solids from settling.

Oxidation ditches use mechanical brush disk aerators, surface aerators, and jet aerator devices to aerate and pump the liquid flow.

6.1.2.7 *High Rate Aeration*

This is a type of short-term aeration process in which relatively high concentrations of MLSS are maintained, by utilizing high sludge recirculation rates (100 to 500%), and low hydraulic retention times. Depending on the excess sludge wasting procedure, 60 to 90% BOD removal is achieved for normal domestic wastes. This process is usually (but not necessarily) accomplished in "combined-tank" units.

6.1.2.8 *High Purity Oxygen*

The most common high purity oxygen activated sludge process uses a covered and staged aeration tank configuration. The wastewater, return sludge, and oxygen feed gas enter the first stage of this system and flow concurrently through the tank. The tanks in this system are covered to retain the oxygen gas and permit a high degree of oxygen use. A prime advantage of the staged reactor configuration of the oxygenation system is the system's ability to match approximately the biological uptake rate with the available oxygen gas purity.

6.1.2.9 *Sequencing Batch Reactor (SBR)*

The Sequencing Batch Reactor (SBR) is a fill-and-draw activated sludge treatment system. All SBR systems utilize five steps that occur sequentially within the same tank as follows: (1) fill, (2) react (aeration), (3) settle (clarification), (4) decant, and (5) idle. Process modifications can be made by varying the times associated with each step in order to achieve specific treatment objectives. When designing or evaluating SBR systems care must be taken with the processes that are unique to the SBR. These include:

a. Fill Method
b. Hydraulic Control Systems
c. Aeration Control Systems
d. Method of Decant
e. Sizing of Disinfection Equipment for Decant Flows
f. Sludge Wasting Methods

One of the main strengths of the SBR process is the process flexibility that can be achieved. Therefore, the above processes can be performed using a variety of methods. Designers of SBR systems must be prepared to supply sufficient detailed information at the request of regulatory authorities.

6.1.3 Activated Sludge Design Parameters

Table 6.1 shows typical design parameters and efficiencies for various activated sludge process modifications.

TABLE 6.1 - TYPICAL DESIGN PARAMETERS FOR ACTIVATED SLUDGE PROCESS MODIFICATIONS

MODIFICATION	PROCESS LOADING RATE	MCRT (days)	F/M (kg BOD / kg MLVSS) (lb BOD/lb MLVSS)	ORGANIC LOADING RATE (kg BOD/cu. m/d) (lb BOD/1000 cu.ft/d)	HYDRAULIC RETENTION TIME (hrs)	MLSS (mg/l)	BOD REMOVAL EFFICIENCY (%)
PLUG FLOW	CONVENTIONAL - LOW RATE	4 - 15	0.20 - 0.50	0.30 - 0.60 (18.7 - 37.4)	4 - 8	1500 - 3000	85 - 95
COMPLETE MIX	CONVENTIONAL - LOW RATE	4 - 15	0.20 - 0.60	0.80 - 2.0 (50 - 125)	3 - 5	3000 - 6000	85 - 95
STEP AERATION	CONVENTIONAL - LOW RATE	4 - 15	0.20 - 0.50	0.30 - 0.60 (18.7 - 37.4)	3 - 5	2000 - 3500	85 - 95
CONTACT STABILIZATION	CONVENTIONAL - LOW RATE	3 - 10	0.20 - 0.60	1.0 - 1.2 (62.5 - 75)	CONTACT TANK 0.5 - 1.0 STABILIZATION TANK 3.0 - 6.0	CONTACT TANK - 1000 - 3000 STABLIZATION TANK - 4000 - 10000	80 - 90
EXTENDED AERATION	LOW RATE	20 - 30	0.05 - 0.15	0.16 - 0.40 (10 - 25)	18 - 36	3000 - 6000	75 - 90
OXIDATION DITCH	LOW RATE	20 - 30	0.05 - 0.15	0.16 - 0.40 (10 - 25)	18 - 36	3000 - 5000	75 - 90
HIGH RATE AERATION	HIGH RATE	2 - 6	0.40 - 1.0	1.0 - 6.0 (62.5 - 375)	2 - 4	3000 - 8000	75 - 90
HIGH PURITY OXYGEN	HIGH - CONVENTIONAL RATE	8 - 20	0.20 - 1.0	1.6 - 4.0 (100 - 250)	1 - 3	3000 - 6000	85 - 95
SEQUENCING BATCH REACTOR (SBR)	CONVENTIONAL - LOW RATE	N/A	0.05 - 3.0	0.08 - 0.25 (5 - 15)	12 - 48	1500 - 5000	85 - 95

The size of the aeration tank for any particular adaptation of the process shall be determined by full scale experience, pilot plant studies, or rational calculations based mainly on food to microorganism ratio and mixed liquor suspended solids levels. Other factors, such as size of treatment plant, diurnal load variations, and degree of treatment required, shall also be considered. In addition, temperature, pH, and reactor dissolved oxygen shall be considered when designing for nitrification.

6.1.4 Aeration

6.1.4.1 Arrangement of Aeration Tanks

6.1.4.1.1 General Tank Configuration

a. Dimensions

The dimensions of each independent mixed liquor aeration tank or return sludge re-aeration tank shall be such as to maintain effective mixing and utilization of air.

Aeration basin depth is an important consideration in the design of aeration systems because of the effect that depth has on the aeration efficiency and air pressure requirements of diffused aeration devices and mixing capabilities of mechanical aerators. A minimum aeration basin depth of 3.0 to 4.6 m is recommended for typical sewage treatment plants. Oxidation ditches should have minimum depth of 1.6 m.

b. Short-circuiting

For very small tanks or tanks with special configuration, the shape of the tank, the location of the influent and sludge return and the installation of aeration equipment should provide for positive control of short-circuiting through the tank.

c. Number of Units

Total aeration tank volume shall be divided among two or more units, capable of independent operation, when the total aeration tank volume required exceeds 140 m^3.

6.1.4.1.2 Inlets and Outlets

a. Controls

Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop plates, weirs or other devices to permit controlling the flow to any unit and to maintain a reasonably constant liquid level. The hydraulic properties of the system shall permit the design peak instantaneous hydraulic load to be carried with any single aeration tank unit out of service. The effluent weir for an oxidation ditch must be easily adjustable by mechanical means.

b. Conduits

Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleansing velocities or shall be agitated to keep such solids in suspension at all rates of flow within the design limits. Adequate provisions should be made to drain segments of channels which are not being used due to alternate flow patterns.

6.1.4.1.3 *Measuring Devices*

Devices should be installed for indicating flow rates of raw sewage or primary effluent, return sludge and air to each tank unit. For plants designed for sewage flows of 5000 m^3/d or more, these devices should totalize and record, as well as indicate flows. Where the design provides for all return sludge to be mixed with the raw sewage (or primary effluent) at one location, then the mixed liquor flow rate to each aeration unit should be measured.

6.1.4.1.4 *Freeboard*

All aeration tanks should have a freeboard of not less than 450 mm. Additional freeboard or windbreak may be necessary to protect against freezing or windblown spray. If a mechanical surface aerator is used, the freeboard should not be less than 900 mm.

6.1.4.2 *Aeration Equipment*

6.1.4.2.1 *General*

Oxygen requirements generally depend on maximum BOD loading, degree of treatment and level of suspended solids concentration to be maintained in the aeration tank mixed liquor. Aeration equipment shall be capable of maintaining a minimum of 2.0 mg/l of dissolved oxygen in the mixed liquor at all times and providing thorough mixing of the mixed liquor. In the absence of experimentally determined values, the design oxygen requirements for all activated sludge processes shall be 1.1 Kg O_2/Kg peak BOD_5 applied to the aeration tanks with the exception of the extended aeration process, for which the value shall be 1.5. In the case of nitrification, the oxygen requirement for oxidizing ammonia must be added to the above requirement for carbonaceous BOD removal. The nitrogen oxygen demand (NOD) shall be taken as 4.6 times the diurnal peak TKN content of the influent. In addition, the oxygen demands due to recycle flows - heat treatment supernatant, vacuum filtrate, elutriates, etc. - must be considered due to the high concentrations of BOD and TKN associated with such flows.

Careful consideration should be given to maximizing oxygen utilization per unit power input. Unless flow equalization is provided, the aeration system should be designed to match diurnal organic load variation while economizing on power input.

6.1.4.2.2 *Variable Oxygenation Capacity*

Consideration should be given to reducing power requirements of aeration systems by varying oxygenation capacity to match oxygen demands within the system. Such a system would utilize automatic D.O. probes in each aeration basin to measure dissolved oxygen levels.

6.1.4.2.3 *Mixing Requirements*

The aeration system which is selected must not only satisfy the oxygen requirements of the mixed liquor, but must also provide sufficient mixing to ensure that the mixed liquor remains in suspension. The power levels necessary to achieve uniform dissolved oxygen and mixed liquor suspended solids concentrations are shown in Table 6.2.

TABLE 6.2 - AERATION MIXING REQUIREMENTS

AERATION SYSTEM	FOR UNIFORM D.O. LEVELS	FOR UNIFORM MLSS LEVELS
MECHANICAL	1.6 TO 2.5 W/cu. m (0.06 to 0.09 HP/1000 cu. ft.)	16 TO 25 W/cu. m (0.6 TO 0.9 HP/1000 cu. ft)
DIFFUSED (COARSE BUBBLE, SPIRAL ROLL)	———	0.33 L/cu. m/s (20 cfm/1000 cu. ft.)
DIFFUSED (FINE BUBBLE DOMES, FULL FLOOR COVERAGE)	———	0.6 L/sq. m/s (0.12 cfm/sq. ft)

NOTES:
1. Mixing requirements vary with basin geometry, MLSS concentrations, placement of aeration devices, pumping efficiency of aerators, etc. Wherever possible, refer to full-scale testing results for the particular aerator being considered.
2. L/cu. m/s refers to volume of air per second per volume of aeration tank.
3. L/sq. m/s refers to volume of air per second per horizontal cross-sectional area of aeration tank.

6.1.4.2.4 *Back-up Requirements*

Aeration systems will require facilities to permit continuous operation, or minimal disruption, in the event of equipment failure. The following factors should be considered when designing the back-up requirements for aeration systems:

- effect on the aeration capacity if a piece of equipment breaks down, or requires maintenance (for instance, the breakdown of one or two blowers will have a greater effect on capacity than the breakdown of one or four mechanical aerators);

- time required to perform the necessary repair and maintenance operations;

- the general availability of spare parts and the time required to obtain delivery and installation; and

- means other than duplicate equipment to provide the necessary capacity in the event of a breakdown (for instance, using over-sized mechanical aerators with adjustable weirs to control power draw and oxygenation capacity, or using two speed mechanical aerators, etc.).

Generally considerations such as the above will mean that diffused aeration systems will require a standby blower but mechanical aeration systems may not require standby units, depending upon the number of duty units, availability of replacement parts, etc.

6.1.4.2.5 *Oxygen Transfer and Oxygen Transfer Efficiency*

Aeration equipment must be designed to carry out its functions under conditions much different than those under which it may be tested by the equipment supplier. The bulk of oxygen transfer tests are conducted under conditions commonly referred to as standard or are corrected to standard conditions.

The designer, therefore, must test the unit under standard conditions and project its efficiency to the mixed liquor, or conduct the test in the mixed liquor. In either case, there are intricacies (related to aerator testing) involved in making this conversion from one condition to another. It is good practice to work with the suppliers when selecting aerators to discuss and agree on, at the time of design, the planned test procedure and interpretation of results.

It is most common to express the oxygenation rate of a particular activated sludge aeration device either as standard oxygen rate, SOR or actual oxygen rate, AOR, both in Kg of oxygen transferred per hour. Either value is considered to be determinable, given the other and its transfer environment. Methods used to calculate oxygen transfer for conditions other than standard, or to correct to standard conditions the results obtained by mixed liquor testing are as follows:

Mechanical surface aerators:

$$AOR = \alpha(SOR)\frac{\beta C_{SW} - C_0}{C_S}\Theta^{(T-20)} \quad (1)$$

Diffused air and submerged turbine aerators:

$$AOR = \alpha(SOR)\frac{\beta C_{SC}{*} - C_0}{C_S}\Theta^{(T-20)} \quad (2)$$

α = relative rate of oxygen transfer as compared to clean water, dimensionless [equal to 1.0 under standard conditions. Mixed liquor range is 0.6 (near basin influent) to 0.94, with the higher value representative of well-treated wastes; values generally range from 0.8 to 0.94; initial stages of plug flow systems may have very low α; industrial wastes may reduce α];

β = relative oxygen saturation value as compared to clean water, dimensionless [equal to 1.0 under standard conditions. Mixed liquor range to 0.9 to 0.97, with upper level seen in well-treated wastes];

Θ = temperature correction constant, 1.024;

C_s = oxygen saturation value of clean water at standard conditions,

$C_s = 9.17$ mg/l,

C_{sw} = saturation value of clean water at the surface, at site conditions of temperature, T, and actual barometric pressure, P_a,

C_{sc}^* = corrected C_s value for water depth, D, and oxygen content of gaseous phase, mg/l,

C_0 = initial (or steady state) DO level mg/l [equal to 0.0 mg/l under standard conditions. Mixed liquor values range from 1.5 to 2.0 mg/l at average oxygen uptake conditions], and

T = Temperature of bulk liquid, °C [equal to 20°C under standard conditions. Mixed liquor values range from 5° to 30°C; highest operating temperature is most conservative in terms of design (C_s and $\theta^{(20-T)}$ to self-correct)].

In the absence of experimentally determined alpha and beta factors, wastewater transfer efficiency shall be assumed to be 50% of clean water efficiency for plants treating primarily (90% or greater) domestic sewage. Treatment plants where the waste contains higher percentages of industrial wastes shall use a correspondingly lower percentage of clean water efficiency and shall have calculations submitted to justify such a percentage.

Oxygen transfer efficiencies are generally represented in terms of Kg of O_2 transferred per MJ (or lb O_2/hp hr). Manufacturers of aeration equipment will generally designate the specific equipment O_2 transfer rate as Ns (the standard transfer efficiency or rated capacity). The rated capacity can be expressed as:

$$Ns = \frac{SOR}{\text{Total Power Consumed (by mixer/aerator, pump, blower)}} \quad (3)$$

The designer must therefore use equation (3) to determine the AOR as described in equation (1) or (2).

6.1.4.2.6 *Characteristics of Aeration Equipment*

Table 6.3 outlines various characteristics of some typical aeration equipment.

6.1.4.2.7 *Diffused Air Systems*

Typical air requirements for all activated sludge processes except extended aeration (assuming equipment capable of transmitting to the mixed liquor the amount of oxygen required in Design Section 6.1.4.2.1) is 100 cu. meters per Kg of BOD_5 peak aeration tank loading. For the extended aeration process the value is 125 m^3.

TABLE 6.3 - CHARACTERISTICS OF SOME AERATION EQUIPMENT

EQUIPMENT TYPE	EQUIPMENT CHARACTERISTICS	PROCESS WHERE USED	ADVANTAGES	DISADVANTAGES	REPORTED TRANSFER EFFICIENCY* (kg/MJ) FOR STD CONDITIONS, 0 DO, 20°c, 101 KPa, AND CLEAN WATER
DIFFUSED AIR: A. BUBBLER POROUS DIFFUSERS	PRODUCE FINE-TO-MEDIUM BUBBLES. MADE OF CERAMIC DOMES, PLATES, TUBES, OR PLASTIC-CLOTH TUBE OR BAG.	HIGH RATE, CONVENTIONAL EXTENDED, STEP, MODIFIED, CONTACT-STABILIZATION ACTIVATED SLUDGE PROCESS.	GOOD MIXING; MAINTAINS LIQUID TEMPERATURE. VARYING AIR FLOW PROVIDES GOOD OPERATIONAL FLEXIBILITY.	HIGH INITIAL AND MAINTENANCE COSTS; AIR FILTERS NEEDED; SPIRAL CONFIGURATION LIMITS TANK GEOMETRY.	0.31 - 0.42
NONPOROUS DIFFUSERS	MADE IN BUBBLE CAP, NOZZLE, VALVE, ORIFICE, OR SHEAR TYPES. THEY PRODUCE COARSE OR LARGE BUBBLES. SOME MADE OF PLASTIC WITH CHECK VALVE DESIGN.	SAME AS FOR POROUS DIFFUSERS.	NON-CLOGGING, MAINTAINS LIQUID TEMPERATURE; LOW MAINTENANCE COST.	HIGH INITIAL COST; LOW OXYGEN TRANSFER EFFICIENCY; HIGH POWER COST. FOULING MAY OCCUR.	0.2 - 0.31
B. TUBULAR	PRODUCES HIGH SHEAR AND ENTRAINMENT AS WATER-AIR MIXTURE IS FORCED THROUGH VERTICAL CYLINDER CONTAINING STATIC MIXING ELEMENTS. CYLINDER CONSTRUCTION IS METAL OR PLASTIC.	PRIMARILY AERATED LAGOON APPLICATIONS.	ECONOMICALLY ATTRACTIVE; LOW MAINTENANCE; HIGH TRANSFER EFFICIENCIES FOR DIFFUSED AIR SYSTEMS. WELL SUITED FOR AERATED LAGOON APPLICATIONS.	ABILITY TO ADEQUATELY MIX REACTOR BASIN CONTENTS IS QUESTIONABLE. APPLICATION FOR USE IN HIGH RATE BIOLOGICAL SYSTEMS UNCONFIRMED.	0.31 - 0.44
C. JET	COMPRESSED AIR AND PUMPED LIQUID ARE VIOLENTLY INTERMIXED IN NOZZLE AND AT DISCHARGE INTO VESSEL.	SAME AS FOR BUBBLER DIFFUSER.	SUITED FOR DEEP TANKS; MODERATE COST.	TANK GEOMETRY LIMITED. CLOGGING OF NOZZLE REQUIRES BLOWER AND PUMP. PRIMARY TREATMENT REQUIRED.	0.43 - 0.60
MECHANICAL SURFACE: A. RADIAL FLOW, LOW SPEED 20 - 60 RPM	LOW OUTPUT SPEED; LARGE DIAMETER TURBINE, FLOATING, FIXED-BRIDGE OR PLATFORM MOUNTED. USED WITH GEAR REDUCER.	SAME AS FOR BUBBLER DIFFUSER.	TANK DESIGN FLEXIBILITY; HIGH PUMPING CAPACITY.	SOME ICING IN COLD CLIMATES. INITIAL COST HIGHER THAN AXIAL FLOW AERATORS. GEAR REDUCER MAY CAUSE MAINTENANCE PROBLEMS.	0.34 - 0.76
B. AXIAL FLOW 300 - 1200 RPM	HIGH OUTPUT SPEED. SMALL DIAMETER PROPELLER. THEY ARE DIRECT, MOTOR DRIVEN UNITS MOUNTED ON FLOATING STRUCTURE.	AERATED LAGOONS AND REAERATION.	LOW INITIAL COST; EASY TO ADJUST TO VARYING WATER LEVEL FLEXIBLE OPERATION.	SOME ICING IN COLD CLIMATES; POOR MAINTENANCE ACCESSIBILITY, MIXING CAPACITY MAY BE INADEQUATE.	0.34 - 0.43
C. BRUSH ROTOR	LOW OUTPUT SPEED; USED WITH GEAR REDUCER.	OXIDATION DITCH, APPLIED EITHER AS AN AERATED LAGOON OR AS AN ACTIVATED SLUDGE.	MODERATE INITIAL COST. GOOD MAINTENANCE ACCESSIBILITY.	SUBJECT TO OPERATIONAL VARIABLES WHICH MAY AFFECT EFFICIENCY; TANK GEOMETRY IS LIMITED.	0.43 - 0.60
SUBMERGED TURBINE	UNITS CONTAIN A LOW SPEED TURBINE AND PROVIDE COMPRESSED AIR TO DIFFUSER RINGS OR OPEN PIPE. FIXED-BRIDGE APPLICATION.	SAME AS FOR BUBBLER DIFFUSER.	GOOD MIXING; HIGH CAPACITY INPUT PER UNIT VOLUME; DEEP TANK APPLICATION; OPERATIONAL FLEXIBILITY. NO ICING OR SPLASH.	REQUIRE BOTH GEAR REDUCER AND BLOWER; HIGH TOTAL POWER REQUIREMENTS; HIGH COST.	0.29 - 0.43

* REPORTED EFFICIENCY VARIES BECAUSE OF TANK GEOMETRY, DESIGN AND OTHER FACTORS.

Air requirements for diffused air systems should be augmented as required by consideration of the following items:

a. To the air requirements calculated shall be added air required for channels, pumps, aerobic digesters or other air-use demand.

b. The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into account that the air intake temperature may reach 40°C or higher and the pressure may be less than normal. The specified capacity of the motor drive should also take into account that the intake air may be -30°C or less and may require oversizing of the motor or a means of reducing the rate of air delivery to prevent overheating or damage to the motor.

c. The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant. Aeration equipment shall be easily adjustable in increments and shall maintain solids suspension within these limits.

d. Diffuser systems shall be capable of providing for the diurnal peak oxygen demand or 200% of the design average day oxygen demand, whichever is larger. The air diffusion piping and diffuser system shall be capable of delivering normal air requirements with minimal friction losses.

   Air piping systems should be designed such that total head loss from the blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 3.4 Kpa at average operating conditions.

   The spacing of diffusers should be in accordance with the oxygen requirements through the length of the channel or tank and should be designed to facilitate adjustment of their spacing without major revision to air header piping. Fifty per cent blanks should be provided in at least the first half of the aeration system, for possible addition of more diffusers if found necessary.

   All plants shall be designed to incorporate removable diffusers that can be serviced and/or replaced without dewatering the tank.

e. Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling, or for complete shutoff. Diffusers in any single assembly shall have substantially uniform pressure loss.

f. Air filters shall be provided in numbers, arrangements and capacities to furnish at all times an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used. Blowers must have silencers, flexible connections and gauges.

g. Blowers which require internal lubrication are not desirable because of the danger of diffuser clogging from oil being carried in the air stream. Water-piston-type compressors are not desirable because they increase the condensation in the air system, resulting in a more severe corrosion problem in the piping and greater pressure loss required to pass the condensate through the diffusers.

6.1.4.2.8 *Mechanical Aeration Systems*

a. Oxygen Transfer Performance

The mechanism and drive unit shall be designed for the expected conditions in the aeration tank in terms of the power performance. Certified testing shall verify mechanical aerator performance. In the absence of specific design information, the oxygen requirements shall be calculated using a transfer rate not to exceed 1.22 Kg 0_2/Kw hr in clean water under standard conditions.

b. Design Requirements

1. maintain a minimum of 2.0 mg/l dissolved oxygen in the mixed liquor at all times throughout the tank or basin;

2. maintain all biological solids in suspension;

3. meet maximum oxygen demand and maintain process performance with the largest unit of service; and

4. provide for varying the amount of oxygen transferred in proportion to the load demand on the plant.

5. provide that motors, gear housing, bearings, grease fittings, etc., be easily accessible and protected from inundation and spray as necessary for the proper functioning of the unit.

c. Winter Protection

Due to high heat loss, the mechanism, as well as subsequent treatment units, shall be protected from freezing where extended cold weather conditions occur.

6.1.5 Return Sludge Equipment

6.1.5.1 *Return Sludge Rate*

The minimum permissible return sludge rate of withdrawal from the final settling tank is a function of the concentration of suspended solids in the mixed liquor entering it, the sludge volume index of these solids and the length of time these solids are retained in the settling tank. Since undue retention of solids in the final settling tank may be deleterious to both the aeration and sedimentation phases of the activated sludge process, the rate of sludge return expressed as a percentage of the average design flow of sewage should generally be variable between the limits set forth as follows:

PERCENTAGE OF AVERAGE DESIGN FLOW			
Type of Process	Minimum	Normal	Maximum
Plug Flow	25	30	100
Complete Mix	25	30	100
Carbonaceous Stage of Separate Stage Nitrification	25		75
Step Aeration	25	50	75
Contact Stabilization	50	100	150
Extended Aeration	50	100	150
Oxidation Ditch	50	100	150
High Rate	50	50	200
Nitrification Stage of Separate Stage Nitrification	50		200

The rate of sludge return shall be varied by means of variable speed motors, drives or timers (small plants) to pump sludge at the above rates.

6.1.5.2 *Return Sludge Pumps*

If motor driven return sludge pumps are used, the maximum return sludge capacity shall be obtained with the largest pump out of service. A positive head should be provided on pump suctions. Pumps should have at least 100 mm suction and discharge openings.

If air lifts are used for returning sludge from each settling tank hopper, no standby unit will be required, provided the design of the air lifts are such as to facilitate their rapid and easy cleaning and provided other suitable standby measures are provided. Air lifts should be at least 100 mm in diameter.

6.1.5.3 *Return Sludge Piping*

Suction and discharge piping should be at least 100 mm in diameter and should be designed to maintain a velocity of not less than 0.6 m/s and not more than 2 m/s, when return sludge facilities are operating at normal return sludge rates. Suitable devices for observing, sampling and controlling return activated sludge flow from each settling tank shall be provided.

6.1.5.4 *Waste Sludge Facilities*

Waste sludge control facilities should be designed for the maximum sludge production of the process. Means for observing, measuring, sampling and controlling waste activated sludge flow shall be provided. Waste sludge may be discharged to the primary settling tank, concentration or thickening tank, sludge digestion tank, mechanical dewatering facilities or any practical combination of these units.

6.1.6 Froth Control Units

It is essential to include some means of controlling froth formation in all aeration tanks. A series of spray nozzles may be fixed on top of the aeration tank. Screened effluent or tap water may be sprayed through these nozzles (either continuously or on a time clock on-off cycle) to physically break up the foam. Provision may be made to use antifoaming chemical agents into the inlet of the aeration tank or preferably into the spray water.

6.2 TRICKLING FILTERS

6.2.1 General

6.2.1.1 Applicability

Trickling filters may be used for treatment of sewage amenable to treatment by aerobic biological processes. They are generally capable of producing adequate treatment of domestic waste where effluent quality of 20 to 30 mg/L of BOD is acceptable.

6.2.1.2 Required Pretreatment

Trickling filters shall be preceded by effective settling tanks, equipped with scum collecting devices or other suitable pretreatment facilities.

6.2.1.3 Design Basis

Consideration for biological filters should include:

- Raw sewage amenability to biological treatment;
- Pretreatment effectiveness including scum and grease removal;
- Expected organic loadings, including variations;
- Expected hydraulic loadings, including variations;
- Treatment requirements, including necessary reduction of carbonaceous and/or nitrogenous oxygen demand;
- Sewage characteristics, including pH, temperature, toxicity, nutrients;
- Maximum organic and hydraulic loading rates;
- Type and dosing characteristics of the flow distribution system;
- Type of filter media to be used;
- Configuration of underdrain system;

- Recirculation rate;
- Provision for adequate ventilation;
- Freezing problems in winter time; and
- Provision for flushing the underdrain system.

Flow distribution system selection should be based on the following:

- Ruggedness of construction;
- Ease of cleaning;
- Ability to handle large variations in flow while maintaining adequate and uniform flow distribution; and
- Corrosion resistance.

Filters shall be designed so as to provide the reduction in biochemical oxygen demand required by local conditions, or to properly condition the sewage for subsequent treatment processes. Each system shall include a primary settling tank, the filter bed and a humus tank.

6.2.2 Design Characteristics

Table 6.4 presents design characteristics for various trickling filter classifications.

6.2.3 Dosing Equipment

6.2.3.1 Distribution

The sewage may be distributed over the filter by rotary distributors or other suitable devices which will permit reasonably uniform distribution to the surface area. At design average flow, the deviation from a calculated uniformly distributed volume per square meter of the filter surface shall not exceed plus or minus ten percent at any point.

6.2.3.2 Dosing

Sewage may be applied to the filters by siphons, pumps or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed. Application of the sewage shall be practically continuous. The piping system shall be designed for recirculation.

6.2.3.3 Piping System

The piping system, including dosing equipment and distributor, shall be designed to provide capacity for the peak hourly flow rate, including recirculation required under Design Section 6.2.6.5

TABLE 6.4 - COMPARISON OF DIFFERENT TYPES OF TRICKLING FILTERS

DESIGN CHARACTERISTICS	TRICKLING FILTER CLASSIFICATION				
	LOW OR STANDARD RATE	INTERMEDIATE RATE	HIGH RATE (STONE MEDIA)	SUPER RATE (PLASTIC MEDIA)	ROUGHING
HYDRAULIC LOADING (cu.m/ha/day) (L/day/sq.m)	9300 TO 37400 1000 TO 3650	37400 TO 93600 3650 TO 9400	93600 TO 377400 9400 TO 36650	140400 TO 842400* 14200 TO 85550*	561600 TO 684800* 57000 TO 171000
ORGANIC LOADING (g/cu. m/day)	80 TO 400	240 TO 500	400 TO 4800	UP TO 4800	1600 PLUS
RECIRCULATION	MINIMUM	USUALLY	ALWAYS	USUALLY	NOT NORMALLY REQ'D
FILTER FLIES	MANY	VARIES	FEW	FEW	FEW
SLOUGHING	INTERMITTENT	VARIES	CONTINUOUS	CONTINUOUS	CONTINUOUS
DEPTH. m	2 TO 2.5	2 TO 2.5	1 TO 2.5	UP TO 12	1 TO 6
BOD REMOVAL, %	80 TO 85	50 TO 70	65 TO 80	65 TO 85	40 TO 65
EFFLUENT QUALITY	WELL NITRIFIED	SOME NITRIFICATION	NITRITES	LIMITED NITRIFICATION	NO NITRIFICATION

* NOT INCLUDING RECIRCULATION

NOTE MIGAD X 7800 = cu m/ha/day, lb/day/1000 cu ft x 16.0 = g/cu m/day, lb/day/acre-ft x 0.368 = g/cu m/day; IG/day/sq ft x 40.74 = L/day/sq m

6.2.3.4 *Hydraulics*

All hydraulic factors involving proper distribution of sewage on the filters should be carefully calculated. For reaction type distributors, a minimum overhead of 600 mm between the low water level in the siphon chamber and the center of the arms is generally desirable.

6.2.3.5 *Clearance*

A minimum clearance of 150 mm between the media and distributor arms shall be provided. Greater clearance is essential where icing occurs.

6.2.4 Filter Media

6.2.4.1 *Materials*

The trickling filter medium shall be crushed rock, blast furnace slag or a synthetic medium specially manufactured for this purpose. The media should serve to provide the anchorage and space for biologically active slime material, to assist in distributing the flow as it passes downward through the bed and to permit circulation of air.

6.2.4.2 *Quality*

The media shall be durable, resistant to spalling or flaking and be relatively insoluble in sewage. The media shall be chemically and biologically inert. The top 450 mm shall have a loss by the 20-cycle, sodium sulfate soundness test of not more than ten percent, as prescribed by ASCE Manual of Engineering Practice, Number 13. The balance shall pass a ten-cycle test using the same criteria. Slag media shall be free from iron. Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalies, organic compounds and fungus and biological attack. Such media shall be structurally capable of supporting a man's weight or a suitable access walkway shall be provided to allow for distributor maintenance.

6.2.4.3 *Depth*

Rock and/or slag filter media shall have a minimum depth of 1.8 meters above the underdrains. Manufactured filter media should have a minimum depth of three meters to provide adequate contact time with the wastewater. Rock and/or slag filter media depths shall not exceed three meters and manufactured filter media depths shall not exceed nine meters except where special construction is justified through extensive pilot studies.

6.2.4.4 *Size and Grading of Media*

a. Crushed Rock, Slag and Similar Media

Crushed rock, slag and similar media shall not contain more than five percent by weight of pieces whose longest dimension is greater than three times the least dimension.

The media shall be free from thin, elongated and flat pieces, dust, clay, sand or fine material and shall conform to the following size and grading when mechanically graded over a vibrating screen with square openings:

Passing 115 mm screen	-	100% by weight
Retained on 75 mm screen	-	95% to 100% by weight
Passing 50 mm screen	-	0-2% by weight
Passing 25 mm screen	-	0-1% by weight

b. Hand-Packed Field Stone

Maximum dimensions of stone - 125 mm
Minimum dimensions of stone - 75 mm

6.2.4.5 *Manufactured Media*

Suitability shall be evaluated on the basis of experience with installations handling similar wastes.

6.2.4.6 *Handling and Placing of Media*

Material delivered to the filter site shall be stored on wood planked or other approved clean hard surfaced areas. All material shall be rehandled at the filter site and no material shall be dumped directly into the filter. Crushed rock, slag and similar media shall be re-screened or forked at the filter site to remove all fines. Such material shall be placed by hand to a depth of 300 mm above the tile underdrains and all material shall be carefully placed so as not to damage the underdrains. The remainder of the material may be placed by means of belt conveyors or equally effective methods approved by the engineer. Manufactured media shall be handled and placed as approved by the regulatory authority. Trucks, tractors or other heavy equipment shall not be driven over the filter during or after construction.

6.2.5 Underdrainage System

6.2.5.1 Arrangement

Underdrains with semi-circular inverts or equivalent should be provided and the underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an un-submerged gross combined area equal to at least 15 percent of the surface area of the filter.

6.2.5.2 Slope

The underdrains shall have a minimum slope of one percent. Effluent channels shall be designed to produce a minimum velocity of 0.6 meters per second at average daily rate of application to the filter, including recirculation flows.

6.2.5.3 Flushing

Provision should be made for flushing the underdrains, unless high rate recirculation is used. In small filters, use of peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities shall be provided.

6.2.5.4 Ventilation

The underdrainage system, effluent channels, and effluent pipe shall be designed to permit free passage of air. The size of drains, channels, and pipe should be such that not more than 50 percent of their cross-sectional area will be submerged under the design peak instantaneous flow, including proposed or possible future recirculated flows.

Forced ventilation should be provided for covered trickling filters to insure adequate oxygen for process requirements. Windows or simple louvred mechanisms so arranged to ensure air distribution throughout the enclosure shall be provided. The design of the ventilation facilities shall provide for operator control of air flow in accordance with outside seasonal temperature. Design computations showing the adequacy of air flow to satisfy process oxygen requirements shall be submitted.

6.2.6 Special Features

6.2.6.1 Flooding

Appropriate valves, sluice gates, or other structures shall be provided to enable flooding of filters comprised of rock or slag media for filter fly control.

6.2.6.2 *Freeboard*

A freeboard of 1.2 m or more should be provided for tall, manufactured media filters to maximize the containment of windblown spray.

6.2.6.3 *Maintenance*

All distribution devices, underdrains, channels and pipes shall be installed so that they may be properly maintained, flushed or drained.

6.2.6.4 *Protection from Freezing*

Covers shall be provided to maintain operation and treatment efficiencies, when climate conditions are expected to result in problems due to cold temperatures.

6.2.6.5 *Recirculation*

The piping system shall be designed for recirculation of filter effluents, secondary sludge or settled effluent as required to achieve the design efficiency. The recirculation rate shall be variable and subject to plant operator control.

6.2.6.6 *Flow Measurement*

Devices shall be provided to permit measurement of influent flow to the filter and the recirculation rate. Time lapse meters and pump head recording devices are acceptable for facilities treating less than 5000 m^3/d.

6.2.7 Multi-Stage Filters

The foregoing standards and recommendations also apply to multi-stage filters. Multi-stage filters may be used in series or in parallel.

6.2.8 Rotary Distributor Seals

Mercury seals shall not be permitted. Ease of seal replacement shall be considered in the design to ensure continuity of operation.

6.2.9 Treatment Efficiency

6.2.9.1 Pilot Testing

Required volumes of trickling filters shall be based upon pilot testing with the particular wastewater or any of the various empirical design equations that have been verified through actual full scale experience. Such calculations must be submitted if pilot testing is not utilized. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when significant amounts of industrial wastes are present.

6.2.9.2 Design Equations

6.2.9.2.1 Stone Media Filters

Stone media filters shall be designed based on the following procedure:

a. NRC Formula

First or Single Stage:

$$E_1 = \frac{100}{1 + 0.0085\left(\frac{W}{VF}\right)^{\frac{1}{2}}}$$

Second Stage:

$$E_2 = \frac{100}{1 + \frac{0.0085}{1-E_1}\left(\frac{W'}{VF}\right)^{\frac{1}{2}}}$$

Where:

E_1 = Percent BOD removal efficiency through the first-stage filter and clarifier,

W = BOD loading (lbs/day) to the first or single-stage filter, not including recycle,

V = Volume of the particular filter stage in acre-ft.,

F	=	Recirculation factor for a particular stage, $(1 + R)/(1 + 0.1R)^2$
R	=	Recirculation ratio = recirculated flow/plant influent flow,
E_2	=	Percent BOD removal efficiency through the second-stage filter and clarifier,
W^1	=	BOD loading (lbs/day) to the second-stage filter, not including recycle.

6.2.9.2.2 *Plastic Media Filters*

The following design criteria, parameters and procedures are suitable for designing a plastic medium trickling filter. The procedure producing the most conservative results (i.e. lowest efficiency) shall be considered acceptable. A designer who uses a different design procedure or exceeds the proposed design criteria may do so provided that the selected criteria are demonstrated and satisfied in an existing plant.

a. Procedure 1

$$\frac{L_e}{L_o} = e^{-K^{20}(1.025)^{(t-20)}} \quad (\frac{AD}{Q^{0.5}})$$

Where:

L_e	=	Clarified effluent BOD (mg/L)
L_o	=	BOD (mg/L) of the mixture of settled influent (primary settling tank effluent) and recycled liquid (also known as applied BOD)
K_{20}	=	BOD removal constant at 20°C
T	=	Liquid temperature in °C
A	=	Specific surface area of media, sq. ft/cu. ft.
D	=	Filter media depth, ft.
Q	=	Hydraulic loading rate, MGAD (millions gal/acre/day)

b. Procedure 2

$$\text{Log}\ \frac{100}{L} = 0.02\ (E\text{-}50)$$

Where:

L	=	Organic load on trickling filter (lb BOD/day/1000 cft)
100	=	A standard organic load (arbitrarily chosen) at which a plastic medium filter can remove 50% of influent BOD
E	=	Average BOD removal efficiency of the filter at the organic load, L.

However, under the following operating ranges of various factors, the efficiency may vary by plus or minus 5% from the average:

Wastewater temperature	=	2 to 15°C
Trickling filter depth	=	15 to 40 ft. (two filters in series, each 20 ft. deep may be assumed to be 40 ft. in effective depth)
Influent wastewater BOD	=	100 to 400 mg/L
Hydraulic Load	=	0.83 to 2.5 IG/min/ft^2 (52 to 158 million IG/day/acre)

6.2.10 Design Safety Factors

Trickling filters are affected by diurnal load conditions. The volume of media determined from either pilot plant studies or use of acceptable design equations shall be based upon the design peak hourly organic loading rate rather than the average rate. An alternative would be to provide flow equalization.

6.3 ROTATING BIOLOGICAL CONTACTORS

6.3.1 General

6.3.1.1 Applicability

The Rotating Biological Contactor (RBC) process may be used where sewage is amenable to biological treatment. The process may be used to accomplish carbonaceous and/or nitrogenous oxygen demand reductions.

Considerations for the rotating biological contactor (RBC) process should include:

- Raw sewage amenability to biological treatment;
- Pretreatment effectiveness including scum and grease removal;
- Expected organic loadings, including variations;
- Expected hydraulic loadings, including variations;
- Treatment requirements, including necessary reduction of carbonaceous and/or nitrogenous oxygen demand;
- Sewage characteristics, including pH, temperature, toxicity, nutrients;
- Maximum organic loading rate of active disc surface area;
- Minimum detention time at maximum design flow.

6.3.1.2 Winter Protection (Enclosures)

Wastewater temperature affects rotating contactor performance. Year-round operation requires that rotating contactors be covered to protect the biological growth from cold temperatures and the excessive loss of heat from the wastewater with the resulting loss of performance.

Enclosures shall be constructed of a suitable corrosion resistant material. Windows or simple louvred mechanisms which can be opened in the summer and closed in the winter shall be installed to provide adequate ventilation. To minimize condensation, the enclosure should be adequately insulated and/or heated. Mechanical ventilation should be supplied when the RBC's are contained within a building provided with interior access for personnel.

6.3.1.3 Required Pretreatment

RBC's must be preceded by effective settling tanks equipped with scum and grease collecting devices, unless substantial justification is submitted for other pretreatment devices which provide for effective removal or grit, debris and excessive oil or grease prior to the RBC units. Bar screening or comminution are not sole means of pretreatment.

6.3.1.4 *Flow Equalization*

For economy of scale, the peaking factor of maximum flow to average daily flow should not exceed 3. Flow equalization should be considered in any instance where the peaking factor exceeds 2.5.

6.3.1.5 *Operating Temperature*

The temperature of wastewater entering any RBC should not drop below 13°C unless there is sufficient flexibility to decrease the hydraulic loading rate or the units have been increased in size to accommodate the lower temperature. Otherwise, insulation or additional heating must be provided to the plant.

6.3.1.6 *Design Flexibility*

Adequate flexibility in process operation should be provided by considering one or more of the following:

a) Variable rotational speeds in first and second stages;
b) Multiple treatment trains;
c) Removable baffles between all stages;
d) Positive influent flow control to each unit or flow train;
e) Positively controlled alternate flow distribution systems;
f) Positive airflow metering and control to each shaft when supplemental operation or air drive units are used;
g) Recirculation of secondary clarifier effluent.

6.3.1.7 *Hydrogen Sulphide*

When higher than normal influent or sidestream hydrogen sulphide concentrations are anticipated, appropriate modifications in the design should be made.

6.3.2 Unit Sizing

The Designer of an RBC system shall conform to the following design criteria, unless it can be shown by thorough documentation that other values or procedures are appropriate. This documentation may include detailed design calculations, pilot test results, and/or manufacturer's empirical design procedures. It should be noted that use of manufacturer's design procedures should be tempered with the realization that they are not always accurate and in some cases can substantially overestimate attainable removals.

6.3.2.1 *Unit Sizing Considerations*

Unit sizing shall be based on experience at similar full-scale installations or thoroughly documented pilot testing with the particular wastewater. In determining design loading rates, expressed in units of volume per day per unit area of media covered by biological growth, the following parameters must be considered:

a) design flow rate and influent waste strength;
b) percentage of BOD to be removed;
c) media arrangement, including number of stages and unit area in each stage;
d) rotational velocity of the media;
e) retention time within the tank containing the media;
f) wastewater temperature; and
g) percentage of influent BOD which is soluble.

In addition to the above parameters, loading rates for nitrification will depend upon influent total kjeldahl nitrogen (TKN), pH and allowable effluent ammonia nitrogen concentration.

6.3.2.2 *Hydraulic Loading*

Hydraulic loading to the RBC's should range between 75 to 155 $L/d/m^2$ of media surface area without nitrification, and 30 to 80 L/s with nitrification.

6.3.2.3 *Organic Loading*

The RBC process is approximately first order with respect to BOD removal; ie., for a given hydraulic loading (or retention time) a specific percent BOD reduction will occur, regardless of the influent BOD concentration. However, BOD concentration does have a moderate effect on the degree of treatment, and thus the possibility of organic overloading in the first stage. With this in mind, organic loading to the first stage of an RBC train should not exceed 0.03 to 0.04 kg $BOD/m^2/d$ or 0.012 to 0.02 kg BOD $soluble/m^2/d$.

Loadings in the higher end of these ranges will increase the likelihood of developing problems such as heavier than normal biofilm thickness, depletion of dissolved oxygen, nuisance organisms, and deterioration of overall process performance. The structural capacity of the shaft; provisions for stripping biomass; consistently low influent levels of sulfur compounds to the RBC units; the media surface area required in the remaining stages; and the ability to vary the operational mode of the facility may justify choosing a loading in the high end of the range, but the operator must carefully monitor process operations.

6.3.2.4 *Tank Volume*

For purposes of plant design, the optimum tank volume is measured as wastewater volume held within a tank containing a shaft of media per unit of growth covered surface on the shaft, or litres per square metre (L/m^2). The optimum tank volume determined when treating domestic wastewater up to 300 mg/L BOD is 0.042 L/m^2, which takes into account wastewater displaced by the media and attached biomass. The use of tank volumes in excess of 0.042 L/m^2 does not yield corresponding increases in treatment capacity when treating wastewater in this concentration range.

6.3.2.5 *Detention Time*

Based on a tank volume of 0.042 L/m^2, the detention time in each RBC stage should range between 40 to 120 minutes without nitrification, and 90 to 250 minutes with nitrification.

6.3.2.6 *Media Submergence and Clearance*

RBC's should operate at a submergence of approximately 40 percent based on total media surface area. To avoid possible shaft overstressing and inadequate media wetting, the liquid operating level should never drop below 35 percent submergence. Media submergence of up to 95 percent may be allowed if supplemental air is provided. A clearance of 10 to 23 cm. between the tank floor and the bottom of the rotating media should be provided so as to maintain sufficient bottom velocities to prevent solids deposition in the tank.

6.3.3 Design Considerations

6.3.3.1 *Unit Staging*

The arrangement of media in a series of stages has been shown to significantly increase treatment efficiency. It is therefore recommended that an RBC plant be constructed in at least four stages for each flow path (or four zones of media area).

Four stages may be provided on a single unit by providing baffles within the tank. For small installations where the total area requirements dictate two units per flow path, two units may be placed in series with a single baffle in each tank, thus providing the minimum of four stages. For larger installations requiring four or more units per flow path, the units may be placed in a series within the flow path, with each unit itself serving as a single stage. Generally, though, plants requiring more than four stages should be constructed in a series of parallel floor trains, each comprised of four separate stages.

Wastewater flow to RBC units may be either perpendicular or parallel to the media shafts.

6.3.3.2 *Tankage*

RBC units may be placed in either steel or concrete tankage with baffles when required, and constructed of a variety of materials. The design of the tankage must include:

1. Adequate structural support for the RBC and drive unit;
2. Elimination of the "dead" areas;
3. Satisfactory hydraulic transfer capacity between stages of units; and
4. Considerations for operator safety.

The structure should be designed to withstand the increased loads which could result if the tank were to be suddenly dewatered with a full biological growth on the RBC units. The sudden loss of buoyancy resulting from unexpected tank dewatering could increase the bearing support loadings by as much as 40%.

Provisions for operator protection can be included in the tankage design by setting the top of the RBC tankage about one foot above the surrounding floor and walkways, with handrails placed along the top of the tankage, to provide an effective barrier between the operator and exposed moving equipment. The high tank walls will also prevent loss or damage by any material accidentally dropped in the vicinity of the units and entering the tankage.

6.3.3.3 *High Density Media*

Except under special circumstances, high density media should not be used in the first stage. Its use in subsequent stages should be based on appropriate loading criteria, structural limitations of the shaft and media, and media configuration.

6.3.3.4 *Shaft Rotational Velocity*

The peripheral velocity of a rotating shaft should be approximately 18 m/min for mechanically driven shaft, and between 9 and 18 m/min for an air driven shaft. Provision should also be made for rotational speed control and reversal.

6.3.3.5 *Biomass Removal*

A means for removing excess biofilm growth should be provided, such as air or water stripping, chemical additives, rotational speed control/reversal, etc.

6.3.3.6 *Dissolved Oxygen Monitoring*

First-stage dissolved oxygen (DO) monitoring should be provided. The RBC should be able to maintain a positive DO level in all stages.

6.3.3.7 *Supplemental Air*

Periodic high organic loadings may require supplemental aeration in the first stage to promote sloughing of biomass.

6.3.3.8 *Side Stream Inflows*

The type and nature of side stream discharges to an RBC must be evaluated, and the resulting loads must be added to the total facility influent loads. Anaerobic digesters increase ammonia nitrogen loadings, and sludge conditioning processes such as heat treatment contribute increased organic and ammonia nitrogen loadings. Whenever septic tank discharges comprise part of the influent wastewater or any unit processes are employed that may produce sulfide ahead of the RBC units, the additional oxygen demand associated with sulfide must be considered in system design.

6.3.3.9 *Recirculation*

Consideration should be given to providing recirculation of RBC effluent flow. This may be necessary during initial start-up and when the inflow rate is reduced to extremes.

For small installations, such as those serving an industrial park or school, the inflow over weekends or at holiday periods may drop to zero. During such periods, the lack of incoming organic load will cause the media biogrowth to enter the endogenous respiration phase where portions of the biogrowth become the food source or substrate for other portions of the biogrowth. If this condition lasts long enough, all of the biogrowth will eventually be destroyed. When this condition is allowed to exist, the RBC process does not have adequate biogrowth to provide the desired treatment when the inflow restarts.

If flow can be recycled through the sludge holding/treatment units and then to the RBC process, an organic load from the sludge units can be imposed on the RBC process. This imposed load will help to maintain the biogrowth and, as a secondary benefit, help stabilize and reduce the sludge.

When any new facility is first started, the biogrowth is slow to establish. If it is desired to build up the biogrowth before directing all of the inflow to the RBC process (as when the RBC is replacing an older existing process) some inflow may be directed to the RBC process and recycled.

In the first few days, minimal biogrowth will develop with only minimal removal of the organic load. By recycling, the unused organic load again becomes available to the biogrowth. As the biogrowth develops, the recycle rate should be reduced, with new inflow added to increase the organic load. As the biogrowth develops further, the recycle is eventually reduced to zero with all of the inflow being the normal RBC influent.

6.3.3.10 *Load Cells*

Load cells, especially in the first stage(s), can provide useful operating and shaft load data. Where parallel trains are in operation, they can pinpoint overloaded or underloaded trains. Stop motion detectors, rpm indicators and clamp-on ammeters are also potentially useful monitoring instruments.

Therefore, load cells shall be provided for all first and second stage shafts. Load cells for all other shafts in an installation are desirable.

6.3.3.11 *Shaft Access*

In all RBC designs, access to individual shafts for repair or possible removal must be considered. Bearings should also be accessible for easy removal and replacement if necessary. Where all units in a large installation are physically located very close together, it may be necessary to utilize large off-the-road cranes for shaft removal. Crane reach, crane size, and the impact of being able to drain RBC tankage and dry a unit prior to shaft removal should all be considered when designing the RBC layout.

6.3.3.12 *Structural Design*

The designer should require the manufacturer to provide adequate assurance that the shaft and media support structures are protected from structural failure for the design life of the facility. Structural designs should be based on appropriate American Welding Society (AWS) stress category curves modified as necessary to account for the expected corrosive environment. All fabrication during construction should conform to AWS welding and quality control standards.

6.3.3.13 *Energy Requirements*

Energy estimates used for planning and design should be based on expected operating conditions such as temperature, biofilm thickness, rotational speed, type of unit (either mechanical or air driven), and media surface area instead of normalized energy data sometimes supplied by equipment manufacturers. Care should be taken to assure that manufacturers' data are current and reflect actual field-validated energy usage.

Only high efficiency motors and drive equipment should be specified. The designer should also carefully consider providing power factor correction for all RBC units.

6.3.3.14 *Nitrification Consideration*

Effluent concentrations of ammonia nitrogen from the RBC process designed for nitrification are affected by diurnal load variations. Therefore, it may be necessary to increase the design surface area proportional to the ammonia nitrogen diurnal peaking rates to meet effluent limitations. An alternative is to provide flow equalization sufficient to insure process performance within the required effluent limitations.

6.4 WASTE STABILIZATION PONDS AND AERATED LAGOONS

6.4.1 Supplement to Pre-Design Report

6.4.1.1 General

The Pre-Design report shall contain pertinent information on location, geology, soil conditions, area for expansion and any other factors that will affect the feasibility and acceptability of the proposed project.

The following information must be submitted in addition to that required in Policy Section 4.

6.4.1.2 Location in Relation to Nearby Facilities

The location and direction of all residences, commercial developments, recreational areas and water supplies within two kilometres of the proposed pond shall be included in the Pre-Design report.

6.4.1.3 Land Use Zoning

Land use zoning adjacent to the proposed pond site shall be included.

6.4.1.4 Soil Borings

Data from soil borings, conducted by an independent soil testing laboratory to determine subsurface soil characteristics and groundwater characteristics (including elevation and flow) of the proposed site and their effect on the construction and operation of a pond, shall also be provided. At least one boring shall be a minimum of 7.5 m in depth or into bedrock, whichever is shallower. If bedrock is encountered, rock type, structure and corresponding geological formation data should be provided. The boring shall be filled and sealed. The permeability characteristics of the pond bottom and pond seal materials shall also be studied.

6.4.1.5 Percolation Rates

Data demonstrating anticipated percolation rates at the elevation of the proposed pond bottom shall be included.

6.4.1.6 Site Description

A description, including maps showing elevations and contours of the site and adjacent area suitable for expansion shall be identified. Due consideration shall be given to additional treatment units and/or increased waste loadings or determining load requirements.

6.4.1.7 Location of Field Tile

The location, depth, and discharge point of any field tile in the immediate area of the proposed site shall be identified.

6.4.1.8 Sulfate Content of Water Supply

Sulfate content of the basic water supply shall be determined.

6.4.1.9 Well Survey

A pre-construction survey of all nearby wells (water level and water quality) is mandatory.

6.4.2 Location

6.4.2.1 Distance From Habitation

A pond site should be located as far as practicable, with a minimum of 150 m from isolated habitation and 300 m from built up areas or areas which may be built up within a reasonable future period. Consideration should be given to site specifics such as topography, prevailing winds, forests, etc.

A minimum distance of 100 m from public roads and highways is also recommended.

6.4.2.2. Prevailing Winds

If practicable, ponds should be located so that local prevailing winds will be in the direction of uninhabited areas.

6.4.2.3 Surface Runoff

Location of ponds in watersheds receiving significant amounts of storm water runoff is discouraged. Adequate provision must be made to divert storm water runoff around the ponds and protect pond embankments from erosion.

6.4.2.4 *Groundwater Pollution*

Existing wells which serve as drinking water sources shall be protected from health hazards. Possible travel of pollutants through porous soils and fissured rocks should be objectively evaluated to safeguard the wells. A pond shall be located as far as practicable, with a minimum of 300 m from any well used as a drinking water source.

A minimum separation of 1.2 m between the bottom of the pond and the maximum groundwater elevation shall be maintained.

6.4.2.5 *Protection of Surface Water Supplies*

Lagoons shall be located downhill, downstream and remote from all sources of surface water supplies (lakes and rivers). The following minimum distances shall be employed as the criteria:

Minimum Distance from a Lake or River to the Centre of a Dyke of a Proposed Lagoon	Remarks
120 m (400 ft)	Lined lagoon, pervious soil
75 m (250 ft)	Lined lagoon, impervious soil

6.4.2.6 *Geology*

Ponds shall not be located in areas which may be subjected to karstification (i.e. sink holes or underground streams generally occurring in areas underlain by limestone or dolomite).

A minimum separation of 3 m between the pond bottom and any bedrock formation is recommended.

6.4.2.7 *Floodplains*

A pond shall not be located within the 100 year floodplain

6.4.3 **Definitions**

6.4.3.1 *Aerobic Ponds*

Aerobic ponds are shallow basins used for Wastewater Treatment. The organic contaminants in the wastewater are degraded by aerobic and facultative bacteria. The basins characteristically receive a light organic loading. They are used primarily to achieve additional organic removal following conventional wastewater treatment. Dissolved oxygen is furnished by oxygen transfer between the air and water surface, and by photosynthetic algae. The amount of oxygen supplied by natural surface re-aeration depends largely on wind-induced turbulence.

6.4.3.2 *Facultative Ponds*

The facultative pond is divided into an aerobic layer at the top and an anaerobic layer on the bottom. The aerobic layer is generated by algae which produce oxygen by photosynthesis. Settleable solids are permitted to accumulate on the pond bottom, and are broken down anaerobically. Waste stabilization is accomplished by a combination of anaerobic, aerobic, and a preponderance of facultative organics interacting with the wastewater.

6.4.3.3 *Aerated Lagoons*

An aerated lagoon may be aerated aerobic (completely mixed) or aerated facultative. It does not depend on algae and sunlight to furnish DO or bacterial respiration, but instead uses diffusers or other mechanical aeration devices to transfer the major portion of oxygen and to create some degree of mixing. Because of the mixing, removal of suspended solids in the lagoon effluent is an important consideration.

Aerated lagoons can be described as heavily loaded oxidation basins, or very lightly loaded activated sludge systems. The micro-organisms responsible for the organic breakdown tend to be similar to those found in activated sludge systems.

Aerated lagoons may be used in series with aerobic lagoons. In such cases, the primary purpose of the lagoon without aeration is for is for solids removal.

6.4.4 Application, Advantages and Disadvantages of Different Lagoon Types

Table 6.5 presents advantages and disadvantages of the different pond and lagoon types for various applications.

TABLE 6.5 - APPLICATION, ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT LAGOON TYPES				
PARAMETER	UNAERATED AEROBIC	FACULTATIVE	AERATED	
			AEROBIC	FACULTATIVE
APPLICATION	NUTRIENT REMOVAL; TREATMENT OF SOLUBLE ORGANIC WASTES; SECONDARY EFFLUENTS	TREATMENT OF RAW DOMESTIC AND INDUSTRIAL WASTES	TREATMENT OF RAW DOMESTIC AND INDUSTRIAL WASTES	TREATMENT OF RAW DOMESTIC AND INDUSTRIAL WASTES
ADVANTAGES	LOW OPERATING AND MAINTENANCE COSTS	LOW OPERATING AND MAINTENANCE COSTS;	SMALL VOLUME AND AREA; RESISTANCE TO UPSETS	SMALL VOLUME AND AREA; RESISTANCE TO UPSETS
DISADVANTAGES	LARGE VOLUME AND AREA; POSSIBLE ODOURS	LARGE VOLUME AND AREA; POSSIBLE ODOURS	SIGNIFICANT MAINTENANCE AND OPERATING COSTS; HIGH SOLIDS IN EFFLUENT; FOAMING	MAINTENANCE AND OPERATION COSTS; FOAMING

6.4.5 Basis of design

6.4.5.1 Waste Stabilization Ponds

6.4.5.1.1 Holding Capacity Requirements

Before the design of a waste stabilization pond system can be initiated, the designer shall determine the following:

- whether the lagoon can be continuously discharged or must operate on a fill-and-draw basis;
- the period of the year if any, when discharge will not be permitted;
- what discharge rates will be permitted with fill-and-draw lagoons and what, if any, provision must be made for controlling effluent discharge rates in proportion to receiving stream flow rates;
- what the minimum time for discharge of lagoon cell contents should be for fill-and-draw systems.

The holding capacity of ponds shall be based upon average daily sewage flow rates, making a special allowance for net precipitation entering the cells.

6.4.5.1.2 *Area and Loadings*

One hectare of water surface should be provided for each 250 design population or population equivalent. In terms of BOD, a loading of 22 kilograms per hectare per day should not be exceeded. Higher or lower design loadings will be judged after review of material contained in the Pre-Design report and after a field investigation of the proposed site by the regulatory authority.

Due consideration shall be given to possible future municipal expansion and/or additional sources of wastes when the original land acquisition is made. Suitable land should be available at the site for increasing the size of the original construction.

Where substantial ice cover may be expected for an extended period, it may be desirable to operate the facility to completely retain winter-time flows.

Design variables such as pond depth, multiple units, detention time and additional treatment units must be considered with respect to applicable standards for BOD_5, total suspended solids (TSS), fecal coliforms, dissolved oxygen (DO) and pH.

6.4.5.1.3 *Flow Distribution*

The main inlet sewer or forcemain should terminate at a chamber which permits hydraulic and organic load splitting between the lagoon cells. The ability to introduce raw sewage to all cells is desirable, but as a minimum, there must be a capability to divide raw sewage flows between enough cells to reduce the BOD_5 loading to 22 kg/ha/d, or less.

The inlet chamber should be provided with a lockable aluminum cover plate or grating, divided into small enough sections to permit easy handling.

6.4.5.1.4 *Typical Performance Potentials*

Nova Scotia environmental conditions are expected to facilitate the following performance of stabilization ponds treating typical domestic wastes:

Winter efficiency	=	70% BOD removal
Summer efficiency	=	80% BOD removal
Organic Load	=	22 kg/hectare/day
Liquid depth	=	1.5 to 1.8 m

Detention Time	=	155 days
Suspended Solids removal	=	80% but may decrease with increasing algal concentrations

6.4.5.1.5 *Controlled -Discharge Stabilization Ponds*

For controlled-discharge systems, the area specified as the primary ponds should be equally divided into two cells. The third or secondary cell volume should, as a minimum, be equal to the volume of each of the primary cells.

In addition, the design should permit for adequate elevation difference between primary and secondary ponds to permit gravity filling of the secondary from the primary. Where this is not feasible, pumping facilities may be provided.

6.4.5.1.6 *Flow-Through Pond Systems*

At a minimum, primary cells shall provide adequate detention time to maximize BOD removal. Secondary cells should then be provided for additional detention time with depths to two meters to facilitate both solids and coliform reduction.

6.4.5.1.7 *Tertiary Pond*

When ponds are used to provide additional treatment for effluents from existing or new secondary sewage treatment works, the reviewing authority will, upon request, establish BOD loadings for the pond after due consideration of the efficiencies of the preceding treatment units.

6.4.5.2 ***Aerated Lagoons***

6.4.5.2.1 *General*

Aerated ponds can be either aerobic or facultative. An aerated aerobic pond contains dissolved oxygen through the whole system with no anaerobic zones. The pond shape and the aerating power provides complete mixing. The aerated facultative pond provides a partially mixed condition which will cause an anaerobic zone to develop at the bottom as suspended solids settle due to low velocity in the system.

a. **Aerated Aerobic Lagoons**

In general, an aerated pond can be classified as an aerobic pond (complete mixed) if the mechanical aeration power level is above six watts per cubic meters of maximum storage.

Aerated aerobic ponds should be designed to maintain complete mixing with bottom velocities of at least 0.15 m/s. It is important that sufficient mixing power be provided.

Quiescent settling areas adjacent to the aerated cell outlets or the addition of suspended solids removal processes such as a clarifier must follow aerated aerobic treatment, to insure compliance with suspended solids discharge requirements. In most cases, a minimum detention time of one day is required to achieve solids separation. Algae growth should be limited by controlling the hydraulic detention time to two days or less. Water depth of not less than one meter shall be maintained to control odours arising from anaerobic decomposition. Adequate provision must be made for sludge storage so that the accumulated solids will not reduce the actual detention time.

b. **Aerated Facultative Lagoons**

Aerated facultative ponds should be designed to maintain a minimum of two mg/1 of dissolved oxygen (DO) in the upper zone of the liquid.

The aeration system must be able to transfer up to 1.0 kilogram of oxygen per kilogram of BOD_5 applied uniformly throughout the pond when the water temperature is 20°C. The organic loading rate should be maintained between 0.031 and 0.048 kg/m^3/day.

The escape of algae into the effluent should be controlled by providing a quiescent area adjacent to each cell outlet with an overflow rate of 32 cubic meters per day per square meter or less. If multiple aerated facultative cells are used, all cells following the first one shall have diminished aeration capacity to permit additional settling.

Whenever possible, provisions should be provided for recirculating part (5-10%) of the final aeration cell effluent back into the influent in order to maintain a satisfactory mix of active micro-organisms.

6.4.5.2.2 *Design Parameters*

Detention Time

The mean cell residence time of an aerated pond should ensure that the suspended micro-organisms have adequate detention time to transform non-settling and dissolved solids into settleable solids, an adequate factor of safety is provided for periods of high hydraulic loading and that the detention time in the aerated pond is controlled by the rate of metabolism during the coldest period of the year.

As a minimum, the detention time should reflect 85% BOD_5 removal from November to April, being based on good and efficient operation of the aeration equipment. For the development of final design parameters, it is recommended that actual experimental data be developed; however, the aerated pond system design for minimum detention time may be estimated using the following formula:

$$t = \frac{E}{2.3\ K_1 \times (100-E)}$$

Where:

t = detention time, days

E = percent of BOD_5 to be removed in an aerated pond

K_1 = reaction coefficient, aerated lagoon, base 10. For normal domestic sewage, the K_1 value may be assumed to be 0.12/day at 20°C and 0.06/day at 1°C.

The reaction rate coefficient for domestic sewage which includes some industrial wastes, other wastes and partially treated sewage must be determined experimentally for various conditions which might be encountered in the aerated ponds. Conversion of the reaction rate coefficient at other temperatures shall be made based on experimental data. Additional storage volume should be considered for sludge and ice cover.

Oxygen Requirement

Oxygen requirements generally will depend on the BOD loading, the degree of treatment and the concentration of suspended solids to be maintained. Aeration equipment shall be capable of maintaining a minimum dissolved oxygen level of two mg/L in the ponds at all times.

The oxygen requirements should meet or exceed the peak 24 hours summer loadings. A safety factor of up to two should be considered in designing oxygen supply equipment based on average BOD_5 loadings. The amount of oxygen requirement has been found to vary from 0.7 to 1.4 times the amount of BOD_5 removed. Suitable protection from weather shall be provided for electrical control.

6.4.5.3 Industrial Wastes

Due consideration shall be given to the type and effects of industrial wastes on the treatment process. In some cases, it may be necessary to pretreat industrial or other discharges.

6.4.5.4 Multiple Units

At a minimum, a waste stabilization pond system shall consist of two cells designed to facilitate both series and parallel operations. The maximum size of a pond cell should be five hectares. A one cell system may be utilized in small installations. Larger cells may be permitted for bigger installations.

All systems should be designed with piping flexibility to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system.

Requirements for multiple units in an aerated lagoon system shall be similar to those in an activated sludge system, including requirements for back-up aeration equipment.

6.4.5.5 *Design Depth*

The minimum operating depth should be sufficient to prevent growth of aquatic plants and damage to the dykes, control structures, aeration equipment and other appurtenances. In no case should pond depths be less than 0.6 metres.

6.4.5.5.1 *Controlled-Discharge Stabilization Ponds*

The maximum water depth shall be 1.8 meters in primary cells. Greater depths in subsequent cells are permissible although supplemental aeration or mixing may be necessary.

6.4.5.5.2 *Flow-Through Stabilization Ponds*

Maximum normal liquid depth should be 1.5 meters.

6.4.5.5.3 *Aerated Pond Systems*

In general, normal water depths vary from 1.2 to 3.6 meters when using surface aerators, however, consideration should be given to depths of up to five meters to minimize surface heat losses.

6.4.5.6 *Pond Shape*

Acute angles within any wastewater stabilization pond or aerated lagoon should be avoided. Square cells are preferred to long narrow rectangular cells. The long dimension of any pond should not align with the prevailing wind direction.

6.4.6 Pond Construction Details

6.4.6.1 Embankments and Dykes

6.4.6.1.1 Materials

Embankments and dykes shall be constructed of relatively impervious materials and compacted to at least 90 percent Standard Proctor Density to form a stable structure. Vegetation and other unsuitable materials should be removed from the area where the embankment is to be placed.

A soils consultant's report shall be required for all earthen berm construction to demonstrate the suitability of the soils. In certain instances a hydrogeologist's report may be required to assess possible impact on the water table. All topsoil must be stripped from the area on which the berms are to be constructed.

6.4.6.1.2 Top Width

The minimum embankment top width should be three meters to permit access of maintenance vehicles.

6.4.6.1.3 Maximum Slopes

Unless otherwise specified by a soil consultant's report, embankment slopes should not be steeper than:

a. Inner

Three horizontal to one vertical.

b. Outer

Three horizontal to one vertical.

6.4.6.1.4 Minimum Slopes

Embankment slopes should not be flatter than:

a. Inner

Four horizontal to one vertical. Flatter slopes are sometimes specified for larger installations because of wave action but have the disadvantage of added shallow areas conducive to emergent vegetation. Other methods of controlling wave action may be considered.

b. Outer

Outer slopes shall be sufficient to prevent surface water runoff from entering the ponds.

6.4.6.1.5 *Freeboard*

Minimum freeboard shall be one meter.

6.4.6.2 ***Erosion Control***

a. Outer Dykes

The outer dykes shall have a cover layer of at least 100 mm of fertile topsoil to promote establishment of an adequate vegetative cover wherever rip rap is not utilized. Adequate vegetation shall be established on dykes from the outside toe to 0.5 m below the top of the embankment as measured on the slope. Perennial-type, low-growing, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding on dykes. Additional erosion control may also be necessary on the exterior dyke slope to protect the embankment from erosion due to severe flooding of a watercourse.

b. Inner Dykes

Alternate erosion control on the interior dyke slopes has become necessary for ponds because of problems associated with mowing equipment not designed to run on slopes as well as a lack of maintenance by the plant owner. The inner dykes shall have a cover of at least 200 mm of pit run gravel or other material graded in a manner to discourage the establishment of any vegetation. The material should be spread on dykes from the inside toe to the top of the embankment. Clean and sound rip rap or an acceptable equal shall be placed from 0.3 m above the high water mark to 0.6 m below the low water mark (measured on the vertical). Maximum size of rock used should not exceed 150 mm.

c. Top of Embankment

The top of the embankment used for access around the perimeter of the dykes shall have a cover layer of at least 300 mm of cover material similar to the one described in Design Section 6.4.6.2. b.

d. Additional Erosion Protection

Rip rap or some other acceptable method of erosion control is required as a minimum around all piping entrances and exits. For aerated cells the design should ensure erosion protection on the slopes and bottoms in the areas where turbulence will occur.

e. Erosion Control During Construction

Effective site erosion control shall be provided during construction, as outlined in the Nova Scotia Department of the Environment publication, "Erosion and Sedimentation Control Handbook for Construction Sites". An approved erosion control plan is required before construction begins.

6.4.6.3 ***Vegetation Control***

A method shall be specified which will prevent vegetation growth over the surface of the inner slope and top of the embankment.

6.4.6.4 ***Pond Bottom***

6.4.6.4.1 *Location*

A minimum separation of 3.0 m between the cell bottom and bedrock is recommended. Cell bottoms should be located at least 1.2 m above the high groundwater level, in order to prevent inflow and/or liner damage.

6.4.6.4.2 *Uniformity*

The pond bottom should be as level as possible at all points. Finished elevations should not be more than 75 mm from the average elevation of the bottom.

6.4.6.4.3 *Vegetation*

The bottom shall be cleared of vegetation and debris. Organic material thus removed shall not be used in the dyke core construction. However, suitable topsoil relatively free of debris may be used as cover material on the outer slopes of the embankment as described in Design Section 6.4.6.2.a.

6.4.6.4.4 *Permeability Tests*

Permeability tests shall be carried out on the soil material at each proposed lagoon site except in cases where the soil is unmistakably impervious. The permeability tests may take either of two forms:

1. Laboratory tests on samples from below the proposed bottom of the lagoon and from the material to be used in the dykes.

2. Field seepage tests. These may be conducted in the following way. A pit shall be dug to the level of the proposed lagoon bottom and the bottom of the dug hole carefully cleaned. At least one test shall be conducted for every two hectares of lagoon area. A pipe with an internal diameter of at least 200 mm and length of at least 1.2 meters shall be carefully placed in a vertical position resting on the bottom of the hole. The hole shall be backfilled around the outside of the pipe to a height of one meter with carefully tamped soil. Particular care should be given to tamping the soil near the bottom.

The pipe shall be filled with water to a depth of 1.2 m. The water must be placed in the pipe gently so as not to disturb the soil at the bottom.

The drop in water level from a head of 1.2 meters shall be recorded for each of at least 3 twenty-four hour periods, or until the readings become consistent. (Level shall be re-adjusted to 1.2 m at the beginning of each 24 hour period).

6.4.6.4.5 *Interpretation of Hydraulic Conductivity Measurements*

There can be major differences between laboratory and field hydraulic conductivity measurements. These differences are likely to occur because of complex geological and hydrogeological conditions, in situ and errors in measurement methods. The ratio of K (in situ) to K (laboratory) may be in the range of 0.38 to 64. The major reasons for higher field values are: 1) laboratory tests are generally run on homogeneous, clayey samples; 2) sand seams, fissures and other macrostructures in the field are not present in laboratory samples; 3) measurement of vertical K in the laboratory and horizontal K in the field; and 4) changes in soil structure, chemical characteristics of the permeant, air entrapment in laboratory samples and other errors associated with laboratory tests.

The value of K from a field test as described above may be obtained from the following equation:

$$K = \frac{A}{FDt} \quad (\ln \frac{h_1}{h_2})$$

Where,

A	=	area of standpipe
t	=	time for head change from h_1 to h_2
D	=	diameter of hole

h = head water above water table

F = 2.0 for a borehole with a flat bottom at an upper impervious boundary,

or

= 2.75 for a cased borehole with a flat bottom in the middle of a deep soil layer.

* Olson and Daniel (1981)

Alternatively, if the laboratory tests show a permeability greater than 1×10^{-8} cm per second, or if the drop in head of the field test exceeds 10 mm per 24 hours, then provision should be made to make the soil more impermeable, as indicated in Design Section 6.4.6.4.8.

6.4.6.4.6 *Soil*

Soil used in constructing the pond bottom (not including liner) and dyke cores shall be relatively incompressible and tight and compacted at or up to four percent above the optimum water content to at least 90 percent Standard Proctor Density. Soft pockets that would prevent sufficient compaction of the liner must be sub-excavated and replaced with suitable, compacted fill.

6.4.6.4.7 *Liner*

Ponds shall be sealed such that seepage loss through the seal is as low as practicably possible. Liners consisting of soils or bentonite as well as synthetic liners may be considered, provided the permeability, durability and integrity of the proposed material can be satisfactorily demonstrated for anticipated conditions. Results of a testing program which substantiates the adequacy of the proposed liner must be incorporated into and/or accompany the Pre-Design report. Standard ASTM procedures or acceptable similar methods shall be used for all tests. Where clay liners are used, precautions should be taken to avoid erosion and desiccation cracking prior to placing the system in operation.

6.4.6.4.8 *Seepage Control Criterion*

The seepage control criterion for municipal wastewater stabilization ponds and aerated lagoons specifies a maximum hydraulic conductivity, K, for the pond liner as a function of the liner thickness, L, and water depth, D, by the equation:

$$\text{Maximum K (m/s)} = \frac{4.6 \times 10^{-8} \text{m/s} \times \text{L (m)}}{\text{D (m)} + \text{L (m)}}$$

where all units are in meters and seconds.

For example, a compacted clay liner that is 0.5 m thick must have a hydraulic conductivity of about 1.3×10^{-8} m/s (1.3×10^{-6} cm/s) or less. The "K" obtained by the above expression corresponds to a percolation rate of pond water of less than 40 cubic meters per day per hectare at a water depth of 1.2 metres.

For a seal consisting of a synthetic liner, seepage loss through the liner shall not exceed the quantity equivalent to seepage loss through an adequate soil seal.

6.4.6.5 *Site Drainage*

Surface drainage must be routed around and away from cells. Field tiles within the area enclosed by the berms must be located and blocked so as to prevent cell content leakage. Measures must be taken, where necessary, to avoid disruption of field tile and surface drainage of adjacent lands, by constructing drainage works to carry water around the site.

6.4.7 Design and Construction Procedures for Clay Liners

6.4.7.1 *Delineation of Borrow Deposit*

The first step in designing a compacted clay liner is delineating a relatively uniform deposit of suitable borrow material, preferably from the pond cut or from a nearby borrow area. The required volume of clayey soil is equal to the surface area of the pond interior times the liner thickness (measured perpendicular to the bottom and side slope surfaces). A large reserve volume is recommended to ensure that there is indeed sufficient clay volume after removing silt and sand pockets and other unsuitable materials.

6.4.7.2 *Liner Thickness*

Recommended minimum compacted clay liner thicknesses are 0.5 m on the pond bottom and 0.7 m (2.3 ft) on the side slopes, to allow for weathering, variations in actual thickness, pockets of poor quality material that escape detection, etc. If a clay core in the dyke is preferred over an upstream clay blanket liner, then the core should be well keyed into the bottom liner. A minimum core width of three meters is suggested to allow economic and proper placement and compaction of the clay using large earth-moving equipment.

6.4.7.3 *Hydraulic Conductivity of Compacted Clay*

The in situ hydraulic conductivity of the compacted clay liner should be predicted from laboratory tests on the proposed clay borrow material. Several samples should be selected representing the range of material within the designated borrow zone, not just the better material. Permeability tests should be performed on the samples compacted to the required density (i.e. 95% of standard Proctor maximum dry density) at a moisture content anticipated in the field. It is recommended that the sensitivity of the compacted clay hydraulic conductivity to variations in density and moisture content be determined. The designer must be prepared to ensure that the soil is brought to the specified moisture content (i.e. by wetting), unless the natural moisture content is already suitable.

A laboratory value for K should be calculated from the weighted average of the individual tests. The weighting of each test value should be according to the estimated percent of the borrow volume that the individual sample represents.

It is recommended that the liner design be based on a K in situ that is one order of magnitude larger than the average K (lab), i.e.:

$$K\ (\text{design}) = K\ (\text{in situ}) = 10 \times \text{average } K\ (\text{lab})$$

The increase in the K value is a factor of safety to allow for the effects of macro-structure, poor quality borrow, etc., in the field. The K (design) and liner thickness values should meet the seepage criteria outlined in Design Section 6.4.6.4.8. If K (design) is too high, the more selective borrowing or adjustment of compaction moisture content could be investigated. Otherwise, an alternative liner material will be required.

6.4.7.4 *Subgrade Preparation*

Clay should not be placed directly over gravel or other materials that do not provide an adequate filter to prevent piping erosion of the liner.

6.4.7.5 *Liner Material Placement and Compaction*

The clay should be placed in uniform, horizontal lifts of about 150 mm maximum loose thickness. The liner should be constructed in at least three lifts. Thin lifts ensure more uniform density, better bonding between lifts and reduces the likelihood of continuous seepage channels existing in the liner. Large lumps, cobbles and other undesirable materials are more easily identified in thin lifts. Lumps of soil greater than 100 mm in maximum dimension should be broken up prior to compaction. As far as practical, the liner should be built up in a uniform fashion over the pond area, in order to avoid sections of butted fill where seepage paths may develop.

Each lift should be compacted within the specified moisture content range to the required density using heavy, self-propelled sheepsfoot compactors. Lift surfaces that have been allowed to dry out should be scarified prior to placing of the next lift. Lift surfaces that have degraded due to precipitation etc., should either be removed or allowed to dry to the required moisture content and then be re-compacted.

The completed liner should be smoothed out with a smooth-barrel compactor to reduce the liner surface area exposed to water absorption and swelling. The liner base should not be allowed to dry out or be exposed to freezing temperatures. Ideally, the liner should be flooded as soon as possible after construction and acceptance.

6.4.7.6 *Construction Control*

The most important form of quality control during construction of compacted clay liners will be observation and direction by the engineer. The characteristics of the desired liner material should be established in as much detail as possible (i.e. by color, texture, moisture content, plasticity or characteristic features such as the mineralogy of pebbles in till). Quick visual or index test identification by experienced field personnel is probably the best way to detect poor quality material. An indirect but simple way of controlling liner quality is to perform frequent in situ density and moisture content tests. The density and moisture content may then be related to hydraulic conductivity by the relationships established during the laboratory test program (see Design Section 6.4.7.3). The frequency of tests should be increased when soil conditions are variable. The tests may be used to statistically evaluate the overall liner properties and to assess suspect zones in the liner.

In situ density and moisture content tests should be carried out on a routine basis for each lift. Tests should be conducted on a grid pattern (say 30 x 30 m to 60 x 60 m grids for large ponds and at closer spacing for small ponds) and in suspect areas.

The completed liner may be assessed by performing in situ infiltration tests, which may be theoretically related to hydraulic conductivity values (see Design Section 6.4.6.4.5). It should be noted that the compacted clay liner is most likely to be partially saturated at the end of construction. The presence of five to ten percent air voids will result in an unsaturated K value that is somewhat higher than the saturated K value.

The completed liner may also be cored and the hydraulic conductivity of a trimmed sample can be tested in a suitable permeameter, i.e., odometer falling head tests or triaxial constant head tests. All holes created in the liner due to tests, stakes or other circumstances should be backfilled with well-compacted liner material.

6.4.7.7 *Planning*

The most important aspect of constructing a compacted clay liner may be the planning stage when the inspection engineer's role is defined, contract specifications are prepared and construction strategies are worked out. The engineer must have an adequate degree of control over material selection and methods of placement. The work procedure must be flexible with respect to earth movement.

Ideally, the borrow for a compacted clay liner would be the cut material just below the eventual pond invert. Thus, material may be cut and placed in a single operation for much of the pond liner area, although some stockpiling of borrow may be inevitable.

The lower lift of the liner might consist of reworked native soil broken up by tilling and re-compacted to eliminate fissures, etc. Nevertheless, the contract should allow for selective borrowing of cut material for liner use, for stockpiling, removal of undesirable materials and possible additional borrowing outside of the cut area.

6.4.8 Prefilling

Prefilling the pond should be considered in order to protect the liner, to prevent weed growth, to reduce odour and to maintain moisture content of the seal. However, the dykes must be completely prepared as described in Design Section 6.4.6.2.b before the introduction of water.

6.4.9 Influent Lines

6.4.9.1 Material

Any generally accepted material for underground sewer construction will be given consideration for the influent line to the pond. Unlined corrugated metal pipe should be avoided however, due to corrosion problems. In material selection, consideration must be given to the quality of the wastes, exceptionally heavy external loadings, abrasion, soft foundations and similar problems.

6.4.9.2 Surcharging

The design and construction of influent piping shall insure that where surcharging exists, due to the head of the pond, no adverse effects will result. These effects shall include basement flooding and overtopping of manholes.

6.4.9.3 Forcemains

Forcemains terminating in a sewage lagoon should be fitted with a valve immediately upstream of the lagoon.

6.4.9.4 Location

Influent lines should be located along the bottom of the pond so that the top of the pipe is below the average elevation of the pond seal. However, the pipe shall have adequate seal below it. The use of an exposed dyke to carry the influent line to the discharge points is prohibited.

6.4.9.5 *Point of Discharge*

The influent line to a square single celled pond should be essentially center discharging. Each square cell of a multiple celled pond operated in parallel shall have its own near center inlet but this does not apply to those cells following the primary cell, when series operation alone is used. Influent lines to single celled rectangular ponds should terminate at approximately the third point farthest from the outlet structure. Influent and effluent piping should be located to minimize short-circuiting within the pond. Consideration should be given to multi-influent discharge points for primary cells of 5 ha or larger.

All aerated cells shall have influent lines which distribute the load within the mixing zone of the aeration equipment. Consideration of multiple inlets should be closely evaluated for any diffused aeration system. For aerated lagoons the inlet pipe may go directly through the dyke and end at the toe of the inner slope.

6.4.9.6 *Influent Discharge Apron*

Inlet pipes should terminate with an upturned elbow, with the pipe extending 450 mm above the cell bottom.

The end of the discharge line shall rest on a suitable concrete apron large enough to prevent the terminal influent velocity at the end of the apron from causing soil erosion. A minimum size apron of one meter square shall be provided.

6.4.9.7 *Pipe Size*

The influent system shall be sized to permit peak raw sewage flow to be directed to any one of the primary cells. Influent piping should provide a minimum scouring velocity of 0.6 m/s.

6.4.10 Control Structure and Interconnecting Piping

6.4.10.1 *Structure*

Facility design shall consider the use of multi-purpose control structures to facilitate normal operational functions such as drawdown and flow distribution, flow and depth measurement, sampling, pumps for re-circulation, chemical additions and mixing and minimization of the number of construction sites within the dykes.

Control structures shall

(a) be accessible for maintenance and adjustment of controls;

(b) be adequately ventilated for safety and to minimize corrosion;

(c) be locked to discourage vandalism;

(d) contain controls to permit water level and flow rate control, complete shutoff and complete draining;

(e) be constructed of non-corrodible materials (metal-on-metal contact in controls should be of similar alloys to discourage electro-chemical reactions); and

(f) be located to minimize short-circuiting within the cell and avoid freezing and ice damage.

Recommended devices to regulate water level are valves, slide tubes, dual slide gates, or effluent chambers complete with a water level regulating weir. Regulators should be designed so that they can be preset to stop flows at any pond elevation.

6.4.10.2 Piping

All piping shall be of ductile iron or other acceptable material. The piping shall not be located within or below the liner. Pipes should be anchored with adequate erosion control.

6.4.10.2.1 Drawdown Structure Piping

a. Submerged Takeoffs

For ponds designed for shallow or variable depth operations, submerged takeoffs are recommended. Intakes shall be located a minimum of three meters from the toe of the dyke and 0.6 meters from the top of the liner and shall employ vertical withdrawal.

b. Multi-level Takeoffs

For ponds that are designed deep enough to permit stratification of pond content, multiple takeoffs are recommended. There shall be a minimum of 3 withdrawal pipes at different elevations. The bottom pipe shall conform to a submerged takeoff. The others should utilize horizontal entrance. Adequate structural support shall be provided.

c. Surface Takeoffs

For use under constant discharge conditions and/or relatively shallow ponds under warm weather conditions, surface overflow-type withdrawal is recommended. Design should evaluate floating weir box or slide tube entrance with baffles for scum control.

d. Maintenance Drawdown

All ponds shall have a pond drain to allow complete emptying, either by gravity or pumping, for maintenance. These should be incorporated into the above-described structures.

In aerated lagoons where a diffused air aeration system and submerged air headers are used, provision should be made to drain each lagoon (independently of others) below the level of the air header.

e. Emergency Overflow

All cells shall be provided with an emergency overflow system which overflows when the liquid reaches within 0.6 m of the top of the berms.

6.4.10.2.2 Hydraulic Capacity

The hydraulic capacity for continuous discharge structures and piping shall allow for at least the expected future peak sewage pumping rate.

The hydraulic capacity for controlled discharge systems shall permit transfer of water at a rate of 150 mm of pond water depth per day at the available head.

6.4.10.2.3 Interconnecting Piping

Interconnecting piping for multiple unit installations operated in series should be valved or provided with other arrangements to regulate flow between structures and permit flexible depth control. The interconnecting pipe to the secondary cell should discharge horizontally near the lagoon bottom to minimize need for erosion control measures and should be located as near the dividing dyke as construction permits. Interconnection piping shall enable parallel or series flow patterns between cells.

6.4.10.3 Location

The outlet structure and the inter-connecting pipes should be located i) away from the corners where floating solids accumulate and ii) on the windward side to prevent short-circuiting.

6.4.11 Miscellaneous

6.4.11.1 Fencing

The pond area shall be enclosed with a suitable fence to preclude livestock and discourage trespassing. The fence should be located on the outer dyke at a distance of 500 mm from the top outside edge of the embankment. Fencing should not obstruct vehicle traffic on top of the dyke. A vehicle access gate of sufficient width to accommodate equipment should be provided. All access gates should be provided with locks.

6.4.11.2 Access

An all-weather access road shall be provided to the pond site to allow year-round maintenance of the facility.

6.4.11.3 Warning Signs

Appropriate signs should be provided along the fence around the pond to designate the nature of the facility and warn against trespassing. At least one sign shall be provided on each side of the site and one for every 150 m of its perimeter.

6.4.11.4 Flow Measurement

Provisions for flow measurement shall be provided on the outlet. Safe access to the device should be made to permit safe measurement.

6.4.11.5 Groundwater Monitoring

An approved system of wells or lysimeters may be required around the perimeter of the pond site to facilitate groundwater monitoring. The need for such monitoring will be determined on a case-by-case basis.

6.4.11.6 Pond Level Gauges

Pond level gauges shall be provided.

6.4.11.7 Service Building

A service building for laboratory and maintenance equipment shall be provided, if required.

6.4.11.8 *Liquid Depth Operation*

Optimum liquid depth is influenced to some extent by lagoon area since circulation in larger installations permits greater liquid depth. The basic plan of operation may also influence depth. Facilities to permit operation at selected depths between 0.6 to 1.5 meters are recommended for operational flexibility. Where winter operation is desirable, the operating level can be lowered before ice formation and gradually increased to 1.5 meters by the retention of winter flows. In the spring, the level can be lowered to any desired depth at the time surface runoff and dilution water are generally at a maximum. Shallow operation can be maintained during the spring with gradual increased depths to discourage emergent vegetation in the summer months. In the fall, the levels can be lowered and again be ready for retention of winter storage.

6.4.11.9 *Pre-Treatment and Post-Treatment*

The wastewater shall be treated by bar screens before entering the lagoon.

The treated effluent shall be disinfected prior to discharging into the receiving water.

6.5 OTHER BIOLOGICAL SYSTEMS

New biological treatment schemes with promising applicability in wastewater treatment may be considered if the required engineering data for new process evaluation is provided in accordance with Design Section 3.4.2. New treatment schemes design criteria may be added to this manual when sufficient and adequate design data becomes available. These additions shall be noted in the revision record.

7.1 BASIS FOR DISINFECTION OF SEWAGE TREATMENT PLANT EFFLUENT

Disinfection of sewage treatment plant effluent shall be required in all cases, unless confirmed otherwise by the regulatory agencies.

The design shall consider meeting both the bacterial standards and the disinfectant residual limit in the effluent. The disinfection process should be selected after due consideration of waste characteristics, type of treatment process provided prior to disinfection, waste flow rates, pH of waste, disinfectant demand rates, current technology application, cost of equipment and chemicals, power cost, and maintenance requirements. The designer shall consider the provisions of the Federal "Transportation of Dangerous Goods Act" and the Provincial "Dangerous Goods and Hazardous - Wastes Management Act" when designing a disinfection system.

7.2 FORMS OF DISINFECTION

Chlorine is the most commonly used chemical for wastewater effluent disinfection. The forms most often used are liquid chlorine and calcium or sodium hypochlorite. Other disinfectants, including chlorine dioxide, ozone, bromine, or ultraviolet disinfection, may be accepted by the approving authority in individual cases. If chlorination is utilized, it may be necessary to dechlorinate if the chlorine level in the effluent would impair the natural aquatic habitat of the receiving stream. The use of chlorine capsules may be considered for small systems.

7.3 CHLORINATION

7.3.1 Design Guidelines

7.3.1.1 Mixing

The disinfectant shall be positively mixed as rapidly as possible, with a complete mix being effected in three seconds. This may be accomplished by either the use of a turbulent flow regime or a mechanical flash mixer.

7.3.1.2 Diffusers

A chlorine solution diffuser shall be placed ahead of the contact tank and near the vicinity of the mixing area.

7.3.1.3 Contact Time and Residual

A total chlorine residual of 0.5 mg/L is generally required. The required detention time shall be based upon the more stringent of either 30 minutes at design average daily flow or 15 minutes at the design peak hourly flow. The criteria to be used in the design shall be that which provides the largest volume for the contact tank.

7.3.1.4 *Coliform Levels*

Acceptable effluent coliform levels shall be based upon the results of the receiving water study and the receiving water quality guidelines.

7.3.1.5 *Contact Tank*

In order that the chlorine contact tank can provide the required detention, dead zones within the tank must be avoided and the flow through the tank must approach plug flow as closely as possible. Back-mixing within the contact tank must be avoided to prevent short-circuiting and the resulting poor disinfection results. Covered tanks are discouraged.

To approach a plug-flow regime, flow channels with length-to-width ratios of greater than 40:1 are required. Length-to-width ratios of 10:1 produce detention times of approximately 70 percent of the theoretical residence times. In rectangular tanks, longitudinal baffling to produce long, narrow flow channels with a serpentine flow pattern and with guide vanes at changes in direction is a preferred method.

Since some sedimentation occurs in chlorine contact tanks, provision should be made for periodic sludge removal from the chlorine contact tank(s). The drain should be valved. If it is necessary to take the contact tank out of operation for cleaning, and if short-term discontinuation of disinfection cannot be tolerated due to other critical uses made of the receiving waters, two contact basins shall be provided. In less critical situations, one contact basin will suffice provided that the bypass facilities are equipped with a chlorine application point for emergency disinfection.

7.3.2 Chlorination Facilities Design

7.3.2.1 *Feed Equipment*

7.3.2.1.1 *Capacity*

The chlorinator shall be sized according to the design flow of the treatment plant and its capacity may vary, depending on the uses and points of application of the chlorine. For disinfection, the capacity should be adequate to produce a concentration of residual chlorine in the plant effluent as measured by the standard DPD test such as to dependably and consistently obtain 0.5 mg/litre chlorine residual after a contact period of 20-30 minutes under average flow conditions.

For normal domestic sewage, the following may be used as a guide in sizing chlorination facilities.

TYPE OF TREATMENT	DOSAGE (mg/L)
Raw Wastewater (Fresh)	6-15
Raw Wastewater (Septic)	12-25
Primary Effluent	5-20
Activated Sludge Plant Effluent	2-8
Trickling Filter Plant Effluent	3-10
RBC Plant Effluent	3-10
Tertiary Filtration Effluent	2-6
Nitrified Effluent	2-6

In order that effective disinfection can be maintained at all times, without the need to overdose excessively at low flow periods, the chlorine feed equipment should be paced by the effluent flow rate.

7.3.2.1.2 *Standby Equipment and Spare Parts*

Standby equipment of sufficient capacity should be available to replace the largest unit during shutdowns. Spare parts shall be available for all chlorinators to replace parts which are subject to wear and breakage.

7.3.2.1.3 *Water Supply*

An ample supply of water shall be available for operating the chlorinator. Where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power. Protection of a potable water supply shall conform to the requirements of Design Section 2.2.9.

The use of a potable water supply for solution-feed chlorinators is the preferred method. However, in the case of small plants, plant effluent may be used for operating the chlorinator.

7.3.2.2 *Odor Control*

Should odor control be a critical factor, additional capacity of a prechlorination system to the extent of about 80 percent of the raw wastewater chlorine demand shall be required during the warm summer days. It is not desirable to split the functions of the chlorinators, especially for large plants. One group shall be designed for prechlorination and another for disinfection. In the case of large plants, each group shall be interchangeable to facilitate a standby feature.

Prechlorination must be accomplished ahead of the first open structure in the plant and thereby reduce the escape of hydrogen sulphide gas into the atmosphere.

7.3.3 Chlorine Supply

7.3.3.1 Type

Chlorine is available for disinfection in gas, liquid (hypochlorite solution), and pellet (Hypochlorite tables) form. The type of chlorine should be carefully evaluated during the facility planning process. The use of chlorine gas or liquid will be most dependent on the size of the facility and the chlorine does required. Large quantities of chlorine, such as are contained in ton cylinders and tank cars, can present a considerable hazard to plant personnel and to the surrounding area, should such containers develop leaks. Both monetary cost and the potential public exposure to chlorine should be considered when making the final determination.

7.3.3.2 Cylinders

Seventy kilogram cylinders should be used when chlorine demand is less than 44 kilograms per day. Cylinders should be stored in an upright position with adequate support brackets and chains at ⅔ of cylinder height for each cylinder.

7.3.3.3 Tonne Containers

The use of one tonne containers should be considered where the average daily chlorine consumption is over 44 kilograms. A hoist or crane with a capacity of at least two tons shall be provided for the handling of the ton containers.

7.3.3.4 Tank Cars

At large installations (chlorine consumption greater than 900 Kg per day), consideration should be given to the use of tank cars, generally accompanied by liquid chlorine evaporators. Liquid chlorine lines from tank cars to evaporators shall be buried and installed in a conduit and shall not enter below grade spaces. Systems shall be designed for the shortest possible pipe transportation of liquid chlorine.

The tank car being used for the chlorine supply shall be located on a dead end, level track that is a private siding. The tank car shall be protected from accidental bumping by other railway cars by a locked derail device or a closed locked switch or both. The area shall be clearly posted "DANGER-CHLORINE". The tank car shall be secured by adequate fencing with gates provided with locks for personnel and rail access.

The tank car site shall be provided with a suitable operating platform at the unloading point for easy access to the protective housing or the tank car for connection of flexible feedlines and valve operation. Adequate area lighting shall be provided for night time operation and maintenance.

7.3.3.5 Scales

Scales of proper size shall be provided at all plants using chlorine gas. At large plants, scales of the indicating and recording type are recommended. At the least a platform scale shall be provided. Scales shall be of corrosion-resistant material. Scales shall be set on grade, or a ramp shall be built to facilitate the moving of cylinders on and off the scale platform. Scales should be sized so as to accommodate the maximum number of containers required to serve the maximum chlorine feed rate.

7.3.3.6 *Evaporators*

Where manifolding of several cylinders or ton containers will be required to supply sufficient chlorine, consideration should be given to the installation of a chlorine evaporator to produce the quantity of gas required.

7.3.3.7 *Hoists*

Handling of ton containers requires hoisting equipment. It is desirable to use a power-operated hoist and travel particularly when it is necessary to change containers frequently. Hoists should have a minimum capacity of 2 tonnes and be equipped with an approved type of lifting-beam container grab.

7.3.3.8 *Leak Detection and Controls*

A bottle of ammonium hydroxide solution of industrial strength (56%) should be available for detecting chlorine leaks. Where ton containers or tank cars are used, a leak repair kit approved by the Chlorine Institute shall be provided. Consideration should also be given to the provision of caustic soda solution reaction tanks for absorbing the contents of leaking one-ton cylinders where such cylinders are in use. At large installations, consideration should be given to the installation of automatic gas detection and related alarm equipment.

7.3.4 Methods of Dosage Control

7.3.4.1 *Open Loop Flow Proportional Control*

Automatic proportioned-to-flow control consists of varying the rate of chlorine feed in proportion to the sewage flow as determined by a metering device. The dosage rate is manually set, and the control device varies the rate in relation to flow rate. The chlorinator may be either automatic or manual start and stop.

Usually over-chlorination is practised to insure results. Invariably, some chlorine is wasted by such a device.

7.3.4.2 *Closed-Loop Flow Proportional Control (Compound-Loop Arrangement with One Chlorine Analyzer):*

Chlorine residual analyzer provides feedback to the chlorinator. Flow signal and dosage signal each separately control the added chlorine feed with a compound-loop arrangement. If the residual is above the pre-determined level, the chlorine feed rate is reduced, and vice versa. In some designs, chlorine residual is measured at one point in the system and in other designs at 2 or 3 points.

7.3.4.3 *Close-Loop Flow Proportional Control (Compound-Loop Arrangement with Two Chlorine Analyzers*

This ideal system employs quantitative as well and qualitative feed control as in the previous case. However, the qualitative control is accomplished at two points in the flow stream. One sample is automatically collected immediately downstream from the point of chlorination (diffuser) and analyzed by another chlorine analyzer which (i) monitors the combined residual after a given contact time and (ii) adjusts the control point on the analyzer which controls the chlorine metering equipment. When the residual chlorine is more than the desired (pre-set) level, the chlorine feed rate is reduced and vice versa.

7.3.4.4 *Required Chlorine Control Systems*

Plants with proper qualitative and quantitative control systems are known to chlorinate effectively and efficiently. However, the plants without such controls show either inadequate performance (due to under dosage) or waste chlorine unnecessarily (by undue overdose). Higher than needed chlorine residuals may result in ecological damage to the receiving waters.

The following table summarizes chlorine control guidelines:

TABLE 7.1 - CHLORINE CONTROL GUIDELINES

SIZE OF PLANT	TYPE OF RECEIVING WATER	RECOMMENDED CONTROL	METHOD OF CHLORINE RESIDUAL DETERMINATION
LARGE	ALL TYPES	CLOSED-LOOP, FLOW PROPORTIONAL, TWO CHLORINE ANALYZERS	AMPEROMETRIC TITRATOR; CONTINUOUS DETERMINATION AND RECORDING
MEDIUM	ECOLOGICALLY SENSITIVE WATERS WITH FISHING POTENTIAL	SAME AS LARGE PLANTS	SAME AS LARGE PLANTS
	WATERS OF PUBLIC HEALTH IMPORTANCE	CLOSED-LOOP, FLOW PROPORTIONAL, ONE CHLORINE ANALYZER	AMPEROMETRIC TITRATOR; CONTINUOUS DETERMINATION (OPTIONAL RECORDING)
SMALL	ECOLOGICALLY SENSITIVE RECEIVING WATER	CLOSED-LOOP, FLOW PROPORTIONAL, ONE CHLORINE ANALYZER	AMPEROMETRIC TITRATOR; CONTINUOUS DETERMINATION
	RECEIVING WATER OF PUBLIC HEALTH IMPORTANCE	OPEN-LOOP, FLOW PROPORTIONAL	STARCH-IODIDE METHOD ORRTHOTOLIDINE METHOD (INTERMITTENT - MANUAL)

7.3.5 Storage and Handling

7.3.5.1 Building Layout and Material Handling

If gas chlorination equipment and chlorine cylinders are to be in a building used for other purposes, a gas-tight partition shall separate this room from any other portion of the building. Doors to the chlorinator room shall open only to the outside of the building and shall be equipped with panic hardware. Such rooms shall be at ground level and should permit easy access to all equipment.

The storage area should be separated from the feed area. A bilingual "DANGER" sign shall be placed on the door and safety precaution instructions to startup and shutdown shall be placed at a visible location on the wall. Full and empty chlorine cylinders shall be stored separately and shall be chained to the wall in the vertical position. Cylinders should not be stored near flammable materials, heating or ventilation units, elevator shafts and on uneven or subsurface floors.

Chlorine cylinders shall be conveyed by a wheeled cart. Suitable lifting bars or hoist shall be used to unload and place the one-ton containers on their side on level rails.

Storage and handling procedures shall conform to the guidelines of the latest edition of the "Chlorine Manual" prepared by "The Chlorine Institute, Inc."

7.3.5.2 Special Construction Details

A clear glass, gas-tight window shall be installed in an exterior door or interior wall of the chlorinator room to permit the chlorinator to be viewed without entering the room. The building shall be of fireproof material.

The distance from any point in the room and the outside door shall not exceed five meters. The chlorinator shall be placed one meter (3 ft) from the outside wall. Twenty-five mm piping shall be used and pipes and valves shall be color coded.

7.3.5.3 Heat

The chlorinator room shall be provided with a means of heating so that a temperature of at least 15°C can be maintained, but the room should be protected from excess heat. Cylinders shall be kept at essentially room temperature.

7.3.5.4 Ventilation

With chlorination systems, forced, mechanical ventilation shall be installed which will provide one complete air change per minute when the room is occupied. The entrance to the air exhaust duct from the room shall be 300 mm above the floor and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas. The air inlet shall be located near the ceiling on the opposite side of the room so as to provide cross ventilation with air and at such temperatures that will not adversely affect the chlorination equipment. The vent hose from the chlorinator should discharge to an air scrubber before venting above grade to the atmosphere.

7.3.5.5 *Electrical Controls*

The controls for the fans and lights shall be such that they will automatically operate when the door is open. The controls shall also be such that they can be manually operated from the outside without opening the door. All electrical equipment shall be vapor-proof. Fans and lights should be on the same off and on switch whenever possible.

7.3.5.6 *Respiratory Protection*

A self-contained air-supply breathing apparatus in good operating condition shall be available at all installations where chlorine gas is handled. This equipment shall be stored outside of any room where chlorine is used or stored. Instructions for using, testing and replacing parts and air tanks shall be posted. The units shall use compressed air, have at least 30-minute capacity and be compatible with the units used by the fire department responsible for the plant. Other safety equipment required includes a first-aid kit, a fire extinguisher, goggles and gloves, a chlorine container repair kit and a shower.

7.3.6 Piping and Connections

Piping systems should be as simple as possible, specially selected and manufactured to be suitable for chlorine, with a minimum number of joints; piping should be well supported and protected against temperature extremes.

The correct weight or thickness of steel shall be suitable for use with DRY chlorine liquid or gas. Even minute traces of water added to chlorine results in a corrosive attack that can only be resisted by pressure piping utilizing materials such as silver, gold, platinum or Hasteloy "C". Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinylchloride (PVC) or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine.

Due to the corrosiveness of wet chlorine, all lines designed to handle dry chlorine should be protected from the entrance of water or air containing water.

7.3.7 Miscellaneous

7.3.7.1 *Drains*

Floor drainage should be provided near all injector assemblies, all chlorine residual analyzers, all evaporators and certain chlorinators which specifically require floor drains. Floor drains from the chlorine room should not be connected to floor drains from other rooms.

7.3.7.2 *Vents*

All chlorinators shall have a pressure vacuum relief vent system, which should be carried to an air scrubber then to the outside atmosphere, without traps, to a safe area, one vent for each chlorinator. The ends of the vent lines should point down, be covered with a copper wire screen to exclude insects, and should not be more than 7.5 m above the chlorinator. The line should have a slight downward pitch from the high point (directly above the chlorinator) to drain any condensate away from the chlorinator. It is acceptable to run the vent vertically (but no more than 7.5 m) above the chlorinator to the roof, with a 180° return bend at the exit.

Each external chlorine pressure-reducing valve should be checked to see if it is provided with a vent; some are not vented, depending on the chlorine capacity. When supplied, these vents should drain away from the valves. These valves should be located high enough so that the individual drains will have a continuous downgrade to the outside atmosphere.

Evaporators have a steam vapor vent which can be manifolded together and discharged to the atmosphere without traps.

7.3.7.3 *Chlorinator Alarms*

Each chlorinator in large plants shall be equipped with a vacuum switch that should close or open a contact (and start an alarm) when there is an unusually high or low vacuum in the line from the chlorinator to the injector.

Medium size plants are encouraged to include such vacuum switch-alarm systems.

7.3.8 Evaluation of Effectiveness

7.3.8.1 *Sampling*

Facilities shall be included for sampling the disinfected effluent after contact. Either grab or continuous monitoring, as conditions warrant, should be made for effluent chlorine residual of the disinfected effluent.

7.3.8.2 *Testing and Control*

Equipment shall be provided for measuring chlorine residual, employing the standard DPD test. The equipment should enable residual measurement to the nearest 0.1 mg/l in the range below 0.5 mg/l and to an accuracy of approximately 25 percent above 0.5 mg/l. Where the discharge occurs at points requiring rigid bacteriological controls such as on public water supply watersheds, recreational watersheds or shellfish waters or waters tributary thereto, the installation of demonstrated effective facilities for automatic chlorine residual analysis, recording and proportioning systems should be considered. In sensitive areas, dechlorination may be required. Chemicals such as sulphur dioxide, hydrogen peroxide, sodium metabisulfite or granular activated carbon may be used for such purposes.

7.3.9 Hypochlorination

7.3.9.1 *Supply*

Hypochlorite for the purpose of wastewater disinfection is usually in a liquid or solid form. Sodium hypochlorite is available in the liquid form with 12 to 15 percent available chlorine. Calcium hypochlorite is a solid with 70 percent available chlorine and comes in either the 22.5 or 45 kg plastic or plastic-lined containers and in pellet form. The choice of chemical is dependent on quantity used and distance of travel from the supplier.

7.3.9.2 *Storage and Handling*

Special storage facilities are required for handling hypochlorination equipment. Chemicals containing chlorine compound should be stored in a separate room used for that purpose only. No other materials should be stored in the same room. The room should be of fire-resistant construction and at or above grade. As heat and light affect the shelf life of sodium hypochlorite, the storage area should be kept cool and be protected from direct sunlight.

Calcium hypochlorite (HTH) shall be kept dry and covered. The storage area must not be serviced by automatic sprinkler systems. When heated above 170°C, HTH releases oxygen. For this reason, HTH must be kept away from flammable materials. Calcium hypochlorite storage areas should be provided with an exhaust system for the purpose of dust removal.

7.3.9.3 *Metering*

Application of hypochlorite for the purpose of disinfection should be by metering pumps specifically designed for this purpose. The system should be capable of maintaining a chlorine residual of at least 0.5 ppm after a retention time of 20-30 minutes. Calcium hypochlorite should be initially mixed in a make-up tank prior to any chlorination purpose.

7.4 DECHLORINATION

7.4.1 General

Dechlorination of effluent shall be considered when the receiving water is:

a. considered to be highly important for the fishing industry; or

b. ecologically sensitive to chlorine toxicity and susceptible to the adverse effects of chlorine residuals; or

c. of public health importance.

The decisions regarding use of dechlorination shall be made on a case-by-case basis.

Dechlorination is especially recommended for situations where low coliform densities, as well as chlorine residuals, are jointly required. The most common dechlorination chemicals are sulphur compounds, particularly sulphur dioxide gas or aqueous solutions of sulphite or bisulphate. Pellet dechlorination systems are also available for small facilities.. The type of dechlorination system should be carefully selected considering criteria including the following: type of chemical storage required, amount of chemical needed, ease of operation, compatibility with existing equipment, and safety.

7.4.2 Dosage

The dosage of dechlorination chemicals should depend on the residual chlorine in the effluent, the final residual chlorine limit, and the particular form of the dechlorinating chemical used. The most common dechlorinating agent is sulphite. The following forms of the compound are commonly used and yield sulphite (SO_2) when dissolved in water.

Dechlorination Chemical	Theoretical mg/L Required to Neutralize 1 mg/L Cl2
Sulphur dioxide (gas)	0.9
Sodium meta bisulphate (solution)	1.34
Sodium bisulphate (solution)	1.46

Theoretical values may be used for initial approximations, to size feed equipment with the consideration that under good mixing conditions 10% excess dechlorinating chemical is required above theoretical values. Excess sulphur dioxide may consume oxygen at a maximum of 1.0 mg dissolved oxygen for every 4 mg SO_2.

The liquid solutions come in various strengths. The solutions may need to be further diluted to provide the proper dose of sulfite.

7.4.3 Containers

Depending on the chemical selected for dechlorination, the storage containers will vary from gas cylinders, liquid in 190 litre drums or dry compounds. Dilution tanks and mixing tanks will be necessary when using dry compounds and may be necessary when using liquid compounds to deliver the proper dosage. Solution containers should be covered to prevent evaporation and spills.

7.4.4 Feed Equipment, Mixing, and Contact Requirements

7.4.4.1 Equipment

In general, the same type of feeding equipment used for chlorine gas may be used with minor modifications for sulphur dioxide gas. However, the manufacturer should be contacted for specific equipment recommendations. No equipment should be alternately used for the two gases. The common type of dechlorination feed equipment utilizing sulphur compounds include vacuum solution feed of sulphur dioxide gas and a positive displacement pump for aqueous solutions of sulphite or bisulphate.

The selection of the type of feed equipment utilizing sulphur compounds shall include consideration of the operator safety and overall public safety relative to the wastewater treatment plant's proximity to populated areas and the security of gas cylinder storage. The selection and design of sulphur dioxide feeding equipment shall take into account that the gas reliquifies quite easily. Special precautions must be taken when using ton containers to prevent reliquefaction.

Where necessary to meet the operating ranges, multiple units shall be provided for adequate peak capacity and to provide a sufficiently low feed rate on turn down to avoid depletion of the dissolved oxygen concentrations in the receiving waters.

7.4.4.2 *Mixing Requirements*

The dechlorination reaction with free or combined chlorine will generally occur within 15-20 seconds. Mechanical mixers are required unless the mixing facility will provide the required hydraulic turbulence to assure thorough and complete mixing. The high solubility of SO_2 prevents it from escaping during turbulence.

7.4.4.3 *Contact Time*

A minimum of 30 seconds for mixing and contact time shall be provided at the design peak hourly flow or maximum pumping rate. A suitable sampling point shall be provided downstream of the contract zone. Consideration shall be given to a means of reaeration to assure maintenance of an acceptable dissolved oxygen concentration in the stream following sulfonation.

7.4.4.4 *Standby Equipment and Spare Parts*

The same requirements apply as for chlorination systems.

7.4.4.5 *Sulphonator Water Supply*

The same requirements apply as for chlorination systems.

7.4.5 Housing Requirements

7.4.5.1 *Feed and Storage Rooms*

The requirements for housing SO_2 gas equipment should follow the same guidelines as used for chlorine gas.

When using solutions of the dechlorinating compounds, the solutions may be stored in a room that meets the safety and handling requirements set forth in Design Section 3.8. The mixing, storage, and solution delivery areas must be designed to contain or route solution spillage or leakage away from traffic areas to an appropriate containment unit.

7.4.5.2 *Protective and Respiratory Gear*

The respiratory air-pac protection equipment is the same as for chlorine, (See Design Section 3.8). Leak repair kits of the type used for chlorine gas that are equipped with gasket material suitable for service with sulphur dioxide gas may be used. For additional safety considerations, See Design Section 3.8.

7.4.6 Sampling and Control

7.4.6.1 Sampling

Facilities shall be included for sampling the dechlorinated effluent for residual chlorine. Provisions shall be made to monitor for dissolved oxygen concentration after sulphonation when required by the regulatory agency.

7.4.6.2 Testing Control

Provision shall be made for manual or automatic control of sulphonator feed rates based on chlorine residual measurement or flow.

7.4.7 Activated Carbon

Granular activated carbon may also be used to dechlorinate wastewater effluent. The dechlorination reaction is dependent on the chemical state of the free chlorine, chlorine concentration and flow rate, physical characteristics of the carbon, and the wastewater characteristics.

Dechlorination usually is accomplished in fixed downflow beds using gravity or pressure type filters. Regular backwashing is necessary to preserve dechlorination efficiency.

Suggested design criteria for a wastewater dechlorination activated carbon system, based on potable water application, include a wastewater application rate of 2 L/m^2s, an empty bed contact time of 15 to 20 min with an influent free residual of 3 to 4 mg/l, and an effective carbon bed life of at least 3 years.

7.5 ULTRAVIOLET (UV) DISINFECTION

The following sections describe factors that affect the performance of Ultraviolet Disinfection Systems. Systems should be designed to account for these effects.

7.5.1 UV Transmission

UV light's ability to penetrate wastewater is measured with a spectrophotometer using the same wavelength (254 nm) that is produced by germicidal lamps. This measurement is called the percent Transmission or Absorbance and it is a function of all the factors which absorb or reflect UV light. As the percent transmission gets lower (higher absorbance) the ability of the UV light to penetrate the wastewater and reach target organisms decreases. The system designer must obtain samples of the wastewater during the worst conditions or carefully attempt to calculate the minimum expected UV transmission by testing wastewater from plants which have a similar influent and treatment process. The designer must also strictly define the disinfection limits since they determine the magnitude of the UV dose required.

7.5.2 **Wastewater Suspended Solids**

Some of the suspended solids in wastewater will absorb or reflect the UV light before it can penetrate the solids to kill any occluded organisms. UV light can penetrate into suspended solids with longer contact times and higher intensities, but there is still a limit to the ability to kill the microorganisms. UV systems must be designed based on maximum effluent SS levels.

7.5.3 **Design Flow Rate and Hydraulics**

The number of microorganisms that are inactivated within a UV reactor is a function of the multiplication of the average intensity and residence time. That is, the UV Dose (D) is equal to the intensity (I) times the Retention Time (t).

$$D = It$$

As the flow rate increases the number or size of the UV lamps must be proportionately increased to maintain the same disinfection requirements. An Ultraviolet Disinfection system must be designed for worst case conditions. The minimum dosage occurs at the maximum flow rate and end of lamp life.

7.5.4 **Level Control**

The height of the wastewater above the top row of UV lamps must be rigidly controlled by a flap gate or weir for all flow rates. The UV system must be designed for the maximum flow rate. This is especially important if the wastewater treatment plant receives storm water runoff. The UV system must also be designed to operate at the maximum flow rate. During low flow periods, the wastewater has a greater chance to warm up around the quartz sleeves and produce deposits on the sleeves. There is also the possibility of exposing the quartz sleeves to the air. Because the lamps are warm, any compounds left on the sleeves will bake onto them. Water splashing onto these exposed sleeves will also result in UV absorbing deposits. When the flow returns to normal, some of the water passing through the UV unit may not be properly disinfected. The designer must be very careful with the selection of the flow control device for the above situation. Both flow gates and weirs may be used for level control.

7.5.5 **Wastewater Iron Content**

Iron can affect the UV disinfection by absorbing UV light. Dissolved iron, iron precipitate on quartz sleeves, and adsorption of iron by suspended solids, bacterial floc and other organic compounds, all decrease UV transmittance. Wastewater with iron levels greater than 0.3 mg/L may require pretreatment to attain the desired disinfection level.

7.5.6 **Wastewater Hardness**

Calcium and magnesium salts, which are generally present in water as bicarbonates or sulfates, cause water hardness. Hard water will precipitate on any warm or hot surface. Since the optimum operating temperature of the low pressure mercury lamp is 40°C, the surface of the protective quartz sleeve will be warm. It will create a molecular layer of warm water where calcium and magnesium salts can be precipitated. These precipitates will prevent some of the UV light from entering the wastewater.

Waters which approach or are above 300 mg/L of hardness may require pilot testing of a UV system. This is especially important if very low flows or no flow situations are expected, because they allow the water to warm up around the quartz sleeves and produce excessive coating.

7.5.7 Wastewater Sources

Periodic influxes of industrial wastewater may contain UV absorbing organic compounds, iron or hardness, any of which may affect UV performance. Industries discharging wastes that contain such materials may be required to pre-treat their wastewater.

Low concentrations of dye may be too diluted to be detected without using a spectrophotometer. Dye can readily absorb ultraviolet light thereby preventing UV disinfection.

7.5.8 UV Lamp Life

Low pressure mercury lamps are rated for 9,000 hours of continuous use. Rated average useful life is defined by the UV disinfection industry as the elapsed operating time under essentially continuous operation for the output to decline to 60 percent of the output the lamp had at 100 hours. The UV system must be designed so that the minimum required dose or intensity is available at the end of lamp life.

Power costs and lamp replacement costs are the two main factors affecting UV maintenance expenditures. Therefore, UV lamps should only be replaced if no other cause for not meeting the disinfection requirements can be found. Examples of other causes are quartz sleeve fouling, decreased levels of UV transmission, or increased levels of suspended solids in the wastewater.

7.5.9 UV System Configuration and Redundancy

Once the number of lamps required to meet the required disinfection permit levels has been determined, a system configuration must be developed. This configuration must meet operational requirements such as plant flow variations and redundancy requirements. Redundancy helps insure that the UV system can continue to operate and meet disinfection permits in spite of a subsystem or component failure. It allows regularly scheduled maintenance such as quartz cleaning to be performed at any time.

7.5.10 Detailed Design Manuals

The following sources contain detailed design information for UV Disinfection:

Water Pollution Control Federation: *Wastewater Disinfection*, Manual of Practice FD-10, Alexandria, VA, 1986.

U.S. Environmental Protection Agency: *Design Manual for Municipal Wastewater Disinfection*, EPA 625/ 1-86-021, Cincinnati, OH, 1987.

7.6 OZONATION

7.6.1 Ozone Generation

Ozone may be produced from either an air or an oxygen gas source. Generation units shall be automatically controlled to adjust ozone production to meet disinfection requirements.

7.6.2 Dosage

The ozone demand in the wastewater must be satisfied, as evidenced by the presence of an ozone residual, before significant disinfection takes place. Below this dosage there is reduction of oxygen-consuming material.

Because of the form of ozone and its short life, it is necessary that it be step-fed into the wastewater to provide the contact period needed to accomplish disinfection.

Effectiveness of ozone as a disinfectant is relatively independent of pH and temperature values, although a pH of 6.0 to 7.0 appears to be the most favourable range. A dosage of 5 to 8 mg/l is needed to accomplish disinfection of secondary effluent. The amount and characteristics of suspended solids present in the secondary effluent can be used to determine ozone dosage empirically:

$$\text{Ozone Dosage} = 1.5 + 0.38\ \text{TSS}$$

7.6.3 Design Considerations

7.6.3.1 Feed Equipment

Ozone dissolution is accomplished through the use of conventional gas diffusion equipment, with appropriate consideration of materials. If ozone is being produced from air, gas preparation equipment (driers, filters, compressors) is required. If ozone is being produced from oxygen, this equipment may not be needed as a clean dry pressurized gas supply will be available.

Where ozone capacities of 500 kg/d or less are required, air feed is preferred. Modification of the single-pass air feed system should be considered in determining the most economic system for application in wastewater treatment.

7.6.3.2 Air Cleaning

Removal of foreign matter such as dirt and dust is essential for optimum performance and life of an ozone device. For small units, cartridge-type impingement filters may be economical. For larger operations, electrical precipitator or combination filters are preferred.

7.6.3.3 *Compression*

Positive displacement rotary-type compressors are preferred for large installations. Internally lubricated units should not be used since oil vapor will permanently impair the water-adsorptive capacity of the driers. Need for standby capacity and flexibility of operation requires the installation of several blower units.

The required compressor rating will depend on the pressure drop through the entire system. Generally, a 70 kN/m^2 pressure is necessary to force the air through the coolers, driers, ozonation devices, and the 4.5 to 6 m head of water in the mixing and contact system.

7.6.3.4 *Cooling and Drying*

Pre-treatment for reducing moisture in the feed gas stream shall be required.

7.6.3.5 *Injection, Mixing and Contact*

Intimate mixing of an ozone-enriched air stream with the wastewater as well as maintaining contact for an adequate period of time are essential. The major problems to be considered are satisfying the ozone demand, the rapid rise of the gas to the liquid surface of the contact chamber and escape of ozonated air bubbles, and the relatively short half-life of ozone. Consequently, where ozone contact beyond a few minutes is needed, the ozonated feed stream is staged with the amount of ozone for each stage set at a level that can be consumed usefully.

7.6.3.6 *Controls*

The design engineer should be cognizant of the fact that ozone is a toxic gas, and that if compressed oxygen is used as the feed gas, special provisions must be met in its handling and storage. The ozonation process involves a series of mechanical and electrical units that require appropriate maintenance and repair and are susceptible to the same malfunctions as are all such pieces of equipment. Standby capacity normally is provided in all essential components. Information can be obtained from the equipment manufacturer on the metering and alarm systems needed for continuous process monitoring and warning of failure in any element of the process.

7.6.3.7 *Piping and Connections*

For ozonation systems, the selection of material should be made with due consideration for ozone's corrosive nature. Copper or aluminum alloys should be avoided. Only material at least as corrosion-resistant to ozone as Grade 304L stainless steel should be specified for piping containing ozone in non-submerged applications. Unplasticized PVC, Type I, may be used in submerged piping, provided the gas temperature is below 60°C and the gas pressure is low.

8.1 PHOSPHORUS REMOVAL

8.1.1 General

8.1.1.1 *Applicability*

The following factors should be considered when determining the need for phosphorus control at municipal wastewater treatment facilities:

a. the present and future phosphorus loadings from the existing municipal wastewater treatment facility to the receiving water;

b. the existing phosphorus levels in the receiving water and the effects of these levels on the rate of eutrophication along the entire length of receiving waters;

c. the predicted response of the receiving water to increased phosphorus loadings;

d. the existing and desired water quality of the receiving water along its entire length;

e. the existing and projected uses of the receiving water; and

f. consideration of the best practicable technology available to control phosphorus discharges.

8.1.1.2 *Phosphorus Removal Criteria*

A municipal wastewater treatment facility shall be required to control the discharge of phosphorus if the following conditions exist:

a. Eutrophication of the receiving water environment is either occurring or may occur at a rate which may affect the existing and potential uses of the water environment; or

b. The municipal wastewater effluent discharge is contributing or may contribute significantly to the rate of receiving water eutrophication.

8.1.1.3 *Method of Removal*

Acceptable methods for phosphorus removal shall include chemical precipitation, high rate filtration or biological processes.

8.1.1.4 *Design Basis*

8.1.1.4.1 *Preliminary Testing*

Laboratory, pilot or full scale studies of various chemical feed systems and treatment processes are recommended for existing plant facilities to determine the achievable performance level, cost-effective design criteria, and ranges of required chemical dosages.

The selection of a treatment process and chemical dosage for a new facility should be based on such factors as influent wastewater characteristics, effluent requirements, and anticipated treatment efficiency.

8.1.1.4.2 *System Flexibility*

Systems shall be designed with sufficient flexibility to allow for several operational adjustments in chemical feed location, chemical feed rates, and for feeding alternate chemical compounds.

8.1.2 **Effluent Requirements**

If phosphorus control is required, the maximum acceptable concentration of final effluent phosphorus and/or the maximum acceptable mass loading to the receiving stream shall be established on a site specific basis.

8.1.3 **Process Requirements**

8.1.3.1 *Dosage*

Typical chemical dosage requirements of various chemicals required for phosphorus removal are outlined in Table 8.1.

TABLE 8.1 - TYPICAL CHEMICAL DOSAGE REQUIREMENTS FOR PHOSPHORUS REMOVAL

TYPE OF TREATMENT PLANT	ADDITION POINT	DOSAGE RATE (mg/L)		
		CHEMICAL	RANGE	AVERAGE
PRIMARY	RAW SEWAGE	ALUM FERRIC CHLORIDE LIME	100 6-30 167-200	100 16 185
SECONDARY	RAW SEWAGE	LIME ALUM FERRIC CHLORIDE	40-100	70
	SECONDARY SECTION	LIME ALUM FERRIC CHLORIDE	 30-150 2-30	 65 11
WASTE STABILIZATION PONDS				
SEASONAL RETENTION LAGOONS	BATCH DOSAGE TO CELLS	ALUM FERRIC CHLORIDE LIME	100-210 17-22 250-350	163 20 300
CONTINUOUS DISCHARGE LAGOON	RAW SEWAGE	ALUM FERRIC CHLORIDE LIME	225 20 400	225 20 400

Dosages will vary with the phosphorus concentration in the effluent. The required chemical dosage shall include the amount needed to react with the phosphorus in the wastewater, the amount required to drive the chemical reaction to the desired state of completion, and the amount required due to inefficiencies in mixing or dispersion. Excessive chemical dosage should be avoided.

8.1.3.2 *Chemical Selection*

The choice of lime or the salts of aluminum or iron should be based on the wastewater characteristics and the economics of the total system.

When lime is used it may be necessary to neutralize the high pH prior to subsequent treatment in secondary biological systems or prior to discharge in those flow schemes where lime treatment is the final step in the treatment process.

8.1.3.3 *Chemical Feed System*

In designing the chemical feed system for phosphorus removal, the following points should be considered:

a. the need to select chemical feed pumps, storage tanks and piping suitable for use with the chosen chemicals(s);

b. selection of chemical feed equipment with the required range in capacity;

c. the need for a standby chemical feed pump;

d. provision of flow pacing for chemical pumps proportional to sewage flow rates;

e. flexibility by providing a number of chemical application points;

f. the need for protection of storage and piping from the effect of low temperatures;

g. selection of the proper chemical storage volume;

h. the need for ventilation in chemical handling rooms; and

i. provision for containment of any chemical spills.

8.1.3.4 *Chemical Feed Points*

Selection of chemical feed points shall include consideration of the chemicals used in the process, necessary reaction times between chemical and polyelectrolyte additions, and the wastewater treatment processes and components utilized. Considerable flexibility in feed location should be provided, and multiple feed points are recommended.

8.1.3.5 *Flash Mixing*

Each chemical must be mixed rapidly and uniformly with the flow stream. Where separate mixing basins are provided, they should be equipped with mechanical mixing devices. The detention period should be at least 30 seconds.

8.1.3.6 *Flocculation*

The particle size of the precipitate formed by chemical treatment may be very small. Consideration should be given in the process design to the addition of synthetic polyelectrolytes to aid settling. The flocculation equipment should be adjustable in order to obtain optimum floc growth, control deposition of solids, and prevent floc destruction.

8.1.3.7 *Liquid - Solids Separation*

The velocity through pipes or conduits from flocculation basins to settling basins should not exceed 0.5 m/s in order to minimize floc destruction. Entrance works to settling basins should also be designed to minimize floc shear.

Settling basin design shall be in accordance with criteria outlined in Design Section 5. For design of the sludge handling system, special consideration should be given to the type and volume of sludge generated in the phosphorus removal process.

8.1.3.8 *Filtration*

Effluent filtration shall be considered where effluent phosphorus concentrations of less than 1 mg/l must be achieved.

8.1.4 Feed Systems

8.1.4.1 *Location*

All liquid chemical mixing and feed installations should be installed on corrosion resistant pedestals and elevated above the highest liquid level anticipated during emergency conditions.

Lime feed equipment should be located so as to minimize the length of slurry conduits. All slurry conduits shall be accessible for cleaning.

8.1.4.2 *Liquid Chemical Feed System*

Liquid chemical feed pumps should be of the positive displacement type with variable feed rate. Pumps shall be selected to feed the full range of chemical quantities required for the phosphorus mass loading conditions anticipated with the largest unit out of service.

Screens and valves shall be provided on the chemical feed pump suction lines.

An air break or anti-siphon device shall be provided where the chemical solution stream discharges to the transport water stream to prevent an induction effect resulting in overfeed.

Consideration shall be given to providing pacing equipment to optimize chemical feed rates.

8.1.4.3 *Dry Chemical Feed System*

Each dry chemical feeder shall be equipped with a dissolver which is capable of providing a minimum 5-minute retention at the maximum feed rate.

Polyelectrolyte feed installations should be equipped with two solution vessels and transfer piping for solution make-up and daily operation.

Make-up tanks shall be provided with an educator funnel or other appropriate arrangement for wetting the polymer during the preparation of the stock feed solution. Adequate mixing should be provided by a large-diameter low-speed mixer.

8.1.5 Storage Facilities

8.1.5.1 *Size*

Storage facilities shall be sufficient to insure that an adequate supply of the chemical is available at all times. The exact size required will depend on the size of the shipment, length of delivery time, and process requirements. Storage for a minimum of 10-days supply should be provided.

8.1.5.2 *Location*

The liquid chemical storage tanks and tank fill connections shall be located within a containment structure having a capacity exceeding the total volume of all storage vessels. Valves on discharge lines shall be located adjacent to the storage tank and within the containment structure.

Auxiliary facilities, including pumps and controls, within the containment area shall be located above the highest anticipated liquid level. Containment areas shall be sloped to a sump area and shall not contain floor drains.

Bag storage should be located near the solution make-up point to avoid unnecessary transportation and housekeeping problems.

8.1.5.3 *Accessories*

Platforms, ladders, and railings should be provided as necessary to afford convenient and safe access to all filling connections, storage tank entries, and measuring devices.

Storage tanks shall have reasonable access provided to facilitate cleaning.

8.1.6 Other Requirements

8.1.6.1 Materials

All chemical feed equipment and storage facilities shall be constructed of materials resistant to chemical attack by all chemicals normally used for phosphorus treatment.

8.1.6.2 Temperature, Humidity and Dust Control

Precautions shall be taken to prevent chemical storage tanks and feed lines from reaching temperatures likely to result in freezing or chemical crystallization at the concentrations employed. A heated enclosure or insulation may be required. Consideration should be given to temperature, humidity and dust control in all chemical feed room areas.

8.1.6.3 Cleaning

Consideration shall be given to the accessibility of piping. Piping should be installed with plugged wyes, tees or crosses at changes in direction to facilitate cleaning.

8.1.6.4 Drains and Drawoff

Above-bottom drawoff from chemical storage or feed tanks shall be provided to avoid withdrawal of settled solids into the feed system. A bottom drain shall also be installed for periodic removal of accumulated settled solids. Provisions shall be made in the fill lines to prevent back siphonage of chemical tank contents.

8.1.7 Hazardous Chemical Handling

The requirements of Design Section 3.8.2 Hazardous Chemical Handling shall be met.

8.1.8 Sludge Handling

8.1.8.1 General

Consideration shall be given to the type and additional capacity of the sludge handling facilities needed when chemicals are added.

8.1.8.2 Dewatering

Design of dewatering systems should be based, where possible, on an analysis of the characteristics of the sludge to be handled. Consideration should be given to the ease of operation, effect of recycle streams generated, production rate, moisture content, dewaterability, final disposal, and operating cost.

8.2 AMMONIA REMOVAL

8.2.1 Breakpoint Chlorination

8.2.1.1 *Applicability*

The breakpoint chlorination process is best suited for removing relatively small quantities of ammonia, less than 5 mg/l NH_3-N, and in situations whose low residuals of ammonia or total nitrogen are required.

8.2.1.2 *Design Considerations*

8.2.1.2.1 *Mixing*

The reaction between ammonia and chlorine occurs instantaneously, and no special design features are necessary except to provide for complete uniform mixing of the chlorine with the wastewater. Good mixing can best be accomplished with in-line mixers or backmixed reactors. A minimum contact time of 10 min is recommended.

8.2.1.2.2 *Dosage*

The sizing of the chlorine producing and/or feed device is dependent on the influent ammonia concentration to be treated as well as the degree of pretreatment the wastewater has received. As the level of wastewater pretreatment increases, the required amount of chlorine decreases and approaches the theoretical amount required to oxidize ammonia to nitrogen (7.6 mg/l Cl_2:1 mg/l NH-N). Table 8.2 shows the quantities of chlorine required, based on operating experience as well as recommended design capabilities. These ratios are applied to the maximum anticipated influent ammonia concentration.

TABLE 8.2 - QUANTITIES OF CHLORINE REQUIRED FOR THREE WASTEWATER SOURCES

WASTEWATER SOURCE	CHLORINE: NH_3 - N RATIO TO REACH BREAKPOINT	
	EXPERIENCE	RECOMMENDED DESIGN CAPABILITY
RAW	10:1	13:1
SECONDARY EFFLUENT	9:1	12:1
LIME SETTLED AND FILTERED SECONDARY EFFLUENT	8:1	10:1

8.2.1.2.3 *Monitoring*

If insufficient chlorine is available to reach the breakpoint, no nitrogen will be formed and the chloramines formed ultimately will revert back to ammonia. Provisions should be made to continuously monitor the waste, following chlorine addition, for free chlorine residual and to pace the chlorine feed device to maintain a set-point free chlorine residual.

8.2.1.2.4 *Standby Equipment*

The chemical feed assembly used for ammonia removal by breakpoint chlorination is considered in the preliminary design of the complete chlorination system, including those requirements for prechlorination, intermediate, and post-chlorination applications. Depending on the use of continuous chlorination at points within the system, some consideration is given to the use of standby chlorination equipment for the ammonia removal system. Reliability needs and maximum dosage requirements for the various application points shall also be examined when sizing the equipment.

8.2.1.2.5 *pH Adjustment*

Except for wastewaters having a high alkalinity or treatment systems employing lime coagulation prior to chlorination, provisions shall be made to feed an alkaline chemical to keep the pH of the wastewater in the proper range. A method for measuring and pacing the alkaline chemical feed pump to keep the pH in the desired range also should be provided.

8.2.2 Air Stripping

8.2.2.1 *Applicability*

The ammonia air stripping process is most economical if it is preceded by lime coagulation and settling. The ammonia stripping process can be used in a treatment system employing biological treatment or in a physical-chemical process. In most instances, more than 90 percent of the nitrogen in raw domestic wastewater is in the form of ammonia, and the ammonia stripping process can be readily applied to most physical-chemical treatment systems. However, when the ammonia stripping process is to be preceded by a biological process, care must be exercised to insure that nitrification does not occur in the secondary treatment process.

There is one serious limitation of the ammonia stripping process that should be recognized; namely, it is impossible to operate a stripping tower at air temperatures less than 0°C because of freezing within the tower. For treatment plants in cold weather locations, high pH stripping ponds may provide a simple solution to the problem of nitrogen removal.

8.2.2.2 *Design Considerations*

8.2.2.2.1 *Tower Packing*

Packings used in ammonia stripping towers may include 10 by 40 mm wood slats, plastic pipe, and a polypropylene grid. No specific packing spacing has been established. Generally, the individual splash should be spaced 40 to 100 mm horizontally and 50 to 100 mm vertically. A tighter spacing is used to achieve higher levels of ammonia removal and a more opening spacing is used where lower levels of ammonia removal are acceptable. Because of the large volume of air required, towers should be designed for a total air headloss of less than 50 to 75 mm of water. Packing depths of 6 to 7.5 m should be used to minimize power costs.

8.2.2.2.2 *Hydraulic Loadings*

Allowable hydraulic loading is dependent on the type and spacing of the individual splash bars. Although hydraulic loading rates used in ammonia stripping towers should range from 0.7 to 2.0 L/m^2s removal efficiency is significantly decreased at loadings in excess of 1.3 L/m^2s. The hydraulic loading rate should be such that a water droplet is formed at each individual splash bar as the liquid passes through the tower.

8.2.2.2.3 *Air Requirements*

Air requirements vary from 2200 to 3800 L/s for each L/s being treated in the tower. The 6 to 7.5 m of tower packing will normally produce a pressure drop of 15 to 40 mm of water.

8.2.2.2.4 *Temperature*

Air and liquid temperatures have a significant effect on the design of an ammonia stripping tower. Minimum operating air temperature and associated air density should be considered when sizing the fans to meet the desired air supply. Liquid temperature also affects the level of ammonia removal.

8.2.2.2.5 *General Construction Features*

The stripping tower may be either of the countercurrent (air inlet at base) or cross flow (air inlet along entire depth of fill) type. Generally, provisions should be made to have the capability to recycle tower effluent to increase the removal of ammonia nitrogen during cooler temperatures.

Provisions shall be made in the design of the tower structure and fill so that the tower packing is readily accessible or removable for removing possible deposits of calcium carbonate.

8.2.2.2.6 *Process Control*

During periods of tower operation when temperature, air and wastewater flow rates, and scale formation are under control, the major process requirement necessary to insure satisfactory ammonia removal is to control the influent pH. pH control should be practiced in the upstream lime-coagulation-settling process. This basin should be monitored closely to prevent excessive carryover of lime solids into the ammonia stripping process. Normal lime-addition required to raise the pH to 11.5 is 300 to 400 mg/l (as CaO).

8.3 EFFLUENT FILTRATION

8.3.1 General

8.3.1.1 Applicability

Effluent filtration is generally necessary when effluent quality better than 15 mg/L BOD_5, 15 mg/L suspended solids and 1.0 mg/L phosphorus is required.

Where effluent suspended solids requirements are less than 10 mg/l, where secondary effluent quality can be expected to fluctuate significantly, or where filters follow a treatment process where significant amounts of algae will be present, a pre-treatment process such as chemical coagulation and sedimentation or other acceptable process should precede the filter units.

8.3.1.2 Design Considerations

Factors to consider when choosing between the different filtration systems which are available, include the following:

a. the installed capital and expected operating and maintenance costs;

b. the energy requirements of the systems (head requirements);

c. the media types and sizes and expected solids capacities and treatment efficiencies of the system; and

d. the backwashing systems, including type, backwash rate, backwash volume, effect on sewage works, etc.

Care should be given in the selection of pumping equipment ahead of filter units to minimize shearing of floc particles. Consideration should be given in the plant design to providing flow-equalization facilities to moderate filter influent quality and quantity.

8.3.2 Location of Filter System

Effluent filtration should precede the chlorine contact chamber to minimize chlorine usage, to allow more effective disinfection and to minimize the production of chloro-organic compounds.

To allow excessive biological growths and grease accumulations to be periodically removed from the filter media, a chlorine application point should be provided upstream of the filtration system (chlorine would only be dosed as necessary at this location).

8.3.3 Number of Units

Total filter area shall be provided in 2 or more units, and the filtration rate shall be calculated on the total available filter area with one unit out of service.

8.3.4 Filter Types

Filters may be of the gravity type or pressure type. Pressure filters shall be provided with ready and convenient access to the media for treatment or cleaning. Where greases or similar solids which result in filter plugging are expected, filters should be of the gravity type.

8.3.5 Filtration Rates

8.3.5.1 Hydraulic Loading Rate

Filtration rates at peak hourly sewage flow rates, including backwash flows, should not exceed 2.1 L/m^2s for shallow bed single media systems (if raw sewage flow equalization is provided, lower peak filtration rates should be used in order to avoid under-sizing of the filter).

Filtration rates at peak hourly sewage flow rates, including backwash flows, should not exceed 3.3 L/m^2s for deep bed filters (if raw sewage flow equalization is provided, lower peak filtration rates should be used in order to avoid undersizing of the filter). The manufacturer's recommended maximum filtration rate should, however, not be exceeded.

8.3.5.2 Organic Loading Rate

Peak solids loading rate should not exceed 50 mg/m^2s for shallow bed filters and 80 mg/m^2s for deep bed filters (if raw sewage flow equalization is provided, lower peak solids loading rates should be used in order to avoid undersizing of the filter).

8.3.6 Backwash

8.3.6.1 Backwash Rate

The backwash rate shall be adequate to fluidize and expand each media layer a minimum of 20 percent based on the media selected. The backwash system shall be capable of providing a variable backwash rate having a maximum of at least 14 L/m^2s and a minimum backwash period of 10 minutes.

8.3.6.2 Backwash

Pumps for backwashing filter units shall be sized and interconnected to provide the required rate to any filter with the largest pump out of service. Filtered water should be used as the source of backwash water. Waste filter backwash shall be adequately treated.

Air scour or mechanical agitation systems to improve backwash effectiveness are recommended.

If instantaneous backwash rates represent more than 15 percent of the average daily design flow rate of the plant, a backwash holding tank should be provided to equalize the flow of backwash water to the plant.

8.3.7 Filter Media

8.3.7.1 Selection

Selection of proper media size will depend on the filtration rate selected, the type of treatment provided prior to filtration, filter configuration, and effluent quality objectives. In dual or multi-media filters, media size selection must consider compatibility among media.

8.3.7.2 Media Specifications

The following table provides minimum media depths and the normally acceptable range of media sizes. The designer has the responsibility for selection of media to meet specific conditions and treatment requirements relative to the project under consideration.

TABLE 8.3 MEDIA DEPTHS AND SIZES

(Minimum Depth)
(Effective Size)

	Single Media	Multi-Media (2)	Multi-Media (3)
Anthracite	-	50 cm (20 in.) 1.0 - 2.0 mm	50 cm (20 in.) 1.0 - 2.0 mm
Sand	120 cm (48 in.) 1.0 - 4.0 mm	30 cm (12 in.) 0.5 - 1.0 mm	25 cm (10 in.) 0.6 - 0.8 mm
Garnet or Similar Material	-	-	5 cm (2 in.) 0.3 - 0.6 mm

Uniformity Coefficient shall be 1.7 or less

8.3.8 Filter Appurtenances

The filters shall be equipped with washwater troughs, surface wash or air scouring equipment, means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, positive means of shutting off flow to a filter being backwashed, and filter influent and effluent sampling points. If automatic controls are provided, there shall be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system shall be designed for uniform distribution of backwash water (and air, if provided) without danger of clogging from solids in the backwash water. Provision shall be made to allow periodic chlorination of the filter influent or backwash water to control slime growths. If air is to be used for filter backwash, separate backwash blowers shall be provided.

8.3.9 Reliability

Each filter unit shall be designed and installed so that there is ready and convenient access to all components and the media surface for inspection and maintenance without taking other units out of service. The need for housing of filter units shall depend on expected extreme climatic conditions at the treatment plant site. As a minimum, all controls shall be enclosed. The structure housing filter controls and equipment shall be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

8.3.10 Backwash Surge Control

The rate of return of waste filter backwash water to treatment units should be controlled such that the rate does not exceed 15 percent of the design average daily flow rate to the treatment units. The hydraulic and organic load from waste backwash water shall be considered in the overall design of the treatment plant. Surge tanks shall have a minimum capacity of two backwash volumes, although additional capacity should be considered to allow for operational flexibility. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out of service.

8.3.11 Backwash Water Storage

Total backwash water storage capacity provided in an effluent clearwell or other unit shall equal or exceed the volume required for two complete backwash cycles.

8.3.12 Proprietary Equipment

Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which supports the capability of the equipment to meet effluent requirements under design conditions shall be provided. Such equipment will be reviewed on a case-by case basis at the discretion of the regulatory agencies.

8.4 MICROSCREENING

8.4.1 General

8.4.1.1 Applicability

Microscreening units may be used following a biological treatment process for the removal of residual suspended solids. Selection of this unit process should consider final effluent requirements, the preceding biological treatment process, and anticipated consistency of the biological process to provide a high quality effluent.

8.4.1.2 Design Considerations

Pilot plant testing on existing secondary effluent is encouraged. Where pilot studies so indicate, where microscreens follow trickling filters or lagoons, or where effluent suspended solids requirements are less than 10 mg/l, a pre-treatment process such as chemical coagulation and sedimentation shall be provided. Care should be taken in the selection of pumping equipment ahead of microscreens to minimize shearing of floc particles. The process design shall include flow equalization facilities to moderate microscreen influent quality and quantity.

8.4.2 Screen Material

The microfabric shall be a material demonstrated to be durable through long-term performance data. The aperture size must be selected considering required removal efficiencies, normally ranging from 20 to 35 microns. The use of pilot plant testing for aperture size selection is recommended.

8.4.3 Screening Rate

The screening rate shall be selected to be compatible with available pilot plant test results and selected screen aperture size, but shall not exceed 3.4 $L/m^2 s$ of effective screen area based on the maximum hydraulic flow rate applied to the units. The effective screen area shall be considered as the submerged screen surface area less the area of screen blocked by structural supports and fasteners. The screening rate shall be that applied to the units with one unit out of service.

8.4.4 Backwash

All waste backwash water generated by the microscreening operation shall be recycled for treatment. The backwash volume and pressure shall be adequate to assure maintenance of fabric cleanliness and flow capacity. Equipment for backwash of at least 1.65 L/m/s of screen length and 4.22 kgf/cm^2, respectively, shall be provided. Backwash water shall be supplied continuously by multiple pumps, including one standby, and should be obtained from microscreened effluent. The rate of return of waste backwash water to treatment units shall be controlled such that the rate does not exceed 15 percent of the design average daily flow rate to the treatment plant. The hydraulic and organic load from waste backwash water shall be considered in the overall design of the treatment plant. Where waste backwash is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out of service. Provisions should be made for measuring backwash flow.

8.4.5 Appurtenances

Each microscreen unit shall be provided with automatic drum speed controls with provisions for manual override, a bypass weir with an alarm for use when the screen becomes blinded to prevent excessive head development, and means for dewatering the unit for inspection and maintenance. Bypassed flows must be segregated from water used for backwashing. Equipment for control of biological slime growths shall be provided. The use of chlorine should be restricted to those installations where the screen material is not subject to damage by the chlorine.

8.4.6 Reliability

A minimum of two microscreen units shall be provided, each unit being capable of independent operation. A supply of critical spare parts shall be provided and maintained. All units and controls shall be enclosed in a heated and ventilated structure with adequate working space to provide for ease of maintenance.

8.5 ACTIVATED CARBON ADSORPTION

8.5.1 Applicability

In tertiary treatment, the role of activated carbon is to remove the relatively small quantities of refractory organics, as well as inorganic compounds such as nitrogen, sulfides, and heavy metals, remaining in an otherwise well-treated wastewater.

Activated carbon may also be used to remove soluble organics following chemical-physical treatment.

8.5.2 Design Considerations

The usefulness and efficiency of carbon adsorption for municipal wastewater treatment depends on the quality and quantity of the delivered wastewater. To be fully effective, the carbon unit should receive an effluent of uniform quality, without surges in the flow. Other wastewater qualities of concern include suspended solids, oxygen demand, other organics such as methylene blue active substance (MBAS) or phenol, and dissolved oxygen. Environmental parameters of importance include pH and temperature. Consideration also should be given to the type of activated carbon available. Activated carbons produced from different base materials and by different activation processes will have varying adsorptive capacities. Some factors influencing adsorption at the carbon/liquid interface are:

a. attraction of carbon for solute;
b. attraction of carbon for solvent;
c. solubilizing power of solvent or solute;
d. association;
e. ionization;
f. effect of solvent on orientation at interface;
g. competition for interface in presence of multiple solutes;
h. coadsorption;
i. molecular size of molecules in the system;
j. pore size distribution in carbon;
k. surface area of carbon; and
l. concentration of constituents.

There are several different activated carbon contactor systems that can be selected. The carbon columns can be either of the pressure or gravity type.

8.5.3 Unit Sizing

8.5.3.1 Contact Time

The contact time shall be calculated on the basis of the volume of the column occupied by the activated carbon. Generally, carbon contact times of 15 to 35 min are used depending on the application, the wastewater characteristics, and the desired effluent quality. For tertiary treatment applications, carbon contact times of 15 to 20 min should be used where the desired effluent quality is a COD of 10 to 20 mg/l, and 30 to 35 min when the desired effluent COD is 5 to 15 mg/l. For chemical-physical treatment plants, carbon contact times of 20 to 35 min should be used, with a contact time of 30 min being typical.

8.5.3.2 *Hydraulic Loading Rate*

Hydraulic loading rates of 2.5 to 7.0 $L/m^2.s$ of cross section of the bed shall be used for upflow carbon columns. For downflow carbon columns, hydraulic loading rates of 2.0 to 3.3 L/m^2s are used. Actual operating pressure seldom rises above 7 kN/m^2 for each 0.3 m of bed depth.

8.5.3.3 *Depth of Bed*

The depth of bed will vary considerably, depending primarily on carbon contact time, and may be from 3 to 12 m. A minimum carbon depth of 3 m is recommended. Typical total carbon depths range from 4.5 to 6 m. Freeboard has to be added to the carbon depth to allow an expansion of 10 to 50 percent for the carbon bed during backwash or for expanded bed operation. Carbon particle size and water temperature will determine the required quantity of backwash water to attain the desired level of bed expansion.

8.5.3.4 *Number of Units*

A minimum of two parallel carbon contactor units are recommended for any size plant. A sufficient number of contactors should be provided to insure an adequate carbon contact time to maintain effluent quality while one column is off line during removal of spent carbon for regeneration or for maintenance.

8.5.4 Backwashing

The rate and frequency of backwash is dependent on hydraulic loading, the nature and concentration of suspended solids in the wastewater, the carbon particle size, and the method of contacting. Backwash frequency can be prescribed arbitrarily (each day at a specified time), or by operating criteria, (headloss or turbidity). Duration of backwash may be 10 to 15 min.

The normal quantity of backwash water employed is less than 5 percent of the product water for a 0.8 m deep filter and 10 to 20 percent for a 4.5 m filter.

Recommended backwash flow rates for granular carbons of 8 x 12 or 12 x 30 mesh are 8 to 14 L/m^2s.

8.5.5 Valve and Pipe Requirements

Upflow units shall be piped to operate either as upflow or downflow units as well as being capable of being backwashed. Downflow units shall be piped to operate as downflow and in series. Each column must be valved to be backwashed individually. Furthermore, downflow series contactors should be valved and piped so that the respective position(s) of the individual contactors can be interchanged.

8.5.6 **Instrumentation**

The individual carbon columns should be equipped with flow and headloss measuring devices.

8.5.7 **Hydrogen Sulphide Control**

Methods that can be incorporated into the plant design to cope with hydrogen sulphide production include:

1. Providing upstream biological treatment to satisfy as much of the biological oxygen demand as possible prior to carbon treatment;

2. Reducing detention time in the carbon columns based on dissolved oxygen concentrations of the effluent;

3. Backwashing the columns at more frequent intervals;

4. Chlorinating carbon column influent; and

5. In upflow expanded beds, the introducing of an oxygen source, such as air or hydrogen peroxide, to keep the columns aerobic.

8.5.8 **Carbon Transport**

Provisions must be made to remove spent carbon from the carbon contactors. It is important to obtain a uniform withdrawal of carbon over the entire horizontal surface area of the carbon bed. Care must be taken to insure that gravel or stone supporting media used in downflow contactors does not enter the carbon transport system.

Activated carbon shall be transported hydraulically. Carbon slurries can be transported using water or air pressure, centrifugal or diaphragm pumps, or eductors. The type of motive equipment selected requires a balance of owner preference, column control capabilities, capital and maintenance costs, and pumping head requirements.

Carbon slurry piping systems shall be designed to provide approximately 8 L of transport water for each kg of carbon removed. Pipeline velocities of 0.9 to 1.5 m/s are recommended.

Long-radius elbows or tees and crosses with cleanouts should be used at points of pipe direction change. Valves should be of the ball or plug type. No valves should be installed in the slurry piping system for the purpose of throttling flows.

8.5.9 Carbon Regeneration

8.5.9.1 Quantities of Spent Carbon

The carbon dose used to size the regeneration facilities depends on the strength of the wastewater applied to the carbon and the required effluent quality. Typical carbon dosages that might be anticipated for municipal wastewaters are shown in Table 8.3.

TABLE 8.3 - TYPICAL CARBON DOSAGES FOR DIFFERENT COLUMN WASTEWATER INFLUENTS

PRETREATMENT	TYPICAL CARBON DOSAGE REQUIRED PER m^3 OF COLUMN THROUGHPUT (g/m^3)*
COAGULATED, SETTLED AND FILTERED ACTIVATED SLUDGE EFFLUENT	35 - 70
FILTERED SECONDARY EFFLUENT	70 - 100
COAGULATED, SETTLED, AND FILTERED RAW WASTEWATER (PHYSICAL - CHEMICAL)	100 - 300

* LOSS OF CARBON DURING EACH REGENERATION CYCLE TYPICALLY WILL BE 5 TO 10 PER CENT. MAKE-UP CARBON IS BASED ON CARBON DOSAGE AND THE QUALITY OF THE REGENERATED CARBON.

8.5.9.2 Carbon Dewatering

Dewatering of the spent carbon slurry prior to thermal regeneration may be accomplished in spent carbon drain bins. The drainage bins shall be equipped with screens to allow the transport of water to flow from the carbon. Two drain bins shall be provided.

Dewatering screws may also be used to dewater the activated carbon. A bin must be included in the system to provide a continuous supply of carbon to the screw, as well as maintain a positive seal on the furnace.

8.5.9.3 Regeneration Furnace

Partially dewatered carbon may be fed to the regeneration furnace with a screw conveyor equipped with a variable speed drive to control the rate of carbon feed precisely.

The theoretical furnace capacity is determined by the anticipated carbon dosage. An allowance for furnace downtime on the order of 40 percent should be added to the theoretical capacity.

Based on the experience gained from two full-scale facilities, provisions should be made to add approximately 1 kg of steam per kg of carbon regenerated. Fuel requirements for the carbon regeneration furnace are 7000 kJ/kg of carbon when regenerating spent carbon on tertiary and secondary effluent applications. To this value, the energy requirements for steam and an afterburner, if required, must be added.

The furnace shall be designed to control the carbon feed rate, rabble arm speed, and hearth temperatures. The off-gases from the furnace must be within acceptable air pollution standards. Air pollution control equipment shall be designed as an integral part of the furnace and include a scrubber for removing carbon fines and an afterburner for controlling odours.

8.6 BIOLOGICAL NUTRIENT REMOVAL

8.6.1 Biological Phosphorus Removal

A number of biological phosphorus removal processes exist that have been developed as alternatives to chemical treatment. Phosphorus is removed in biological treatment by means of incorporating orthophosphate, polyphosphate, and organically bound phosphorus into cell tissue. The key to the biological phosphorus removal is the exposure of the microorganisms to alternating anaerobic and aerobic conditions. Exposure to alternating conditions stresses the microorganisms so that their uptake of phosphorus is above normal levels. Phosphorus is not only used for cell maintenance, synthesis, and energy transport but is also stored for subsequent use by the microorganisms. The sludge containing the excess phosphorus is either wasted or removed through a sidestream to release the excess. The alternating exposure to anaerobic and aerobic conditions can be accomplished in the main biological treatment process, or "mainstream," or in the return sludge stream, or "sidestream."

8.6.1.1 Mainstream Phosphorus Removal (A/O Process)

The proprietary A/O process is a single sludge suspended-growth system that combines anaerobic and aerobic sections in sequence. Settled sludge is returned to the influent end of the reactor and mixed with the incoming wastewater. Under anaerobic conditions, the phosphorus contained in the wastewater and the recycled cell mass is released as soluble phosphates. Some BOD reduction also occurs in this stage. The phosphorus is then taken up by the cell mass in the aerobic zone. Phosphorus is removed from the liquid stream in the waste activated sludge. The concentration of phosphorus in the effluent is dependent mainly on the ratio of BOD to phosphorus of the wastewater treated.

8.6.1.2 Sidestream Phosphorus Removal (PhoStrip Process)

In the proprietary phostrip process a portion of the return activated sludge from the biological treatment process is diverted to an anaerobic phosphorus stripping tank. The retention time in the stripping tank typically ranges from 8 to 12 hours. The phosphorus released in the stripping tank passes out of the tank in the supernatant, and the phosphorus-poor activated sludge is returned to the aeration tank. The phosphorus-rich supernatant is treated with lime or another coagulant in a separate tank and discharged to the primary sedimentation tanks or to a separate flocculation/clarification tank for solids separation. Phosphorus is removed from the system in the chemical precipitant. Conservatively designed PhoStrip and associated activated-sludge systems are capable of consistently producing an effluent with a total phosphorus content of less than 1.5 mg/L before filtration.

8.6.1.4 Design Criteria

TABLE 8.4 - DESIGN CRITERIA FOR BIOLOGICAL PHOSPHORUS REMOVAL			
DESIGN PARAMETER	TREATMENT PROCESS		
	A/O	PhoStrip	SBR
Food/Microorganism Ratio (kg BOD_5/kg MLVSS.d)	0.2 - 0.7	0.1 - 0.5	0.15 - 0.5
Solids Retention Time (d)	2 - 25	10 - 30	
MLSS (mg/L)	2000 - 4000	600 - 5000	2000 - 3000
Hydraulic Retention Time (hrs)			
Anaerobic Zone	0.5 - 1.5	8 - 12	1.8 - 3
Aerobic Zone	1 - 3	4 - 10	1.0 - 4
Return Activated Sludge (% of Influent Flowrate)	25 - 40	20 - 50	N/A
Stripper Underflow (% of Influent Flowrate)	N/A	10 - 20	N/A

8.6.2 Biological Nitrogen Removal

The principal nitrogen conversion and removal processes are conversion of ammonia nitrogen to nitrate by biological nitrification and removal of nitrogen by biological nitrification/denitrification.

8.6.2.1 Nitrification

Biological nitrification consists of the conversion of ammonia nitrogen to nitrite followed by the conversion of nitrite to nitrate. This process does not increase the removal of nitrogen from the waste stream over that achieved by conventional biological treatment. The principal effect is that nitrified effluent can be denitrified biologically. To achieve nitrification, all that is required is the maintenance of conditions suitable for the growth of nitrifying organisms.

Nitrification is also used when treatment requirements call for oxidation of ammonia-nitrogen. Nitrification may be carried out in conjunction with secondary treatment or in a tertiary stage. In each case, either suspended growth or attached growth reactors can be used.

8.6.2.1.1 *Design Criteria*

TABLE 8.5 - DESIGN CRITERIA FOR NITRIFICATION		
DESIGN PARAMETER	SINGLE STAGE	SEPARATE STAGE
Food/Microorganism Ratio (kg BOD_5/kg MLVSS.d)	012 - 0.25	0.05 - 0.2
Solids Retention Time (d)	8 - 20	15 - 100
MLSS (mg/L)	1500 - 3500	1500 - 3500
Hydraulic Retention Time (hrs)	6 - 15	3 - 6
Return Activated Sludge (% of Influent Flowrate)	50 - 150	50 - 200

8.6.2.2 *Combined Nitrification/Denitrification*

The removal of nitrogen by biological nitrification/denitrification is a two step process. In the first step, ammonia is converted aerobically to nitrate (NO_3^-) (nitrification). In the second step, nitrates are converted to nitrogen gas (denitrification).

The removal of nitrate by conversion to nitrogen gas can be accomplished biologically under anoxic conditions. The carbon requirements may be provided by internal sources, such as wastewater and cell material, or by an external source.

8.6.2.2.1 *Bardenpho Process (Four-Stage)*

The four-stage proprietary Bardenpho process uses both the carbon in the untreated wastewater and carbon from endogenous decay to achieve denitrification. Separate reaction zones are used for carbon oxidation and anoxic denitrification. The wastewater initially enters an anoxic denitrification zone to which nitrified mixed liquor is recycled from a subsequent combined carbon oxidation nitrification compartment. The carbon present in the wastewater is used to denitrify the recycled nitrate. Because the organic loading is high, denitrification proceeds rapidly. The ammonia in the wastewater passes unchanged through the first anoxic basin to be nitrified in the first aeration basin. The nitrified mixed liquor from the first aeration basin passes into a second anoxic zone, where additional denitrification occurs using the endogenous carbon source. The second aerobic zone is relatively small and is used mainly to strip entrained nitrogen gas prior to clarification. Ammonia released from the sludge in the second anoxic zone is also nitrified in the last aerobic zone.

8.6.2.2.2 *Oxidation Ditch*

In an oxidation ditch, mixed liquor flows around a loop-type channel, driven and aerated by mechanical aeration devices. For nitrification/denitrification applications, an aerobic zone is established immediately downstream of the aerator, and an anoxic zone is created upstream of the aerator. By discharging the influent wastewater stream at the upstream end of the anoxic zone, some of the wastewater carbon source is used for denitrification. The effluent from the reactor is taken from the end of the aerobic zone for clarification. Because the system has only one anoxic zone, nitrogen removals are lower than those of the Bardenpho process.

8.6.3 Combined Biological Nitrogen and Phosphorus Removal

A number of biological processes have been developed for the combined removal of nitrogen and phosphorus. Many of these are proprietary and use a form of the activated sludge process but employ combinations of anaerobic, anoxic, and aerobic zones or compartments to accomplish nitrogen and phosphorus removal.

8.6.3.1 A^2/O Process

The proprietary A^2/O process provides an anoxic zone for denitrification with a detention period of approximately one hour. The anoxic zone is deficient in dissolved oxygen, but chemically bound oxygen ion the form of nitrate or nitrite is introduced by recycling nitrified mixed liquor from the aerobic section. Effluent phosphorus concentrations of less than 2 mg/L can be expected without effluent filtration; with effluent filtration, effluent phosphorus concentrations may be less than 1.5 mg/L.

8.6.3.2 Bardenpho Process (5 Stage)

The proprietary Bardenpho process can be modified for combined nitrogen and phosphorus removal. The Phoredox modification of the bardenpho process incorporates a fifth (anaerobic) stage for phosphorus removal. The five-stage system provides anaerobic, anoxic, and aerobic stages for phosphorus, nitrogen, and carbon removal. A second anoxic stage is provided for additional denitrification using nitrate produced in the aerobic stage as the electron acceptor and the endogenous organic carbon as the electron donor. The final aerobic stage is used to strip residual nitrogen gas from solution and to minimize the release of phosphorus in the final clarifier. Mixed liquor from the first aerobic zone is recycled to the anoxic zone.

8.6.3.3 UCT Process

The UCT process eliminates return activated sludge to the anoxic stage and the internal recycle is from the anoxic stage to the anaerobic stage. By returning the activated sludge to the anoxic stage, the introduction of nitrate to the anaerobic stage is eliminated, thereby improving the release of phosphorus in the anaerobic stage. The internal recycle feature provides for increased organic utilization in the anaerobic stage. The mixed liquor from the anoxic stage contains substantial soluble BOD but little nitrate. The recycle of the anoxic mixed liquor provides for optimal conditions for fermentation uptake in the anaerobic stage.

8.6.3.4 *Design Criteria*

TABLE 8.6 - DESIGN CRITERIA FOR COMBINED BIOLOGICAL NITROGEN AND PHOSPHORUS REMOVAL				
DESIGN PARAMETER	TREATMENT PROCESS			
	A^2/O	Bardenpho (5 Stage)	UCT	SBR
Food/Microorganism Ratio (kg BOD_5/kg MLVSS.d)	0.15 - 0.25	0.1 - 0.2	0.1 - 0.2	0.1
Solids Retention Time (d)	4 - 27	10 - 40	10 - 30	—
MLSS (mg/L)	3000 - 5000	2000 - 4000	2000 - 4000	600 - 5000
Hydraulic Retention Time (hrs)				Batch Times
Anaerobic Zone	0.5 - 1.5	1 - 2	1 - 2	0 - 3
Anoxic Zone - 1	0.5 - 1.0	2 - 4	2 - 4	0 - 1.6
Aerobic Zone - 1	3.5 - 6.0	4 - 12	4 - 12	0.5 - 1
Anoxic Zone - 2		2 - 4	2 - 4	0 - 0.3
Aerobic Zone - 2		0.5 - 1		0 - 0.3
Settle/Decant				1.5 - 2
Total	4.5 - 8.5	9.5 - 23	9 - 22	4 - 9
Return Activated Sludge (% of Influent Flowrate)	20 - 50	50 - 100	50 - 100	—
Internal Recycle (% of Influent Flowrate)	100 - 300	400	100 - 600	—

8.6.4 Sequencing Batch Reactor (SBR)

The SBR can be operated to achieve any combination of carbon oxidation, nitrogen reduction, and phosphorus removal. Reduction of these constituents can be accomplished with or without chemical addition by changing the operation of the reactor. Phosphorus can be removed by coagulant addition or biologically without coagulant addition. By modifying the reaction times, nitrification of nitrogen removal can also be accomplished. Overall cycle time may vary from 3 to 24 hours. A carbon source in the anoxic phase is required to support denitrification-either an external source or endogenous respiration of the existing biomass.

8.6.5 Detailed Design Manuals

The following sources contain detailed design information for biological nutrient removal:

Water Pollution Control Federation: *Nutrient Control*, Manual of Practice FD-7, Washington, DC, 1983.

U.S. Environmental Protection Agency: *Design Manual for Phosphorus Removal*, EPA 625/1-87-001, Cincinnati, OH, 1987.

U.S. Environmental Protection Agency: *Process Design Manual for Nitrogen Control*, Office of Technology Transfer, Washington, DC, October 1975.

U.S. Environmental Protection Agency: *Process Design Manual for Phosphorus Removal*, Office of Technology Transfer, Washington, DC, April 1976.

9.1 NATURAL TREATMENT SYSTEMS

9.1.1 General

In the natural environment, physical, chemical, and biological processes occur when water, soil, plants, microorganisms, and the atmosphere interact. Natural treatment systems are designed to take advantage of these processes to provide wastewater treatment. The processes involved in natural systems include many of those used in mechanical or in-plant treatment systems, plus others unique to natural systems such as photosynthesis, photo-oxidation, and plant uptake. In natural systems, the processes occur at "natural" rates and tend to occur simultaneously in a single "ecosystem reactor" as opposed to mechanical systems in which processes occur sequentially in separate reactors or tanks at accelerated rates as a result of energy input.

9.1.2 Pre-Design Report

In addition to the required pre-design report, the designer shall include supplemental information, as outlined below, where wastewater application to the land is being considered. This information shall include any material that is pertinent about the location, geology, topography, hydrology, soils, areas for future expansion, and adjacent land use.

9.1.3 Required Supplemental Information

9.1.3.1 Location

1. A copy of the N.T.S. topographic map of the area showing the exact boundaries of the proposed application area.

2. A topographic map of the total area owned by the applicant at a scale of approximately 1:500. It should show all buildings, the waste disposal system, the spray field boundaries and the buffer zone. An additional map should show the spray field topography in detail with a contour interval of 0.5 m and include buildings and land use on adjacent lands within 400 m of the project boundary.

3. All water supply wells which might be affected shall be located and identified as to use; e.g., potable, industrial, agricultural, and class of ownership; e.g., public, private, etc.

4. All abandoned wells, shafts, etc., shall be located and identified. Pertinent information therein shall be furnished.

9.1.3.2 Geology

1. The geologic formations (name) and the rock types at the site.

2. The degree of weathering of the bedrock.

3. The local bedrock structure including the presence of faults, fractures and joints.

4. The character and thickness of the surficial deposits (residual soils and glacial deposit).

5. In limestone terrain, additional information about solution openings and sinkholes is required.

6. The source of the above information must be indicated.

9.1.3.3 *Hydrology*

1. The depth to seasonal high water table (perched and/or regional) must be given, including an indication of seasonal variations. Static water levels must be determined at each depth for each aquifer in the depth under concern. Critical slope evaluation must be given to any differences in such levels.

2. The direction of groundwater movement and the point(s) of discharge must be shown on one of the attached maps.

3. Chemical analyses indicating the quality of groundwater at the site must be included.

4. The source of the above data must be indicated.

5. The following information shall be provided from existing wells and from such test wells as may be necessary:

   a. Construction details - where available; Depth, well log, pump capacity, static levels, pumping water levels, casing, grout material, and such other information as may be pertinent.

   b. Groundwater quality: e.g., Nitrates, total nitrogen, chlorides, sulphates, pH, alkalinities, total hardness, coliform bacteria, etc.

6. A minimum of one groundwater monitoring well must be drilled in each dominant direction of groundwater movement and between the project site and public wells(s) and/or high-capacity private wells, with provision for sampling at the surface of the water table and at 1.5 m below the water table at each monitoring site. The location and construction of the monitoring well(s) must be approved by the regulatory authority. These may include one or more of the test wells where appropriate.

9.1.3.4 *Soils*

1. A soils maps of the spray field should be furnished, indicating the various soil types. This may be included on the large-scale topographic map. Soils information can normally be secured through the Federal Department of Energy Mines and Resources, the Federal Department of Agriculture, or the applicable provincial department.

2. The soils should be named and their texture described.

3. Slopes and agricultural practice on the sprayfield are closely related. Slopes on cultivated fields should be limited to 4%.

Slopes on sodded fields should be limited to 8%. Forested slopes should be limited to 8% for year-round operation, but some seasonal operation slopes up to 14% may be acceptable.

4. The thickness of soils should be indicated. Method of determination should be included.

5. Data should be furnished on the exchange capacity of the soils. In case of industrial wastes particularly, this information must be related to special characteristics of the wastes.

6. Information must be furnished on the internal and surface-drainage characteristics of the soil materials. This includes the soil's infiltration capacity and permeability.

7. Proposed application rates should take into consideration the drainage and permeability of the soils, the discharge capacity, and the distance to the water table.

9.1.3.5 *Agricultural Practice*

1. The present and intended soil-crop management practices, including forestation, shall be stated.

2. Pertinent information shall be furnished on existing drainage systems.

3. When cultivated crops are anticipated, the kinds used and the harvesting frequency should be given; the ultimate use of the crop should also be given.

9.1.3.6 *Adjacent Land Use*

1. Present and anticipated use of the adjoining lands must be indicated. This information can be provided on one of the maps and may be supplemented with notes.

2. The plan shall show existing and proposed screens, barriers, or buffer zones to prevent blowing spray from entering adjacent land areas.

3. If expansion of the facility is anticipated, the lands which are likely to be used for expanded spray fields must be shown on the map.

9.2 FEATURES AND PERFORMANCE FOR WASTEWATER UTILIZATION, TREATMENT AND DISPOSAL SYSTEMS

Table 9.1 outlines various features and performance for wastewater land application systems.

TABLE 9.1 - COMPARISON OF FEATURES AND PERFORMANCE FOR WASTEWATER UTILIZATION, TREATMENT AND DISPOSAL SYSTEMS

SYSTEM REQUIREMENT	STANDARD RATE IRRIGATION	HIGH RATE IRRIGATION	OVERLAND FLOW	RAPID INFILTRATION	WETLANDS SYSTEMS	AQUATIC PLANT SYSTEMS
SOIL PERMEABILITY	MODERATE (MEDIUM TEXTURE SOIL)	MODERATE TO HIGH (MEDIUM TO COARSE TEXTURE SOIL)	LOW (FINE TEXTURE)	RAPID (LOAMY SANDS AND GRAVELS)	LOW	LOW (FINE TEXTURE)
UTILIZATION OF WATER AND NUTRIENTS	HIGH	MEDIUM	MEDIUM TO LOW	NONE	MINIMAL	MEDIUM TO LOW
SLOPE	UP TO 30% FOR SPRINKLER AND 6% FOR SURFACE METHODS	SAME AS FOR STANDARD RATE	1 - 12%	NOT CRITICAL	LEVEL	LESS THAN 5%
STORAGE	HIGH (7-9 MONTHS)	MEDIUM (5-7 MONTHS)	MEDIUM (5-7 MONTHS)	NIL	NIL	NIL
LAND AREA	HIGH	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM
WATER QUALITY - SALINITY, ETC.	VERY HIGH	HIGH	MEDIUM TO LOW	MEDIUM TO LOW	LOW	LOW
TREATMENT EFFICIENCY	VERY HIGH	HIGH	HIGH	MEDIUM	MEDIUM	MEDIUM

9.3 SOIL BASED TREATMENT

9.3.1 General

Land application of treated sewage effluent is a method of disposing of effluent without direct discharge to surface waters. Ground disposal installations are normally used where the waste contains pollutants which can successfully be removed through distribution to the soil mantle. These pollutants can be removed through organic decomposition in the vegetation-soil complex and by adsorptive, physical, and chemical reactions with earth materials. Preliminary considerations of a site for ground disposal should be the compatibility of the waste with the organic and earth materials and the percolation rates and exchange capacity of the soils. The ground disposal of wastewater will eventually recharge the local groundwater; therefore, the quality, direction and rate of movement, and local use of the groundwater, present and potential, are prime considerations in evaluating a proposed site.

It is essential to provide good vegetation growth conditions and removal of nutrients. It must be realized that a groundwater mound will develop below after it is in use. The major factors in design of ground disposal fields are topography, soils, geology, hydrology, weather, agricultural practice, adjacent land use, and equipment selection and installation.

The primary methods used for distributing wastewater on the land are irrigation, infiltration, and overland flow.

9.3.1.1 *Pre-Treatment Requirements*

Wastewater pre-treatment levels, prior to disposal on land, shall be dependant on current land use and method of wastewater application to the land. Wastewater applied to the land, normally shall be treated to a minimum of a secondary effluent level. Disinfection may also be required. Specific effluent limits will be evaluated by the regulatory authority on a case-by-case basis.

9.3.1.2 *Application to the Land*

9.3.1.2.1 *Piping to Sprinklers*

The piping should be arranged to allow the irrigation pattern to be varied easily. Stationary systems are preferred; but if a moveable system is proposed, one main header must be provided with individual connections for each field and sufficient spare equipment must be available to assure non-interrupted irrigation. Facilities must be provided to allow the pipes to be completely drained at suitable points to prevent pollution and freezing.

9.3.1.2.2 *Sprinkling System*

Sprinklers must be so located as to give a non-irrigated buffer zone around the irrigated area, and design of the buffer zone must consider wind transport of the wastewaters. The system shall be designed to provide an even distribution over the entire field.

The application rate must be selected low enough to allow the waters to percolate into the soil and to assure proper residency within the soil mantle. Proposed application rates will not be accepted without substantiating data.

In general, sufficient monitoring controls should be provided to indicate the degree of efficiency with which the sprinklers are working. A pressure gauge and flow meter should be provided.

9.3.1.2.3 *Site Buffer Zone*

In the absence of detailed assessments, the distance from spray nozzles to the property limit shall be 150 metres. Spraying is possible at closer distances from the property limit provided that low pressure, low angle, closely spaced sprinklers are used to minimize the formation of aerosols. In addition, the risk associated with aerosols can be minimized by providing a fence or tree screen around the site perimeter and by terminating spraying operations when wind speeds exceed that of a gentle breeze (15 km/h).

9.3.1.3 *Runoff*

The system shall be designed to prevent surface runoff from entering or leaving the project site.

9.3.1.4 *Fencing and Warning Signs*

The project area shall be enclosed with a suitable fence to exclude livestock and discourage trespassing. A vehicle access gate of sufficient width to accommodate mowing equipment should be provided. All access gates should be provided with locks.

Appropriate signs should be provided along the fence around the project boundaries to designate the nature of the facility and advise against trespassing.

9.3.2 Irrigation

9.3.2.1 *General*

The primary objective of wastewater land application for the purpose of irrigation, is to optimize the use of water and nutrients for crop production. The application of wastewater for irrigation purposes shall be evaluated on a case-by-case basis.

For successful operation, an effluent irrigation system will require:

- suitable soils;
- suitable topography and hydrological conditions;
- adequate site area at reasonable cost;
- suitable site isolation from conflicting land uses;
- suitable climate;
- effective site preparation;
- proper crop selection;
- good management;
- adequate waste treatment prior to irrigation;
- adequate effluent holding capacity for non-irrigation periods.

9.3.2.2 *Monitoring*

A comprehensive monitoring program shall be required to ensure that proper wastewater utilization is being achieved and that environmental degradation is not occurring. Groundwater, treated wastewater, vegetation and soils shall be monitored. Generally, nitrate nitrogen is the parameter monitored in groundwater. To assess the overall impact of the system, changes in groundwater quality can be compared with the quality of background wells.

In addition to changes in groundwater quality, changes in groundwater level should be monitored. The effect of elevated levels should be assessed with respect to changes in the hydrogeological condition of the area. Changes in groundwater movement and the appearance of seeps and perched water tables. should be noted; system modification, such as underdraining or reduced application rates in the area, may be necessary.

9.3.3 Overland Flow

9.3.3.1 Applicability

Overland flow differs from spray irrigation primarily in that a substantial portion of the applied wastewater becomes runoff which must be collected or discharged to a receiving water or stored for further treatment.

Overland flow is best suited for sites having surface soils that are slowly permeable or have a restrictive layer such as a clay pan at depths of 0.3 to 0.6 m. The topsoil should be of sufficient depth and quality for good cover crop establishment. It is possible to design an overland flow system on very permeable soils by constructing an artificial barrier to prevent downward water movement through the soil, although the capital costs of such construction may be prohibitive for all but the smallest systems. A minimum depth to groundwater of one metre is required to maintain aerobic conditions for plant growth. Underdrainage may be used to lower the water table.

Overland flow may be used at sites with gently sloping terrain with grades in the range of 1 to 12%. Slopes can be constructed on nearly level terrain and terraced construction can be used when the natural slope exceeds about 10%. If reuse of the runoff is not possible, then a drainage system must be constructed to transport the treated wastewater from the site.

9.3.3.2 Wastewater Loading

The maximum seasonal wastewater loading rate shall be determined by the following equation:

$$R_W = P + SR$$

where

R_W = loading rate (cm/annum)

P = soil permeability (cm/annum)

SR = seasonal runoff rate (cm/annum)

Typical permeability rates used in overland flow systems range from 0.15 cm/h to 0.3 cm/h. Runoff rates typically range from 40% in the summer to 80% in the early spring and late fall. Actual runoff should be confirmed by on-site pilot studies.

The following equation can be used to calculate land requirements:

$$A_W = 0.01\ Q/R_W$$

where

A_W = total land area required (ha)

Q = total annual wastewater production (m^3/annum)

R_W = seasonal water removal rate (cm,/annum), as determined from the equation above.

9.3.3.3 *Crop Selection*

Crops best suited to the overland flow system are grasses with a long growing season, high moisture tolerance and extensive root formation. Reed canary grass has a very high nutrient uptake capacity and yields a good quality hay. Other suitable grasses include ryegrass and tall fescue.

9.3.3.4 *Treatment Efficiency*

Removal efficiencies of overland flow systems for pathogens such as viruses and indicator organisms are comparable to conventional secondary treatment systems without chlorination. Consequently, chlorination of runoff water may be required by regulatory agencies prior to discharge into streams.

Typical treatment efficiencies are given in Table 9.2

TABLE 9.2 - TYPICAL WASTEWATER CONSTITUENT REDUCTIONS FOR OVERLAND FLOW

Constituent	% Reduction Range*
BOD_5	25 - 95
Suspended Solids	33 - 85
Total N	50 - 82
Total P	0 - 80
Calcium	63 - 85
Zinc	75 - 84

* Reduction from concentrations in untreated wastewater.

9.3.3.4 *Monitoring*

Monitoring is necessary to maintain loadings within design limits. A routine monitoring program should be established for the following parameters:

a. wastewater application rate (m^3/d);

b. runoff flow rates (m^3/d);

c. wastewater quality, including BOD_5 and COD, suspended solids, total dissolved solids, total nitrogen, total phosphorus, pH, and sodium adsorption ratio (SAR); and

d. runoff water quality according to the analyses summarized in item (c) above.

9.3.4 Rapid Infiltration (RI)

9.3.4.1 *Applicability*

Rapid infiltration (RI) involves the application of wastewater (usually after some pretreatment) to land by means of basins. The wastewater percolates through the soil, undergoes a variety of physical, chemical and biological reactions and eventually reaches the groundwater. The loss of water via plants or evaporation is minor compared to the loss by percolation. The loading must be intermittent to allow for the restoration of aerobic conditions in the soil. Acceptable salinity, boron, nitrogen and phosphorus levels in the wastewater will be governed by the potential use of the groundwater downstream of the RI site. The permeability of the site is, however, very important to the performance of a RI system. Therefore, the sodium adsorption ratio of the effluent should be below 9.

Optimum site conditions for rapid infiltration (RI) are dependent upon the quantity of wastewater to be treated and the degree of treatment required. Generally, there will be an inverse relationship between maximum wastewater application rate and the degree of treatment. Soil conditions required for a good RI site are a deep uniform sandy loam to loamy sand having the following chemical characteristics;

pH	6.0 - 8.5
Organic Matter	0.5 - 3.0%
Electrical Conductivity	2 dS/m
Sodium Adsorption Ratio	10
Cation Exchange Capacity	10 meq/100 g

Free Ca or Mg CO_3 should be present

Rapid infiltration installations require permeable granular subsurface materials. A minimum of 4 m separation between the water table and the basin bottom before flooding is recommended. The water table should be greater than 1 m below the bottom of the basin during operation. Adverse natural groundwater conditions can be modified by the installation of underdrains and/or recovery wells.

Excessive slopes will restrict the usefulness of a RI site. The maximum slope is that which maintains downward infiltration with no premature lateral discharge. Generally, the maximum slope is 5% unless considerable earth moving is undertaken. Uniform flat topography will reduce construction costs. Ponds or lagoons are not recommended for RI pretreatment methods unless cold weather storage is provided. In areas where facultative lagoons are used for treatment, the lagoons will generally be large enough to provide cold weather storage. However, the infiltration area will have to be large enough to treat the annual wastewater production during the warm weather period. Wastewater from treatment plants with short detention times will retain sufficient heat to allow continuous RI treatment and eliminate the need for storage.

9.3.4.2 *Area and Infiltration Rate*

Prior to site selection the planner must determine the approximate land area required for an RI system. This can be obtained by using sewage flow data and the annual amount of infiltration per unit area. The hydraulic conductivity required to estimate total infiltration can be determined from Table 9.3 and the following calculations. It is then suggested that a factor of 1.5 be applied to the calculated area requirements.

TABLE 9.3 - HYDRAULIC CONDUCTIVITIES OF VARIOUS GRANULAR DEPOSITS

Deposit	Hydraulic Conductivity (cm/s)
Clean, well sorted sand and gravel	10^{-1}
Clean sand, moderately sorted gravel	10^{-2}
Moderately sorted sand and gravel	10^{-3}
Poorly sorted sand and gravel	10^{-4}

Infiltration capacity is estimated by the following procedure:

a. Estimate site hydraulic conductivity, in cm/s.

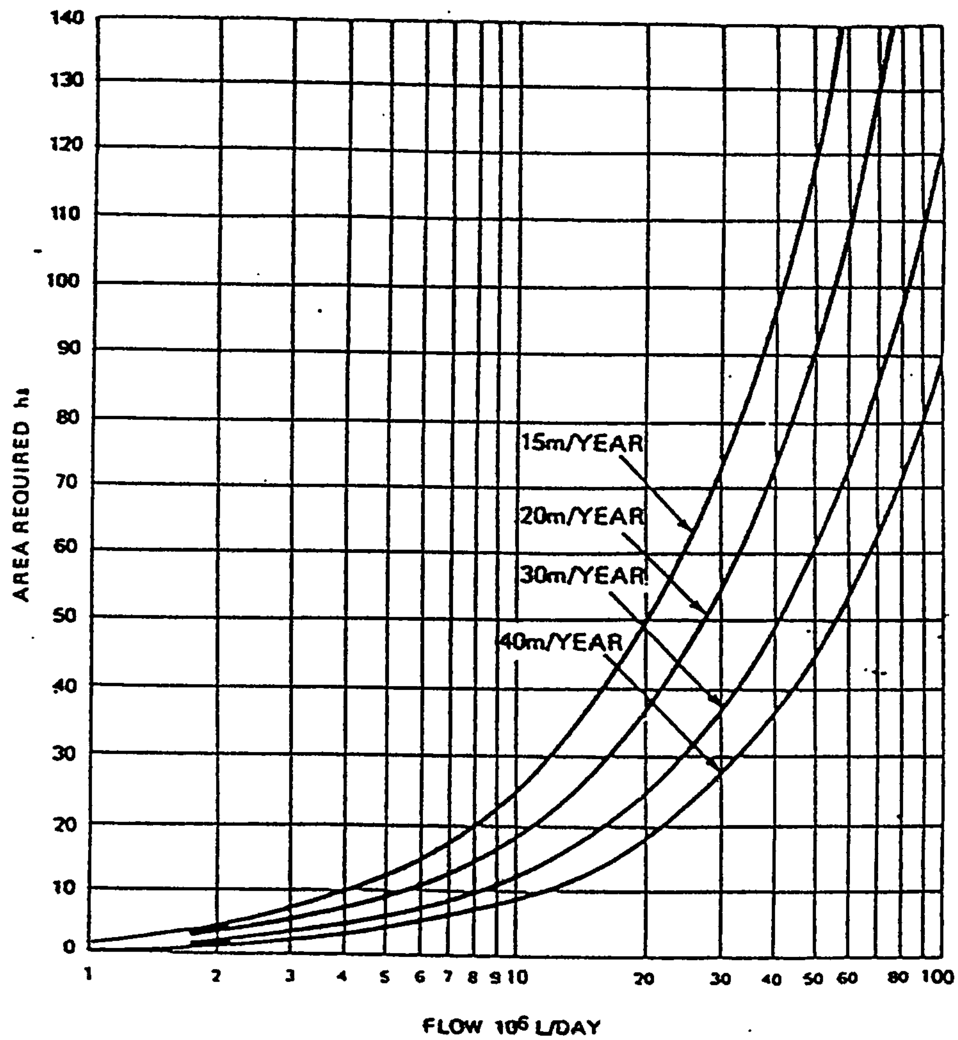
b. Determine annual hydraulic loading and convert cm/s to m/annum (multiply by 3.15×10^{4}).

c. Extrapolate site area (on the y-coordinate of Figure 9.1) using the line most closely representing the estimated hydraulic loading rate determined.

d. Maximum daily infiltration capacity of the site in question can be read off the x-coordinate (Figure 9.1).

FIGURE 9.1

DETERMINATION OF LAND AREA REQUIRED
FOR RAPID INFILTRATION SYSTEMS



The infiltration rate must be confirmed by field testing. Areal requirements for an RI system must include:

a. infiltration basins and dykes;

b. maintenance and laboratory buildings(s);

c. possibly on-site treatment facilities;

d. on-site roads;

e. expansion and emergency use areas;

f. buffer strips.

9.3.4.3 *Loading Cycle*

Canadian RI systems would likely require an altered loading cycle with respect to seasons because longer resting periods may be required for soil drying and aeration during winter. Decreasing the application rate and increasing the length of the application and resting period are possible means of overcoming the problems of winter application.

Suggested loading cycles are shown in Table 9.4. The values given in this table are considered guidelines. Actual loading cycles should take into account site-specific conditions.

TABLE 9.4 - SUGGESTED HYDRAULIC LOADING CYCLES FOR RAPID INFILTRATION SYSTEMS

Objective of Preapplication Treatment Period (Days)	Preapplication Treatment Level	Season	Application Period (Days)	Drying (Days)
Maximize infiltration rates of nitrification	Primary	Summer Winter	1 - 2 1 - 2	5 - 7 7 - 14
	Secondary	Summer Winter	1 - 3 1 - 3	4 - 5 5 - 12
Maximize nitrogen removal	Primary	Summer Winter	1 - 2 1 - 2	10 - 14 12 - 18
	Secondary	Summer Winter	7 - 9 9 - 12	10 - 15 12 - 18

9.3.4.4 *Application Rate*

Once the loading rate and loading cycle have been established, the application rate can be calculated. For example, if the hydraulic loading rate is 20 m/annum and the loading cycle is one day of application alternated with seven days of drying, the application rate is as follows:

$$\text{Hydraulic loading rate} \times \frac{(\text{time on} + \text{time off})}{\text{time on}} \times \text{conversion factor annual to daily} = \text{daily application rate}$$

The application rate should be used to determine the maximum depth of the applied wastewater. For instance, if the measured basin infiltration rate is 15 cm/d, the maximum wastewater depth will be the daily application rate minus 15.

In general, maximum wastewater depth should not exceed 46 cm with a preferable maximum depth of 30 cm. If the wastewater depth calculation indicates the recommended maximum will be exceeded, either the loading rate should be decreased or the loading cycle adjusted until the maximum basin depth is acceptable.

9.3.4.5 *Monitoring*

A monitoring program should provide applied wastewater quality, the quality of groundwater affected by the RI system and, if required, an analysis of the soil affected by the RI system. Several groundwater samples should be collected from sites expected to be influenced by RI and compared with samples from areas not affected by wastewater infiltration.

9.4 CONSTRUCTED WETLANDS

9.4.1 General

Constructed wetlands are inundated land areas with water depths typically less than 2 ft (0.6 m) that support the growth of emergent plants such as cattail, bulrush, reeds, and sedges. The vegetation provides surface for the attachment of bacterial films, aids in the filtration and adsorption of wastewater constituents, transfers oxygen into the water column, and controls the growth of algae by restricting the penetration of sunlight.

Although plant uptake is an important consideration in contaminant, particularly nutrient, removal it is only one of many active removal mechanisms in the wetland environment. Removal mechanisms have been classified as physical, chemical and biological and are operative in the water column, the humus and soil column beneath the growing plants, and at the interface between the water and soil columns. Because most of the biological transformations take place on or near a surface to which bacteria are attached, the presence of vegetation and humus is very important. Wetland systems are designed to provide maximum production of humus material through profuse plant growth and organic matter decomposition.

9.4.2 Types

Wastewater treatment systems using constructed wetlands have been categorized as either free water surface (FWS) or subsurface flow (SFS) types.

a. Free Water Surface Wetlands (FWS)

A FWS system consists of basins or channels with a natural or constructed subsurface barrier to minimize seepage. Emergent vegetation is grown and wastewater is treated as it flows through the vegetation and plant litter. FWS wetlands are typically long and narrow to minimize short-circuiting.

b. Subsurface Flow Wetlands (SFS)

A SFS wetland system consists of channels or basins that contain gravel or sand media which will support the growth of emergent vegetation. The bed of impermeable material is sloped typically between 0 and 2 percent. Wastewater flows horizontally through the root zone of the wetland plants about 100 to 150 mm below the gravel surface. Treated effluent is collected in an outlet channel or pipe.

9.4.3 Site Evaluation

Site characteristics that must be considered in wetland system design include topography, soil characteristics, existing land use, flood hazard, and climate.

a. Topography

Level to slightly sloping, uniform topography is preferred for wetland sites because free water systems (FWS) are generally designed with level basins or channels, and subsurface flow systems (SFS) are normally designed and constructed with slopes of 1 percent or slightly more. Although basins may be constructed on steeper sloping or uneven sites, the amount of earthwork required will affect the cost of the system. Thus, slope gradients should be less than 5 percent.

b. Soil

Sites with slowly permeable (<0.5 cm/h) surface soils or subsurface layers are most desirable for wetland systems because the objective is to treat the wastewater in the water layer above the soil profile. Therefore, percolation losses through the soil profile should be minimized. As with overland-flow systems, the surface soil will tend to seal with time due to deposition of solids and growth of bacterial slimes. Permeabilities of native soils may be purposely reduced by compacting during construction. Sited with rapidly permeable soils may be used for small systems by constructing basins with clay or artificial liners. The depth of soil to groundwater should be a minimum of 0.3 - 0.6 m to allow sufficient distance for treatment of any percolate entering the groundwater.

c. Flood Hazard

Wetland sites should be located outside of flood plains, or protection from flooding should be provided.

d. Existing Land Use

Open space or agricultural lands, particularly those near existing natural wetlands, are preferred for wetland sites. Constructed wetlands can enhance existing natural wetlands by providing additional wildlife habitat and , in some cases, by providing a more consistent water supply.

e. Climate

The use of wetland systems in cold climates is possible. Because the principle treatment systems are biological, treatment performance is strongly temperature sensitive. Storage will be required where treatment objectives cannot be met due to low temperatures.

9.4.4 Preapplication Treatment

Artificial wetlands may be designed to accept wastewater with minimal (coarse screening and comminution) pretreatment. However, the level of pretreatment will influence the quality of the final effluent and therefore overall treatment objectives must be considered. Since there is no permanent escape mechanism for phosphorus within the wetland. Phosphorus reduction by chemical addition is also recommended as a pretreatment step to ensure continued satisfactory phosphorus removal within the marsh.

9.4.5 Vegetation Selection and Management

The plants most frequently used in constructed wetlands include cattails, reeds, rushes, bulrushes, and sedges. All of these plants are ubiquitous and tolerate freezing conditions. The important characteristics of the plants related to design are the optimum depth of water for FWS systems and the depth of rhizome and root systems for SFS systems. Cattails tend to dominate in water depths over 0.15 m. Bulrushes grow well at depths of 0.05 - 0.25 m. Reeds grow along the shoreline and i water up to 1.5 m deep, but are poor competitors in shallow waters. Sedges normally occur along the shoreline and in shallower water than bulrushes. Cattail rhizomes and roots extend to a depth of approximately 0.3 m, whereas reeds extend to more than 0.6 m and bulrushes to more than 0.75 m. Reeds and bulrushes are normally selected for SFS systems because the depth of rhizome penetration allows for the use of deeper basins.

Harvesting of wetland vegetation is generally not required, especially for SFS systems. However dry grasses in FWS systems are burned off periodically to maintain free-flow conditions and to prevent channelling of the flow. Removal of the plant biomass for the purpose of nutrient removal is normally not practical.

9.4.6 Design Parameters

9.4.6.1 Detention Time

a. Free Water Surface Wetlands (FWS)

The relationship between BOD removal and detention times for FWS is represented by the equation:

$$C_e/C_o = \exp -[k_T(86.68)t - \ln F]$$

where :

C_e = effluent BOD, mg/L
C_o = influent BOD, mg/L

k_T = temperature dependent rate constant, d^{-1}
= $k_{20} \times 1.06^{(T-20)}$
k_{20} = 0.0057 d^{-1}
T = average monthly water temperature, °C

t	=	average detention time, d
	=	LWnd / Q
L	=	basin length, m
W	=	basin width, m
n	=	fraction of cross sectional area not used by plants (≈ 0.75)
d	=	depth of basin, m
Q	=	average flowrate through system [(Qin + Qout) / 2], m^3/d
F	=	fraction of BOD that does not settle out in the first few meters of wetland
	=	0.52 (primary effluent); 0.75 (pond effluent); 0.8 (secondary effluent)
86.68	=	constant accounting for surface area and void fraction

b. Subsurface Flow Systems (SFS)

The relationship between BOD removal and detention times for SFS is represented by the equation:

$$C_e/C_o = \exp(-K_T t')$$

where

C_e	=	effluent BOD, mg/L
C_o	=	influent BOD, mg/L
K_T	=	temperature dependent rate constant, d^{-1}
	=	$K_{20} \times 1.06^{(T-20)}$
T	=	average monthly water temperature, °C
K_{20}	=	0.86 (gravelly sand); 1.35 (coarse sand); 1.84 (medium sand)
t'	=	$(LW\alpha d) / Q$
L	=	basin length, m
W	=	basin width, m
α	=	porosity of basin medium
	=	0.35 (gravelly sand); 0.39 (coarse sand); 0.42 (medium sand)
d	=	depth of basin, m
Q	=	average flowrate through system [(Qin + Qout) / 2], m^3/d

9.4.6.2 *Water Depth*

For FWS, the design water depth depends on the optimum depth for the selected vegetation. In cold climates, the operating depth is normally increased in the winter to allow for ice formation on the surface and to provide the increased detention time required at colder temperatures. Systems should be designed with an outlet structure that allows for varied operating depths. Water depths should range from 0.1 - 0.5 m.

The design depth of SFS systems is controlled by the depth of penetration of the plant rhizomes and roots because the plants supply oxygen to the water through the root/rhizome system. The media depth may range from 0.3 - 0.75 m.

9.4.6.3 *Aspect Ratio*

The aspect ration for FWS wetlands is important to the performance for removal of BOD, TSS, NH_3, and total nitrogen. Length to width ratios of 4:1 to 6:1 are needed to achieve expected performances and avoid short circuiting of wastewater through the wetland. For large systems, an aspect ratio of 2:1 is the minimum recommended.

For SFS wetlands the bed width is determined by the hydraulic flowrate. The length of the bed is determined by the needed detention time for pollutant removal. Therefore SFS wetlands may have aspect ratios less than or greater than 1:1 depending on the treatment goal.

9.4.6.4 *Loading Rates*

Table 9.5 summarizes the hydraulic, BOD, and SS loading rates for BOD removal in both FWS and SFS systems.

TABLE 9.5 - LOADING RATES FOR CONSTRUCTED WETLANDS

Wetland Type	Hydraulic Loading Rate	Maximum BOD Loading Rate	Maximum SS Loading Rate at inlet
Free Water Surface	150 - 500 m^3/ha.d	65 kg/Ha.d	Not applicable
Subsurface Flow System	Not Applicable	65 kg/Ha.d	0.08 kg/m^2.d

9.4.6.5 *Nutrient Removal*

a. Free Water Surface Wetlands (FWS)

Detention times for nutrient removal need to be longer than the 5 - 10 days required for BOD and SS. Foe ammonia or total nitrogen removal, both minimum temperature and detention time are important. Detention times for significant nitrogen removal should be 8 - 14 days or more. Nitrogen removal and nitrification will be reduced when water temperatures fall below 10 °C and should not be expected when water temperatures fall below 4 °C.

Plant uptake of phosphorus is rapid, and following plant death, phosphorus may be quickly recycled to the water column or deposited in the sediments. The only major sink for phosphorus in most wetlands is in the soil. Significant phosphorus removal requires long detention times (15 - 20 days) and low phosphorus loading rates (< 0.3 kg/ha.d).

b. Subsurface Flow Wetlands (SFS)

Both detention time and oxygen transfer can limit nitrification and subsequent nitrogen removal in SFS wetlands. Because nitrification of 20 mg/L of ammonia will require 100 mg/L of oxygen, oxygen transfer is critical to nitrification in SFS wetlands. Plant roots can generate a portio of this demand for oxygen in the subsurface, however, direct oxygen transfer from the atmosphere may be required to achieve effective nitrification. The detention time and temperature limits for FWS apply to SFS wetlands.

9.4.7 Vector Control

FWS systems provide ideal breeding habitat for mosquitoes. Plans for biological control of mosquitoes through the use of mosquito fish and sparrows plus application of chemical control agents as necessary must be incorporated in the design. Thinning of vegetation may also be necessary to eliminate pockets of water that are inaccessible to fish.

Mosquito breeding should not be a problem in SFS systems, provided the system is designed to prevent mosquito access to the subsurface water zone. The surface is normally covered with pea gravel or coarse sand to achieve this purpose.

9.4.8 Vegetation Harvesting

Harvesting of the emergent vegetation is only required to maintain hydraulic capacity, promote active growth, and avoid mosquito growth. Harvesting for nutrient removal is not practical and is not recommended.

9.4.9 Monitoring

Monitoring is necessary to maintain loadings within design limits. A routine monitoring program should be established for the following parameters:

a.. wastewater application rates (m^3/d);

b. discharge flow rates (m^3/d);

c. wastewater quality, including BOD_5 and COD, suspended solids, total dissolved solids, total nitrogen, total phosphorous, pH and sodium adsorption ratio; and

d. discharge water quality according to the analyses summarized in item (c).

9.5 FLOATING AQUATIC PLANT TREATMENT SYSTEMS

9.5.1 General

Aquatic treatment systems consist of one or more shallow ponds in which one or more species of water tolerant vascular plants such as water hyacinths or duckweed are grown. The shallower depths and the presence of aquatic macrophytes in the place of algae are the major differences between aquatic treatment systems and stabilization ponds. The presence of plants is of great practical significance because the effluent from aquatic systems is of higher quality than the effluent from stabilization pond systems for equivalent or shorter detention times. This is true, particularly when the systems are situated after conventional pond systems which provide greater than primary treatment.

In aquatic systems, wastewater is treated principally by bacterial metabolism and physical sedimentation, as is the case in conventional trickling filter systems. The aquatic plants themselves bring about very little actual treatment of the wastewater. Their function is to provide components of the aquatic environment that improve the wastewater treatment capability and/or reliability of that environment.

9.5.2 Plant Selection

The principal floating aquatic plants used in aquatic treatment systems are water hyacinth, duckweed and pennywort. These plants are described in greater detail in the following discussion.

9.5.3 Water Hyacinths

Water hyacinth is a perennial, fresh water aquatic vascular plant with rounded, upright, shiny green leaves and spikes of lavender flowers. The petioles of the plant are spongy with many air spaces and contribute to the buoyancy of the hyacinth plant. When grown in waste water, individual plants range from 0.5 to 1.2 m from the top of the flower to the root tips. The plants spread laterally until the water surface is covered, and then the vertical growth increases. The growth of water hyacinth is influenced by efficiency of the plant to use solar energy, nutrient composition of the water, cultural methods, and environmental factors.

Under normal conditions, loosely packed water hyacinths can cover the water surface at relatively low plant densities, about 10 kg/m^2 wet weight. Plant densities as high as 80 kg/m^2 wet weight can be reached. As in other biological processes, the growth rate of water hyacinths is dependent on temperature. Both air and water temperatures are important in assessing plant vitality.

9.5.3.2 Duckweed

Duckweed are small, green freshwater plants with fronds from one to a few millimetres in width with a short root, usually less than 12 mm in length. Duckweed are the smallest and the simplest of the flowering plants and have one of the fastest reproduction rates. Duckweed grown in wastewater effluent (at 27°C) doubles in frond numbers, and therefore in area covered, every four days. The plant is essentially all metabolically active cells with very little structural fibre.

Small floating plants, particularly duckweed, are sensitive to wind and may be blown in drifts to the leeward side of the pond unless baffles are used. Redistribution of the plants requires manual labour. If drifts are not redistributed, decreased treatment efficiency may result due to incomplete coverage of the pond surface. Odours have also developed where accumulated plants are allowed to remain and undergo anaerobic decomposition.

9.5.3.3 Pennywort

Pennywort is generally a rooted plant. However, under high-nutrient conditions, it may form hydroponic rafts that extend across water bodies. Pennywort tends to intertwine and grows horizontally; at high densities, the plants tend to grow vertically. Unlike water hyacinth, the photosynthetic leaf area of pennywort is small, and, at dense plant stands, yields are significantly reduced as a result of self shading. Pennywort exhibits mean growth rates greater than 0.010 kg/m^2/day in warm climates. Although rates of nitrogen and phosphorous uptake by water hyacinth drop sharply during the winter, nutrient uptake by pennywort is approximately the same during both warm and cool seasons. Pennywort is a cool season plant that can be integrated into water hyacinth/water lettuce biomass production systems.

9.5.4 Types of Systems

The principal types of floating aquatic plant treatment systems used for wastewater treatment are those employing water hyacinth and duckweed.

9.5.4.1 Water Hyacinth Systems

Water hyacinth systems represent the majority of aquatic plant systems that have been constructed. Three types of hyacinth systems can be described based on the level of dissolved oxygen and the method of aerating the pond: (1) aerobic nonaerated, (2) aerobic aerated, and (3) facultative anaerobic.

A nonaerated aerobic hyacinth system will produce secondary treatment or nutrient (nitrogen) removal depending on the organic-loading rate. This type of system is the most common of the hyacinth systems now in use. The advantages of this type of system include excellent performance with few mosquitoes or odours.

For plant locations in which no mosquitoes or odours can be tolerated, an aerated aerobic hyacinth system is required. The added advantages of such a system are that with aeration, higher organic-loading rates are possible, and reduced land area is required.

The third configuration for a hyacinth system is known as a facultative anaerobic hyacinth system. These systems are operated at very high organic-loading rates. Odours and increased mosquito populations are the principal disadvantages of this type of system. Facultative anaerobic hyacinth systems are seldom used because of these problems.

9.5.4.2 Duckweed Systems

Duckweed and pennywort have been used primarily to improve the effluent quality from facultative lagoons or stabilization ponds by reducing the algae concentration. Conventional lagoon design may be followed for this application, except for the need to control the effects of wind. Without controls, duckweed will be blown to the downwind side of the pond, resulting in exposure of large surface areas and defeating the purpose of the duckweed cover. As noted previously, accumulations of decomposing plants can also result in the production of odours. Floating baffles can be used to construct cells of limited size to minimize the amount of open surface area exposed to wind action.

9.5.5 Climatic Constraints

The water hyacinth systems that are currently used to treat wastewater are located in the warm temperature climates. The optimum water temperature for water hyacinth growth is 21-30 °C. Air temperatures of -3 °C for 12 hours will destroy the leaves and exposure at -5 °C for 48 hours will kill the plants. If a water hyacinth system were to be used in a colder climate, it would be necessary to house the system ion a greenhouse and maintain the temperature in the optimum range. Duckweed is more cold tolerant than water hyacinths and can be grown practically at temperatures as low as 7 °C.

9.5.6 Preapplication Treatment

The minimum level of preapplication treatment should be primary treatment, short detention time aerated ponds or the equivalent. Treatment beyond primary depends on the effluent requirements. Use of oxidation ponds or lagoons in which high concentrations of algae are generated should be avoided prior to aquatic treatment because algae removal is inconsistent. When there are effluent limitations on phosphorus, it should be removed in the preapplication treatment step because phosphorus removal in aquatic treatment systems is minimal.

9.5.7 Design Parameters

The principal design parameters for aquatic treatment systems include hydraulic detention time, water depth, pond geometry, organic-loading rate, and hydraulic loading rate. Typical design guidelines for water hyacinth and duckweed systems are summarized in Table 9.6 for different levels of preapplication treatment.

TABLE 9.6 - FLOATING AQUATIC PLANT SYSTEM DESIGN CRITERIA

ITEM	TYPE OF WATER HYACINTH TREATMENT SYSTEM			DUCKWEED TREATMENT SYSTEM
	Secondary Aerobic (non-aerated)	Secondary Aerobic (aerated)	Nutrient Removal Aerobic (nonaerated)	
Influent Wastewater	Primary Effluent	Primary Effluent	Secondary Effluent	Facultative Pond Effluent
Influent BOD_5 (mg/L)	130 - 180	130 - 180	30	40
BOD_5 Loading (kg/Ha.d)	45 - 90	170 - 340	10 - 45	22 - 28
Water Depth (m)	0.5 - 1.0	1.0 - 1.3	0.7 - 1.0	1.3 - 2.0
Detention Time (d)	10 - 36	4 - 8	6 - 18	20 - 25
Hydraulic Loading Rate (m^3/Ha.d)	190 - 570	95 - 285	375 - 1500	570 - 860
Water Temperature (°C)	> 10	>10	>10	>7
Harvest Schedule	Seasonally	Bi - monthly	Bi - monthly	Monthly

9.5.8 Pond Configuration

9.5.8.1 Water Hyacinth Systems

Typical pond configurations used for water hyacinth systems involve rectangular basins in series similar to stabilization ponds. Recycle and step feed are employed to reduce the concentration of the organic constituent at the plant root zone, improve the transport of wastewater to the root zone, and reduce the formation of odours.

9.5.8.2 Duckweed Systems

Duckweed systems should be designed as conventional stabilization ponds except for the need to control the effects of wind. Floating baffles are used to minimize the amount of surface area exposed to direct wind action. Without this control, duckweed will be blown by the wind and treatment efficiencies cannot be achieved.

9.5.9 Plant Harvesting and Processing

The need for plant harvesting depends on water quality objectives, the growth rates of the plants, and the effects of predators such as weevils. Harvesting of aquatic plants is needed to maintain a crop with high metabolic uptake of nutrients. Frequent harvesting of hyacinths is practiced to achieve nutrient removal. Significant phosphorus removal is achieved only with frequent harvesting. In areas where weevils pose a threat to healthy hyacinth populations, selective harvesting is often used to keep the plants from being infected. Duckweed harvesting for nutrient removal may be required as often as once per week during warm periods.

Harvested water hyacinth plants are typically dried and landfilled or spread on land and tilled into the soil. Water hyacinth can also be composted readily. However, if the plants are not first partially dried or squeezed, the high moisture content tends to reduce the effectiveness of the compost process and results in the production of a liquid stream that must be disposed of. Ground duckweed can be used as animal feed without air drying.

9.5.10 Detailed Design Guidelines

The following sources contain detailed design information for natural wastewater treatment systems:

Water Pollution Control Federation: *Natural Systems for Wastewater Treatment*, Manual of Practice FD-16, Alexandria, VA, 1990.

U.S. Environmental Protection Agency: *Design Manual for Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment*, EPA 625/ 1-88-022, Cincinnati, OH, 1988.

10.1 GENERAL

Sludge handling and disposal must be considered as an integral part of any complete sewage treatment system. The following is a summary of the sludge handling and disposal options and the various process and treatment requirements best suited to the option selected. Re-use and recovery alternatives of sludge by-products are also included as disposal options.

Plans and specifications for sludge handling disposal must be incorporated in the design of all sewage treatment facilities.

10.2 PROCESS SELECTION

The selection of sludge handling unit processes should be based upon at least the following considerations:

a. Local land use;

b. system energy requirements;

c. Cost effectiveness of sludge thickening and dewatering;

d. Equipment complexity and staffing requirements;

e. Adverse effects of heavy metals and other sludge components upon the unit processes;

f. Sludge digestion or stabilization requirements;

g. Side stream or return flow treatment requirements (e.g., digester or sludge storage facilities supernatant, dewatering unit filtrate, wet oxidation return flows);

h. Sludge storage requirements;

i. Methods of ultimate disposal; and

j. Back-up techniques of sludge handling and disposal.

10.3 SLUDGE CONDITIONING

10.3.1 Chemical Conditioning

10.3.1.1 Chemical Requirements

Chemical conditioning methods involve the use of organic or inorganic flocculants to promote the formation of a porous, free draining cake structure. The ranges of some chemical conditioning requirements are outlined in Table 10.1.

TABLE 10.1 - SOME CHEMICAL CONDITIONING REQUIREMENTS			
SLUDGE	$FeCl_3$ (kg/tonne DRY SOLIDS)	$Ca(OH)_2$ (kg/tonne DRY SOLIDS)	POLYMERS (kg/tonne DRY SOLIDS)
RP	10 - 30	0 - 50	1.5 - 2.5
R(P + TF)	30 - 60	0 - 150	2 - 5
R(P + AS)	40 - 80	0 - 150	3 - 7.5
AS	60 - 100	50 - 1500	4 - 12.5
DP	20 - 30	30 - 80	1.5 - 4
D(P + TF)	40 - 80	50 - 150	3 - 7.5
D(P + AS)	60 - 100	50 - 150	3 - 10

KEY : R = RAW; P = PRIMARY; TF = TRICKLING FILTER; AS = ACTIVATED SLUDGE; D = DIGESTED

10.3.1.2 *Laboratory Testing*

The selection of the most suitable chemical(s) and the actual dosage requirements for sludge conditioning shall be determined by full-scale testing.

Laboratory testing should, however, only be used to narrow down the selection process and to arrive at approximate dosage requirements. Generally, laboratory testing will yield dosage requirements within 15 percent of full-scale needs.

10.3.1.3 *Conditioning Chemicals*

10.3.1.3.1 *General*

With most thickening operations and with belt filter press dewatering operations the most commonly used chemicals are polymers. For dewatering by vacuum filtration, ferric salts, often in conjunction with lime, are most commonly used, although with centrifuge dewatering, chemical conditioning using polymers is most prevalent, with metal salts being avoided mainly due to corrosion problems. The ultimate disposal methods may also have an effect on the choice of conditioning chemicals. For instance, lime and ferric compounds should be avoided with incineration options.

10.3.1.3.2 *Iron or Aluminum Salts*

Most raw sludges can be filtered with ferric salts alone, although digested sludge will require an addition of lime with the ferric salt. The lime:ferric chloride ratio is typically 3:1 to 4:1 for best results. If metallic salts are used without lime, the resulting low pH sludge will be highly corrosive to carbon steel and shall require materials such as plastic, stainless steel, or rubber for proper handling.

10.3.1.3.3 *Lime*

Hydrated limes, both the high calcium and dolomitic types, can be used for sludge conditioning in conjunction with metal salts or alone.

10.3.1.3.4 *Polymers*

Polymers used for sludge conditioning are long-chain water-soluble organic molecules of high molecular weight. They are used in wastewater suspensions to cause flocculation through adsorption. Equipment for polymer addition must be able to withstand potential corrosion.

10.3.1.3.5 *Chemical Feed System*

The chemical feed system shall be paced at the rate of sludge flow to the dewatering unit. The chemical feed system should be either close to the dewatering unit or controllable from a point near the dewatering unit. Sufficient mixing shall be provided so as to disperse the conditioner throughout the sludge. The chemical feed rates should allow for at least a 10:1 range of chemical flow to the dewatering unit.

10.3.2 **Heat Conditioning**

10.3.2.1 *General*

Heat conditioning of sludge consists of subjecting the sludge to high levels of heat and pressure. Heat conditioning can be accomplished by either a non-oxidative or oxidative system. Heat conditioning high temperatures cause hydrolysis of the encapsulated water-solids matrix and lysing of the biological cells. The hydrolysis of the water matrix destroys the gelatinous components of the organic solids and thereby improves the water-solids separation characteristics.

10.3.2.2 *Operating Temperatures and Pressures*

Typical operating temperatures range from 150 to 260°C. Operating pressures range from 1100 to 2800 kPa. Typical sludge detention times vary between 15 and 60 minutes.

10.3.2.3 *Increase in Aeration Tank Organic Loading*

Although the heat conditioning system has been proven to be an effective sludge conditioning technique for subsequent dewatering operations, the process results in a significant organic loading to the aeration tanks of the sewage treatment plant if supernatant is returned to the aeration system. This is due to the solubilization of organic matter during the sludge hydrolysis. This liquor can represent 25 to 50 percent of the total loading on the aeration tanks and allowances must be made in the treatment plant design to accommodate this loading increase.

10.3.2.4 Design Considerations

10.3.2.4.1 Materials

Heat conditioning results in the production of extremely corrosive liquids requiring the use of corrosion-resistant materials for the liquid handling.

10.3.2.4.2 Sludge Grinding

Sludge grinders shall be provided to macerate the sludge to a particle size less than 6 mm to prevent fouling of the heat exchangers.

10.3.2.4.3 Feed Pumps

Feed pumps shall be capable of discharging sludge at pressures of 1400 to 2800 Kpa and must be resistant to abrasion.

10.3.2.4.4 Heat Exchangers

The efficiency of the heat exchangers is dependent on the transfer coefficients and the temperature differences of the incoming and outgoing sludges.

10.3.2.4.5 Reaction Vessel

The reaction vessel shall be of sufficient volume to provide for a sludge detention time of 15 to 60 min. The detention time depends on the sludge characteristics, temperature and the level of hydrolysis required.

10.3.2.4.6 Hot Water Recirculation Pump

The hot water recirculation pump shall be capable of handling hot water at a temperature of 25 to 65°C.

10.3.2.4.7 Odour Control

Heat conditioning, particularly the non-oxidative process, can result in the production of odorous gases in the decant tank. If ultimate sludge disposal is via incineration, these gases can be incinerated in the upper portion of the furnace. If incineration is not a part of the sludge handling process, a catalytic or other type of oxidating unit should be used.

10.3.2.4.8 Solvent Cleaning

Scale formation in the heat exchangers, pipes and reaction vessel require acid washing equipment to be provided.

10.3.2.4.9 *Piping*

All the high pressure piping for the sludge heat conditioning system shall be tested at a pressure of 3500 kPa. Low pressure piping shall be tested at 1.5 times the working pressure or 1400 kPa, whichever is greater.

10.3.2.4.10 *Decant Tank*

The decant tank functions as a storage and sludge consolidation unit. The tank should be covered and provided with venting and a deodorization arrangement. The tank should be designed using loadings of 245 $kg/m^2/d$ for primary sludge and 145 $kg/m^2/d$ for biological sludges. The underflow will range from 10 to 15 percent TS.

10.3.2.5 ***Laboratory Testing***

Since process efficiency is dependent on achieving a degree of solubilization (hydrolysis) that reduces the specific resistant to an acceptable range, batch testing with a laboratory autoclave should be employed. This procedure permits accurate control of the time and temperature functions affecting the level of hydrolysis. The level of solubilization is determined from the loss of TSS during heat treatment.

10.3.3 **Addition of Admixtures**

Another common form of physical conditioning is the addition of admixtures such as fly ash, incinerator ash, diatomaceous earth, or waste paper. These conditioning techniques are most commonly used with filter presses or vacuum filters. The admixtures when added in sufficient quantities produce a porous lattice structure in the sludge which results in decreased compressibility and improved filtering characteristics. When considering such conditioning techniques, the beneficial and detrimental effects of the admixture on such parameters as overall sludge mass, calorific value, etc., must be evaluated along with the effects on improved solids content.

10.4 SLUDGE THICKENING

10.4.1 **General**

10.4.1.1 ***Applicability***

As the first step of sludge handling, the need for sludge thickeners to reduce the volume of sludge should be considered.

The design of thickeners (gravity, dissolved-air flotation, centrifuge and others) should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs and the cost of operation. Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions. Sludge thickening to at least 5% solids prior to transmission to digesters should be considered.
Wherever possible, pilot-plant and/or bench-scale data should be used for the design of

sludge thickening facilities. With new plants, this may not always be possible and, in such cases, empirical design parameters must be used. The following subsections outline the normal ranges for the design parameters of such equipment.

In considering the need for sludge thickening facilities, the designer should evaluate the economics of the overall treatment processes, with and without facilities for sludge water content reduction. This evaluation should consider both capital and operating costs of the various plant components and sludge disposal operations affected.

10.4.1.2 Multiple Units

With sludge thickening equipment, multiple units will generally be required unless satisfactory sludge storage facilities or alternate sludge disposal methods are available for use during periods of equipment repair. Often the need for full standby units will be unnecessary if the remaining duty units can be operated for additional shifts in the event of equipment breakdown.

10.4.2 Thickener Location

Sludge thickening can be employed in the following locations in a sewage treatment plant:

- prior to digestion for raw primary, excess activated sludge or mixed sludges;
- prior to dewatering facilities;
- following digestion for sludges or supernatant; or
- following dewatering facilities for concentration of filtrate, decant, centrate, etc.

Where thickeners are to be housed, adequate ventilation shall be provided.

10.4.3 Thickening Methods and Performance With Various Sludge Types

The commonly employed methods of sludge thickening and their suitability for the various types of sludge are shown in Table 10.2 In selecting a design figure for the thickened sludge concentration, the designer should keep in mind that all thickening devices are adversely affected by high Sludge Volume Indices (SVI's) and benefitted by low SVI's in the influent activated sludges. The ranges of thickened sludge concentrations given in Table 10.2 assume an SVI of approximately 100.

TABLE 10.2 - SLUDGE THICKENING METHODS AND PERFORMANCE WITH VARIOUS SLUDGE TYPES		
THICKENING METHOD	SLUDGE TYPE	PERFORMANCE EXPECTED
GRAVITY	Raw Primary	Good, 8-10% Solids
	Raw Primary and Waste Activated	Poor, 5-8% Solids
	Waste Activated	Very Poor, 2-3% Solids (Better results reported for oxygen excess activated sludge)
	Digested Primary Digested Primary and Waste Activated	Very Good, 8-14% Solids
DISSOLVED AIR FLOTATION	Waste Activated (Not generally used for other sludge types)	Good, 4-6% Solids and ≥ 95% Solids Capture With Flotation Aids.
CENTRIFUGATION	Waste Activated	8-10% and 80-90% Solids Capture with Basket Centrifuges; 4-6% and 80-90% Solids Capture with Disc-nozzle Centrifuges; 5-8% and 70-90% Solids Capture with Solid Bowl Centrifuges

10.4.4 Sludge Pretreatment

Wherever thickening devices are being installed, special consideration must be given to the need for sludge pretreatment in the form of sludge grinding to avoid plugging pumps, lines and thickening equipment. Sludge conditioning by chemical conditioning is also considered as a type of pretreatment.

10.4.5 Gravity Thickening

10.4.5.1 Process Application

Gravity thickening is principally used for primary sludge, and mixtures of primary and waste activated sludges, with little use for waste activated sludges alone. Due to the better performance of other methods for waste activated sludges, gravity thickening has limited application for such sludges.

10.4.5.2 Design Criteria

10.4.5.2.1 Tank Shape

The gravity thickener shall be circular in shape.

10.4.5.2.2 *Tank Dimensions*

Typical maximum tank diameters should range between 21 and 24 m. Sidewater depth shall be between 3 and 3.7 m.

10.4.5.2.3 *Floor Slope*

The acceptable range for gravity sludge thickener floor slopes is 2:12 to 3:12.

10.4.5.2.4 *Solids Loading*

The type of sludge shall govern the design value for solids loading to the gravity thickener. Table 10.3 outlines recommended solids loading values.

TABLE 10.3 - SOLIDS LOADING ON GRAVITY THICKENERS FOR VARIOUS SLUDGE TYPES

TYPE OF SLUDGE	SOLIDS LOAD (kg/m^2.day) ACCEPTABLE RANGE
PRIMARY	95 - 120
WASTE ACTIVATED	12 - 40
MODIFIED ACTIVATED	50 - 100
TRICKLING FILTER	40 - 50

Solids loading for any combination of primary sludge and waste activated sludge shall be based on a weighted average of the above loading rates.

Use of metal salts for phosphorus removal may affect the solids loading rates.

10.4.5.2.5 *Dilution*

Improved thickening is achieved by diluting sludge to 0.5 to 1% solids because that dilution reduces the interface between the settling particles. Primary sewage effluent or secondary effluent may be utilized to dilute sludge before thickening.

10.4.5.2.6 *Hydraulic Overflow Rate*

The hydraulic overflow rate shall be kept sufficiently high to prevent septic conditions from developing in the thickener. The acceptable ranges for overflow rates are as follows:

Primary Sludge	0.28-0.38 L/m^{2}s
Secondary Sludge	0.22-0.34 L/m^{2}s
Mixture	0.25-0.36 L/m^{2}s

10.4.5.2.7 Sludge Volume Ratio

The sludge volume ratio (SVR) is defined as the volume of the sludge blanket divided by the daily volume of sludge (underflow) pumped from the thickener. Though deeper sludge blankets and longer SVR are desirable for maximum concentrations, septic conditions due to anaerobic biodegradation on warmer months limit the upper values of SVR to about 2 days.

	Warmer Months	Colder Months
Recommended SVR values (days)	0.3 to 1	0.5 to 2

10.4.5.2.8 Hydraulic Retention Time

A minimum of 6 hr. detention of liquid is required. For maximum compaction of the sludge blanket, 24 hrs. is the recommended time required.

During peak conditions, the retention time may have to be shortened to keep the sludge blanket depth below the overflow weirs, thus, preventing excessive solids carry-over.

10.4.5.2.9 Sludge Underflow Piping

The length of suction lines should be kept as short as possible. Consideration should be given to the use of dual sludge withdrawal lines.

10.4.5.2.10 Chemical Conditioning

Provision should be made for the addition of conditioning chemicals into the sludge influent lines (polymers, ferric chloride or lime are the most likely chemicals to be used to improve solids capture).

10.4.5.2.11 Mechanical Rake

The mechanical rake should have a tip speed of 50 to 100 mm/s. The rake shall be equipped with hinged-lift mechanisms when handling heavy sludges such as lime treated primary sludge. The use of a surface skimmer is recommended.

10.4.5.2.12 Overflow Handling

The normal quality of thickener overflow (also known as thickener overhead or supernatant) is about the same as raw sewage quality. Consequently, returning the overflow to primary settling tank or aeration tank should not present any operational problem.

Direct recycling of thickener overflow to the grit chamber, primary settling tank, trickling filter, RBC or aeration tank is permitted. The supernatant shall not be discharged into the secondary settling tank, disinfection tank, sewer outfall, or receiving water.

10.4.6 **Air Flotation**

10.4.6.1 ***Applicability***

Unlike heavy sludges, such as primary and mixtures of primary and excess activated sludges, which are generally most effectively thickened in gravity thickeners, light excess activated sludges can be successfully thickened by flotation. In general, air flotation thickening can be employed whenever particles tend to float rather, than sink. These procedures are also applied if the materials have a long subsidence period and resist compaction for thickening by gravity.

The advantages of air flotation compared with gravity thickeners for excess activated sludges include its reliability, production of higher sludge concentrations, and better solids capture. Its disadvantages include the need for greater operating skill and higher operating costs.

10.4.6.2 ***Pilot Scale Testing***

Experience has shown that flotation operations cannot be designed on the basis of purely mathematical formulations or by the use of generalized design parameters, and therefore some bench-scale and/or pilot-scale testing will be necessary.

10.4.6.3 ***Design Parameters***

The following design parameters are given only as a guide to indicate the normal range of values experienced in full-scale operations.

10.4.6.3.1 *Recycle Ratio*

The recycle ratio varies with suppliers and typically falls between 0 and 500% of the influent flow. Recycled flows may be pressurized up to 520 kPa.

10.4.6.3.2 *Air to Solids Weight Ratio*

Typical air to solids weight ratios shall be between 0.02 and 0.05.

10.4.6.3.3 *Feed Concentration*

Feed concentration of activated sludge (including recycle) to the flotation compartment should not exceed 5000 mg/L.

10.4.6.3.4 *Hydraulic Feed Rate*

Where the hydraulic feed rate includes influent plus recycle, the flotation units shall be designed hydraulically to operate in the range of 0.3 to 1.5 $L/m^2/s$. A maximum hydraulic loading rate of 0.5 $L/m^2/s$ shall be adhered to when no coagulant aids are used to improve flotation. The feed rate should be continuous rather than on-off.

10.4.6.3.5 Solids Loading

Without any addition of flocculating chemicals, the solids loading rate for activated sludge to a flotation unit should be between 40 and 100 kg/m^2/d. With the proper addition of flocculating chemicals, the solids loading rate may be increased to 240 kg/m^2/d. These loading rates will generally produce a thickened sludge of 3 to 5 percent total solids.

10.4.6.3.6 Chemical Conditioning

Chemicals used as coagulant aids shall be fed directly to the mixing zone of the feed sludge and recycle flow.

10.4.6.3.7 Detention Time

Detention time is not critical provided particle rise rate is sufficient and horizontal velocity in the unit does not produce scouring of the sludge blanket.

10.4.6.4 Thickened Sludge Withdrawal

The surface skimmer shall move thickened sludge over the dewatering beach into the sludge hopper. Either positive displacement, or centrifugal pumps which will not air bind should be used to transfer sludge from the hopper to the next phase of the process.

In selecting pumps, the maximum possible sludge concentrations should be taken into consideration.

10.4.6.5 Bottom Sludge

A bottom collector to move draw off settled sludge into a hopper must be provided. Draw off from the hopper may be by gravity or pumps.

10.4.7 Centrifugation

10.4.7.1 Types of Centrifuges

Three types of centrifuges may be utilized for sludge thickening. These include the solid bowl conveyor, disc-nozzle and basket centrifuges.

10.4.7.2 Applicability

To date, there has only been limited application of centrifuges for sludge thickening, despite their common use for sludge dewatering. As thickening devices, their use has been generally restricted to excess activated sludges.

In the way of general comments, the following are given:

- centrifugal thickening operations can have substantial maintenance and operating costs;

- where space limitations, or sludge characteristics make other methods unsuitable, or where high-capacity mobile units are needed, centrifuges have been used; and
- thickening capacity, thickened sludge concentration and solids capture of a centrifuge are greatly dependent on the SVI of the sludge.

10.4.7.3 *Solids Recovery*

Eighty-five to ninety-five percent solids recovery will generally be the most suitable operation range.

10.4.7.4 *Polymer Feed Range*

A polymer feed range of 0 to 4.0 g/kg of dry solids is generally acceptable.

10.5 ANAEROBIC SLUDGE DIGESTION

10.5.1 General

10.5.1.1 *Applicability*

Anaerobic digestion may be considered beneficial for sludge stabilization when the sludge volatile solids content is 50% or higher and if no inhibitory substances are present or expected. Anaerobic digestion of primary sludge is preferred over activated sludge because of the poor solids-liquid separation characteristics of activated sludges. Combining primary and secondary sludges will result in settling characteristics better than activated sludge but less desirable than primary alone. Chemical sludges containing lime, alum, iron, and other substances can be successfully digested if the volatile solids content remains high enough to support the biochemical reactions and no toxic compounds are present. If an examination of past sludge characteristics indicates wide variations in sludge quality, anaerobic digestion may not be feasible because of its inherent sensitivity to changing substrate quality. Table 10.4 lists sludges which are suitable for anaerobic digestion.

TABLE 10.4 - SLUDGES SATISFACTORY FOR ANAEROBIC DIGESTION
PRIMARY AND LIME
PRIMARY AND FERRIC CHLORIDE
PRIMARY AND ALUM
PRIMARY AND TRICKLING FILTER
PRIMARY, TRICKLING FILTER, AND ALUM
PRIMARY AND WASTE ACTIVATED
PRIMARY, WASTE ACTIVATED, AND LIME
PRIMARY, WASTE ACTIVATED, AND ALUM
PRIMARY, WASTE ACTIVATED, AND FERRIC CHLORIDE
PRIMARY, WASTE ACTIVATED, AND SODIUM ALUMINATE
WASTE ACTIVATED ONLY (PILOT PLANT ONLY)

The advantages offered by anaerobic digestion include:

- Excess energy over that required by the process is produced. Methane is produced and can be used to heat and mix the reactor. Excess methane gas can be used to heat space or produce electricity, or as engine fuel.
- The quantity of total solids for ultimate disposal is reduced. The volatile solids present are converted to methane, carbon dioxide, and water thereby reducing the quantity of solids. About 30 to 40% of the total solids may be destroyed and 40 to 60% of the volatile solids may be destroyed.
- The product is a stabilized sludge that may be free from strong or foul odours and can be used for land application as ultimate disposal because the digested sludge contains plant nutrients.
- Pathogens are destroyed to a high degree during the process. Thermophilic digestion enhances the degree of pathogen destruction.
- Most organic substances found in municipal sludge are readily digestible except lignins, tannins, rubber, and plastics.

The disadvantages associated with anaerobic digestion include:

- The digester is easily upset by unusual conditions and erratic or high loadings and very slow to recover.
- Operators must follow proper operating procedures.
- Heating and mixing equipment are required for satisfactory performance.
- Large reactors are required because of the slow growth of methanogens and required solid retention times (SRT's) of 15 to 20 days for a high-rate system. Thus capital cost is high.

- The resultant supernatant sidestream is a strong waste stream that greatly adds to the loading of the wastewater plant. It contains high concentrations of BOD, COD, suspended solids and ammonia nitrogen.

- Cleaning operations are difficult because of the closed vessel. Internal heating and mixing equipment can become major problems as a result of corrosion and wear in harsh inaccessible environments.

- A sludge poor in dewatering characteristics is produced.

- The possibility of explosion as a result of inadequate operation and maintenance, leaks, or operator carelessness exists.

- Gas line condensation or clogging can cause major maintenance problems.

10.5.1.2 Digestion Tanks and Number of Stages

With anaerobic sludge digestion facilities, the need for multiple units can often be avoided by providing two-stage digestion along with sufficient flexibility in sludge pumpage and mixing so that one stage can be serviced while the other stage receives the raw sludge pumpage. Single stage digesters will generally not be satisfactory due to the usual need for sludge storage, and effective supernating. They will be considered, however, where the designer can show that the above concerns can be satisfied and that alternate means of sludge processing or emergency storage can be used in the event of breakdown.

10.5.1.3 Access Manholes

At least two, 1-meter diameter access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole shall be provided. The opening should be large enough to permit the use of mechanical equipment to remove grit and sand. This manhole shall be located near the bottom of the sidewall. All manholes shall be provided with gas-tight and water-tight covers.

10.5.1.4 Safety

Non-sparking tools, safety lights, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases and at least two self-contained breathing units shall be provided for workers involved in cleaning the digesters.

Necessary safety facilities shall be included where sludge gas is produced. All tank covers shall be provided with pressure and vacuum relief valves and flame traps together with automatic safety shut-off valves. Water seal equipment shall not be installed.

10.5.2 Field Data

Wherever possible, such as in the case of plant expansions, actual sludge quantity data should be considered for digester design. Often, due to errors introduced by poor sampling techniques, inaccurate flow measurements or unmeasured sludge flow streams, the sludge data from existing plants may be unsuitable for use in design. Therefore, before sludge data is used for design, it should be assessed for its accuracy.

10.5.3. Typical Sludge Qualities and Generation Rates for Different Unit Processes

When reliable data are not available, the sludge generation rates and characteristics given in Table 10.5 may be used.

TABLE 10.5 - TYPICAL SLUDGE QUALITIES AND GENERATION RATES FOR DIFFERENT UNIT PROCESSES

UNIT PROCESS	LIQUID SLUDGE	SOLIDS CONCENTRATION		VOLATILE SOLIDS	DRY SOLIDS	
	(L/cu.m)	RANGE (%)	AVERAGE (%)	(%)	(g/cu. m)	(g/cap/day)
PRIMARY SEDIMENTATION WITH ANAEROBIC DIGESTION						
UNDIGESTED (NO P REMOVAL)	2.0	(3.5-8)	5.0	65	120	55
UNDIGESTED (WITH P REMOVAL)	3.2	(3.5-7)	4.5	65	170	77
DIGESTED (NO P REMOVAL)	1.1	(5-13)	6.0	50	75	34
DIGESTED (WITH P REMOVAL)	1.6	(5-13)	5.0	50	110	50
PRIMARY SEDIMENTATION AND CONVENTIONAL ACTIVATED SLUDGE WITH ANAEROBIC DIGESTION						
UNDIGESTED (NO P REMOVAL)	4.0	(2-7)	4.5	65	180	82
UNDIGESTED (WITH P REMOVAL)	5.0	(2-6.5)	4.0	60	220	100
DIGESTED (NO P REMOVAL)	2.0	(2-6)	5.0	50	115	52
DIGESTED (WITH P REMOVAL)	3.5	(2-6)	4.0	45	150	68
CONTACT STABILIZATION AND HIGH RATE WITH AEROBIC DIGESTION						
UNDIGESTED (NO P REMOVAL)	15.5	(0.4-2.8)	1.1	70	170	77
UNDIGESTED (WITH P REMOVAL)	19.1	(0.4-2.8)	1.1	60	210	95
DIGESTED (NO P REMOVAL)	6.1	(1-3)	1.9	70	115	52
DIGESTED (WITH P REMOVAL)	8.1	(1-3)	1.9	60	155	70
EXTENDED AERATION WITH AERATED SLUDGE HOLDING TANK						
WASTE ACTIVATED (NO P REMOVAL)	10.0	(0.4-1.9)	0.9	70	90	41
WASTE ACTIVATED (WITH P REMOVAL)	13.3	(0.4-1.9)	0.9	60	120	55
SLUDGE HOLDING TANK (NO P REMOVAL)	4.0	(0.4-5.0)	2.0	70	80	36
SLUDGE HOLDING TANK (WITH P REMOVAL)	5.5	(0.4-4.5)	2.0	60	110	50

NOTE:

1. (L/cu. m) DENOTES LITRES OF LIQUID SLUDGE PER CUBIC METRE OF TREATED SEWAGE
2. (g/cu. m) DENOTES GRAMS OF DRY SOLIDS PER CUBIC METRE OF TREATED SEWAGE
3. THE ABOVE VALUES ARE BASED ON TYPICAL RAW SEWAGE WITH TOTAL BOD = 170 mg/L, SOLUBLE BOD = 50%, SS = 200 mg/L, P = 7 mg/L, NH4 = 20 mg/L

10.5.4 Solids Retention Time

The minimum solids retention time for a low rate digester shall be 30 days. The minimum solids retention time of a high rate digester shall be 15 days.

10.5.5 Design of Tank Elements

10.5.5.1 Digester Shape

Anaerobic digesters are generally cylindrical in shape with inverted conical bottoms. Heat loss from digesters can be minimized by choosing a proper depth-diameter ratio such that the total surface area is the least for a given volume. A cylinder with diameter equal to depth can be shown to be the most economical shape from heat loss viewpoint. However, structural requirements and scum control aspects also govern the optimum depth-diameter ratio.

10.5.5.2 Floor Shape

To facilitate draining, cleaning and maintenance, the following features are desirable:

The tank bottom should slope to drain toward the withdrawal pipe. For tanks equipped with mechanisms for withdrawal of sludge, a bottom slope not less than 1:12 (vertical:horizontal) is recommended. Where the sludge is to be removed by gravity alone, 1:4 slope is recommended.

10.5.5.3 Depth and Freeboard

For those units proposed to serve as supernatant development tanks, the depth should be sufficient to allow for the formation of a reasonable depth of supernatant liquor. A minimum water depth of 6 meters is recommended. The acceptable range for sidewater depth is between 6 and 14 m.

The freeboard provided must take into consideration the type of cover and maximum gas pressure. For floating covers, the normal working water level in the tank under gas pressure is approximately 0.8 m below the top of the wall, thus providing from 0.5 to 0.6 m of freeboard between the liquid level and the top of the tank wall. For fixed flat slab roofs, a freeboard of 0.3 to 0.6 m above the working liquid level is commonly provided. For fixed conical or domed roofs, the freeboard between the working liquid level and the top of the wall inside the tank can be reduced to less than 0.3 m.

10.5.5.4 Scum Control

Scum accumulation can be controlled by including any of the following provisions in the equipment design:

a. Floating covers keep the scum layer submerged and thus moist and more likely to be broken up;

b. Discharging recirculated sludge on the scum mat serves the same purpose as (a);

c. Recirculating sludge gas under pressure through the tank liquors and scum;

d. Mechanically destroying the scum by employing rotating arms or a propeller in a draft tube;

e. A large depth-area ratio; or

f. A concentrated sludge feed to the digester.

Items (e) and (f) would release large volumes of gas per unit area, keep the scum in motion and mix the solids in the digester.

10.5.5.5 *Grit and Sand Control*

The digesters should be designed to minimize sedimentation of the particles and facilitate removal if settling takes place. These objectives can be achieved if tank contents are kept moving at 0.23 to 0.3 m/s and the floor slopes are about 1:4.

10.5.5.6 *Alkalinity and pH Control*

The effective pH range for methane producers is approximately 6.5 to 7.5 with an optimum range of 6.8 to 7.2. Maintenance of this optimum range is important to ensure good gas production and to eliminate digester upsets.

The stability of the digestion process depends on the buffering capacity of the digester contents; the ability of the digester contents to resist pH changes. The alkalinity is a measure of the buffer capacity of a freshwater system. Higher alkalinity values indicate a greater capacity for resisting pH changes.. The alkalinity shall be measured as bicarbonate alkalinity. Values for alkalinity in anaerobic digesters range from 1500 to 5000 mg/L as $CaCO_3$. The volatile acids produced by the acid producers tend to depress pH. Volatile acid concentrations under stable conditions range from 100 to 500 mg/L. Therefore, a constant ratio below 0.25 of volatile acids to alkalinity shall be maintained so that the buffering capacity of the system can be maintained.

Sodium bicarbonate, lime, sodium carbonate, and ammonium hydroxide application are recommended for increasing alkalinity of digester contents.

10.5.5.7 *Mixing*

Thorough mixing via digester gas (compressor power requirement 5 to 8 W/m^3) or mechanical means (6.6 W/m^3) in the primary stage will be necessary in all cases when digesters are proposed. This mixing shall assure the homogeneity of the digester contents, and prevent stratification.

Gas mixing methods are preferred. Gas mixing may be accomplished in any one of the following manners:

a. Short mixing tubes;
b. One or more deep-draft tubes;
c. Diffusers at the digester floor; or
d. Gas discharge below scum level.

10.5.5.8 ***Sludge Inlets, Outlets, Recirculation, and High Level Overflow***

10.5.5.8.1 *Multiple Inlets and Draw-Offs*

Multiple sludge inlets and draw-offs and, where used, multiple recirculation suction and discharge points to facilitate flexible operation and effective mixing of the digester contents, shall be provided unless adequate mixing facilities are provided within the digester.

10.5.5.8.2 *Inlet Configurations*

One inlet should discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. The second inlet should be opposite to the suction line at approximately the _ diameter point across the digester.

10.5.5.8.3 *Inlet Discharge Location*

Raw sludge inlet discharge points should be so located as to minimize short circuiting to the digester sludge or supernatant draw-offs.

10.5.5.8.4 *Sludge Withdrawal*

Sludge withdrawal to disposal should be from the bottom of the tank. The bottom withdrawal pipe should be interconnected with the necessary valving to the recirculation piping, to increase operational flexibility in mixing the tank contents.

10.5.5.8.5 *Emergency Overflow*

An unvalved vented overflow shall be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. This emergency overflow shall be piped to an appropriate point and at an appropriate rate in the treatment process or sidestream treatment facilities to minimize the impact on process units.

10.5.5.9 ***Primary Tank Capacity***

The primary digestion tank capacity should be determined by rational calculations based upon such factors as volume of sludge added, its percent solids and character, the temperature to be maintained in the digesters, the degree or extent of mixing to be obtained and the degree of volatile solids reduction required. Calculations shall be submitted to justify the basis of design.

When such calculations are not based on the above factors, the minimum primary digestion tank capacity outlined in Design Sections 10.5.5.9.1 and 10.5.5.9.2 will be required. Such requirements assume that a raw sludge is derived from ordinary domestic wastewater, that a digestion temperature is to be maintained in the range of 32°C to 39°C, that 40 to 50 percent volatile matter will be maintained in the digested sludge and that the digested sludge will be removed frequently from the system.

10.5.5.9.1 *High Rate Digester*

The primary high rate digester shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity of digester content. The system may be loaded at a rate up to 1.6 kg of volatile solids per cubic meter of volume per day in the active digestion unit. When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered.

10.5.5.9.2 *Low Rate Digester*

For low rate digesters where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded up to 0.64 kg of volatile solids per cubic meter of volume per day in the active digestion unit. This loading may be modified upward or downward depending upon the degree of mixing provided.

10.5.5.10 ***Secondary Digester Sizing***

The secondary digester should be sized to permit solids settling for decanting and solids thickening operations, and in conjunction with possible off-site facilities, to provide the necessary digested sludge storage. The necessary total storage time will depend upon the means of ultimate sludge disposal, with the greatest time required with soil conditioning operations (winter storage), and with less storage required with landfilling or incineration ultimate disposal methods. Offsite storage in sludge lagoons, sludge storage tanks, or other facilities may be used to supplement the storage capacity of the secondary digester. If high-rate primary digesters are used and efficient dewatering within the secondary digester is required, the secondary digester must be conservatively sized to allow adequate solids separation (secondary to primary sizing ratios of 2:1 to 4:1 are recommended).

10.5.5.11 ***Digester Covers***

To provide gas storage volume and to maintain uniform gas pressures, a separate gas storage sphere should be provided, or at least one digester cover should be of the gas-holder floating type. If only one floating cover is provided, it shall be on the secondary digester. Insulated pressure and vacuum relief valves and flame traps shall be provided. Access manholes and at least two 200 mm sampling wells should also be provided on the digester covers.

Steel is the most commonly used material for digester covers. However, other properly designed and constructed materials can also be successfully employed, such as concrete and fibreglass.

10.5.5.12 ***Sludge Piping***

Maximum flexibility should be provided in terms of sludge transfer from primary and secondary treatment units to the digesters, between the primary and secondary digesters, and from the digesters to subsequent sludge handling operations. The minimum diameter of sludge pipes shall be 200 mm for gravity withdrawal and 150 mm for pump suction and discharge lines. Provision should be made for flushing and cleaning sludge piping. Sampling points should be provided on all sludge lines. Main sludge transfer lines should be from the bottom of the primary digester to the mid-point of the secondary digester. Additional transfer lines should be from intermediate points in the primary digester (these can be dual-purpose supernatant and sludge lines).

10.5.5.13 *Overflows*

Each digester should be equipped with an emergency overflow system.

10.5.6 **Gas Collection, Piping and Appurtenances**

10.5.6.1 *General*

All portions of the gas system including the space above the tank liquor, storage facilities and piping shall be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated. All gas collection equipment, piping and appurtenances shall comply with the Canadian Gas Association Standard B105-M87.

10.5.6.2 *Safety Equipment*

All necessary safety facilities shall be included where gas is produced. Pressure and vacuum relief valves and flame traps together with automatic safety shut-off valves, are essential. Water seal equipment shall not be installed. Gas safety equipment and gas compressors should be housed in a separate room with an exterior entrance.

Provision should also be made for automatically purging the combustion chamber of the heating unit thoroughly with air after a shut-down or pilot light failure, and before it can be ignited. This will provide certainty that no explosive mixture exists within the unit.

10.5.6.3 *Gas Piping and Condensate*

The main gas collector line from the digestion tanks shall be at least 64 mm in diameter with the gas intake being well above the digester scum level, generally at least 1.2 m above the maximum liquid level in the tank. If gas mixing is used, the gas withdrawal pipe must be of sufficient size to limit the pressure drop in terms of the total gas flow from the digester. Such flow includes not only the daily gas production, but also the daily gas recycling flow. The recycling gas flow information should be combined with the estimate peak daily gas flow data to determine the proper piping size.

Gas pipe slopes of 20 mm/m are desirable with a minimum slope of 10 mm/m for drainage. The maximum velocity in sludge-gas piping shall be limited to not more than 3.4 or 3.7 m/s.

Gas piping shall slope to condensation traps at low points. The use of float controlled condensate traps is not permitted.

Adequate pipe support is essential to prevent breaking, and special care should be given where pipes are located underground.

Gas piping and pressure relief valves must include adequate flame traps. They should be installed as close as possible to the device serving as a source of ignition.

10.5.6.4 *Gas Utilization Equipment*

Gas burning boilers, engines, etc., should be located at ground level and in well ventilated rooms, not connected to the digester gallery. Gas lines to these units shall be provided with suitable flame traps.

10.5.6.5 *Electrical Systems*

Electrical fixtures and controls, in places enclosing anaerobic digestion appurtenances, where hazardous gases are normally contained in the tanks and piping, shall comply with the Canadian Electrical Code, Part 1 and the Nova Scotia Power Standards. Digester galleries should be isolated from normal operating areas.

10.5.6.6 *Waste Gas*

Waste gas burners shall be readily accessible and should be located at least 15 m away from any plant structure if placed at ground level, or may be located on the roof of the control building if sufficiently removed from the tank. In remote locations it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least 3 m above the walking surface, provided the assembly incorporates a flame trap. Waste gas burners shall be of sufficient height and so located to prevent injury to personnel due to wind or downdraft conditions.

All waste gas burners shall be equipped with automatic ignition, such as a pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to insure reliability of the pilot light.

Provision for condensate removal, pressure control, and flame protection ahead of waste burners is always required.

10.5.6.7 *Ventilation*

Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment shall be provided with forced ventilation in accordance with Design Sections 2.2.7.1 and 2.2.7.3. Tightly fitting self-closing doors should be provided at connecting passageways and tunnels to minimize the spread of gas.

10.5.6.8 *Meter*

A gas meter with bypass shall be provided, to meter total gas production for each active digestion unit. Total gas production for two-stage digestion systems operated in series may be measured by a single gas meter with proper interconnected gas piping.

Where multiple primary digestion units are utilized with a single secondary digestion unit, a gas meter shall be provided for each primary digestion unit. The secondary digestion unit may be interconnected with the gas measurement unit of one of the primary units. Interconnected gas piping shall be properly valved with gas tight gate valves to allow measurement of gas production from either digestion unit or maintenance of either digestion unit.

Gas meters may be of the orifice plate, turbine or vortex type. Positive displacement meters should not be utilized. The meter must be specifically designed for contact with corrosive and dirty gases.

10.5.7 Digestion Tank Heating

10.5.7.1 Heating Capacity

10.5.7.1.1 Capacity

Sufficient heating capacity shall be provided to consistently maintain the design sludge temperature considering insulation provisions and ambient cold weather conditions. Where digestion tank gas is used for other purposes, an auxiliary fuel may be required.

10.5.7.2 Insulation

Wherever possible, digestion tanks should be constructed above ground-water level and should be suitably insulated to minimize heat loss.

10.5.7.3 Heating Facilities

Sludge may be heated by circulating the sludge through external heaters or by heating units located inside the digestion tank. The external heat exchanger systems are preferred.

10.5.7.3.1 External Heating

Piping shall be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions shall be made in the lay-out of the piping and valving to facilitate heat exchanger tube removal and cleaning of these lines. Heat exchanger sludge piping shall be sized for peak heat transfer requirements. Heat exchangers should have a heating capacity of 130 percent of the calculated peak heating requirement to account for the occurrence of sludge tube fouling.

10.5.7.3.2 Other Heating Methods

a. The use of hot water heating coils affixed to the walls of the digester, or other types of internal heating equipment that require emptying the digester contents for repair, are not acceptable.

b. Other systems and devices have been developed recently to provide both mixing and heating of anaerobic digester contents. These systems will be reviewed on their own merits. Operating data detailing their reliability, operation, and maintenance characteristics will be required.

10.5.7.4 *Hot Water Internal Heating Controls*

10.5.7.4.1 *Mixing Valves*

A suitable automatic mixing valve shall be provided to temper the boiler water with return water so that the inlet water to the removable heat jacket or coils in the digester can be held below a temperature at which caking will be accentuated. Manual control should also be provided by suitable by-pass valves.

10.5.7.4.2 *Boiler Controls*

The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 80°C to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, excessive temperature, or low gas pressure.

10.5.7.4.3 *Boiler Water Pumps*

Boiler water pumps shall be sealed and sized to meet the operating conditions of temperature, operating head, and flow rate. Duplicate units shall be provided.

10.5.7.4.4 *Thermometers*

Thermometers should be provided to show inlet and outlet temperatures of sludge, hot water feed, hot water return and boiler water.

10.5.7.4.5 *Water Supply*

The chemical quality should be checked for suitability for this use.

10.5.7.5 *External Heater Operating Controls*

All controls necessary to insure effective and safe operation are required. Provision for duplicate units in critical elements should be considered.

10.5.8 **Supernatant Withdrawal**

10.5.8.1 *Piping Size*

Supernatant piping should not be less than 150 mm in diameter. Precaution must be taken to avoid loss of digester gas through supernatant piping.

10.5.8.2 *Withdrawal Arrangement*

10.5.8.2.1 *Withdrawal Levels*

Piping should be arranged so that withdrawal can be made from three or more levels in the tank. A positive unvalved vented overflow shall be provided.

Both primary and secondary digesters should be equipped with supernating lines, so that during emergencies the primary digester can be operated as a single stage process.

10.5.8.2.2 *Supernatant Selector*

A fixed screen supernatant selector or similar type device shall be limited for use in an unmixed secondary digestion unit.

If a supernatant selector is provided, provisions shall be made for at least one other draw-off level located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe. High pressure back-wash facilities shall be provided.

10.5.8.2.3 *Withdrawal Selection*

On fixed cover tanks the supernatant withdrawal level should preferably be selected by means of interchangeable extensions at the discharge end of the piping.

10.5.8.3 *Sampling*

Provision should be made for sampling at each supernatant draw-off level. Sampling pipes should be at least 40 mm in diameter and should terminate at a suitably-sized sampling sink or basin.

10.5.8.4 *Alternate Supernatant Disposal*

An alternate disposal method for the supernatant liquor such as a lagoon, an additional sand bed or hauling from the plant site should be provided for use in case supernatant is not suitable or other conditions make it advisable not to return it to the plant. Consideration should be given to supernatant conditioning where appropriate in relation to its effect on plant performance and effluent quality.

10.5.9 Sludge Sampling Requirements

An adequate number of sampling pipes at proper locations should enable the operator to assess the quality of the contents and to know how much sludge is in the digesters. The following requirements shall govern the design:

a. To avoid clogging, sludge sampling pipes should be at least 75 mm in diameter;

b. Provision should be made for the connection of a water source of adequate pressure to these pipes for back flushing when the need arises; and

c. There shall be at least three sampling pipes each separately valved for the primary digesters and four for the secondary digesters.

10.6 AEROBIC SLUDGE DIGESTION

10.6.1 General

Aerobic digestion is accomplished in single or multiple tanks, designed to provide effective air mixing, reduction of the organic matter, supernatant separation and sludge concentration under controlled conditions.

10.6.2 Applicability

Aerobic digestion is considered suitable for secondary sludge or a combination of primary and secondary sludge. Table 10.6 presents the advantages and disadvantages in the use of aerobic sludge digestion.

TABLE 10.6 - ADVANTAGES AND DISADVANTAGES OF AEROBIC SLUDGE DIGESTION

ADVANTAGES	DISADVANTAGES
LOW INITIAL COST PARTICULARLY FOR SMALL PLANTS	HIGH ENERGY COSTS
SUPERNATANT LESS OBJECTIONABLE THAN ANAEROBIC	GENERALLY LOWER VSS DESTRUCTION THAN ANAEROBIC
SIMPLE OPERATIONAL CONTROL	REDUCED pH AND ALKALINITY
BROAD APPLICABILITY	POTENTIAL FOR PATHOGEN SPREAD THROUGH AEROSOL DRIFT
IF PROPERLY DESIGNED, DOES NOT GENERATE NUISANCE ODOURS	SLUDGE IS TYPICALLY DIFFICULT TO DEWATER BY MECHANICAL MEANS
REDUCES TOTAL SLUDGE MASS	COLD TEMPERATURES ADVERSELY AFFECT PERFORMANCE

10.6.3 Field Data

Wherever possible, such as in the case of plant expansions, actual sludge quantity data should be considered for digester design. Often, due to errors introduced by poor sampling techniques, inaccurate flow measurements or unmeasured sludge flow streams, the sludge data from existing plants may be unsuitable for use in design. Before sludge data is used for design, it should be assessed for its accuracy.

10.6.4 Multiple Units

Multiple digestion units capable of independent operation are desirable and shall be provided in all plants where the design average flow exceeds 455 m^3/d (100,000 IGpd). All plants not having multiple units shall provide alternate sludge handling and disposal methods.

10.6.5 Pretreatment

Thickening of sludge is recommended prior to aerobic digestion.

10.6.6 Design Considerations

Factors which should be considered when designing aerobic digesters include:

a. the type of sludge to be digested;
b. the ultimate method of disposal;
c. required winter storage;
d. digester pH;
e. sludge temperature; and
f. raw sludge qualities.

10.6.7 Solids Retention Time

Where land disposal of digested sludge is practised, a minimum solids retention time of 45 days is required. If local conditions require a more stable sludge, a sludge age of 90 days shall be necessary. To produce a completely stable sludge, a sludge age in excess of 120 days is required.

10.6.8 Hydraulic Retention Time

The minimum required hydraulic retention time for aerobic digesters provided with pre-thickening facilities are as follows:

Minimum HRT (days)	Type of Sludge
25	Waste Activated Sludge Only
25	Trickling Filter Sludge Only
30	Primary Plus Secondary Sludge

The more critical of the two guidelines, solids retention time and hydraulic retention time, shall govern the design.

10.6.9 Tank Design

10.6.9.1 Tank Capacity

The determination of tank capacities shall be based on rational calculations, including such factors as quantity of sludge produced, sludge characteristics, time of aeration and sludge temperature.

Calculations shall be submitted to justify the basis of design.

When such calculations are not based on the above factors, the minimum combined digestion tank capacity shall be based on the following:

Volatile solids loading shall not exceed 1.60 kg per cubic meter of volume per day in the digestion units. Lower loading rates may be necessary depending on temperature, type of sludge and other factors.

If a total of 45 days sludge age is all that is provided, it is suggested that 2/3 of the total digester volume be in the first tank and 1/3 be in the second tank. Actual storage requirements will depend upon the ultimate disposal operation. Any minor additional storage requirements may be made up in the second stage digester, but if major additional storage volumes are required, separate on-site or off-site sludge storage facilities should be considered to avoid the power requirements associated with aerating greatly oversized aerobic digesters.

10.6.9.2 Air and Mixing Requirements

Aerobic sludge digestion tanks shall be designed for effective mixing by satisfactory aeration equipment. Sufficient air shall be provided to keep the solids in suspension and maintain dissolved oxygen between one and two mg/l. A minimum mixing and air requirement of 0.85 litres per second per cubic meter of tank volume shall be provided with the largest blower out of service. If diffusers are used, the non-clog type is recommended and they should be designed to permit continuity of service. If mechanical aerators are utilized, at least two turbine aerators per tank shall be provided. Use of mechanical equipment is discouraged where freezing temperatures are normally expected.

Air supply to each tank should be separately valved to allow aeration shut-down in either tank.

10.6.9.3 Tank Configuration

Aerobic digesters are generally open tanks. The tankage should be of common wall construction or earthen-bermed to minimize heat loss. Tank depths shall be between 3.5-4.5 m; tanks and piping should be designed to permit sludge addition, sludge withdrawal, and supernatant decanting from various depths. Freeboard depths of at least 0.9 to 1.2 m should be provided to account for excessive foam levels. Floor slopes of 1:12 to 3:12 should be provided.

10.6.9.4 Supernatant Separation and Scum and Grease Removal

10.6.9.4.1 Supernatant Separation

Facilities shall be provided for effective separation or decanting of supernatant. Separate facilities are recommended; however, supernant separation may be accomplished in the digestion tank provided additional volume is provided. The supernatant drawoff unit shall be designed to prevent recycle of scum and grease back to plant process units. Provision should be made to withdraw supernatant from multiple levels of the supernatant withdrawal zone.

10.6.9.4.2 Scum and Grease Removal

Facilities shall be provided for the effective collection of scum and grease from the aerobic digester for final disposal and to prevent its recycle back to the plant process and to prevent long term accumulation and potential discharge in the effluent.

10.6.10 High Level Emergency Overflow

An unvalved high level overflow and any necessary piping shall be provided to return digester overflow back to the head of the plant or to the aeration process in case of accidental overfilling. Design considerations related to the digester overflow shall include waste sludge rate and duration during the period the plant is unattended, potential effects on plant process units, discharge location of the emergency overflow, and potential discharge or suspended solids in the plant effluent.

10.6.11 Digested Sludge Storage Volume

10.6.11.1 Sludge Storage Volume

Sludge storage must be provided in accordance with Design Section 10.11 to accommodate daily sludge production volumes and as an operational buffer for unit outage and adverse weather conditions. Designs utilizing increased sludge age in the activated sludge system as a means of storage are not acceptable.

10.6.11.2 Liquid Sludge Storage

Liquid sludge storage facilities shall be based on the following values unless digested sludge thickening facilities are utilized to provide solids concentrations of greater than 2 percent.

Sludge Source	Volume m^3/P.E./day	Volume $ft.^3$/P.E./day
Waste activated sludge--no primary settling, primary plus waste activated sludge, and extended aeration activated sludge	0.004	0.13
Waste activated sludge exclusive of primary sludge	0.002	0.06
Primary plus fixed film reactor sludge	0.003	0.10

10.7 HIGH pH STABILIZATION

10.7.1 General

Alkaline material may be added to liquid primary or secondary sludges for sludge stabilization in lieu of digestion facilities; to supplement existing digestion facilities; or for interim sludge handling. There is no direct reduction of organic matter or sludge solids with the high pH stabilization process. There is an increase in the mass of dry sludge solids. Without supplemental dewatering, additional volumes of sludge will be generated. The design shall account for the increased sludge quantities for storage, handling, transportation, and disposal methods and associated costs.

10.7.2 Operational Criteria

Sufficient alkaline material shall be added to liquid sludge in order to produce a homogeneous mixture with a minimum pH of 12 after 2 hours of vigorous mixing. Facilities for adding supplemental alkaline material shall be provided to maintain the pH of the sludge during interim sludge storage periods.

10.7.3 Odour Control and Ventilation

Odour control facilities shall be provided for sludge mixing and treated sludge storage tanks when located with 800 m of residential or commercial areas. The reviewing authority should be contacted for design and air pollution control objectives to be met for various types of air scrubber units. Ventilation is required for indoor sludge mixing, storage or processing facilities.

10.7.4 **Mixing Tanks and Equipment**

10.7.4.1 ***Tanks***

Mixing Tanks may be designed to operate as either a batch or continuous flow process. A minimum of two tanks shall be provided of adequate size to provide a minimum 2 hours contract time in each tank. The following items shall be considered in determining the number and size of tanks:

a. peak sludge flow rates;

b. storage between batches;

c. dewatering or thickening performed in tanks;

d. repeating sludge treatment due to pH decay of stored sludge;

e. sludge thickening prior to sludge treatment; and

f. type of mixing device used and associated maintenance or repair requirements.

10.7.4.2 ***Equipment***

Mixing equipment shall be designed to provide vigorous agitation within the mixing tank, maintain solids in suspension and provide for a homogeneous mixture of the sludge solids and alkaline material. Mixing may be accomplished either by diffused air or mechanical mixers. If diffused aeration is used, an air supply of 0.85 $L/s/m^3$ of mixing tank volume shall be provided with the largest blower out of service. When diffusers are used, the nonclog type is recommended, and they should be designed to permit continuity of service. If mechanical mixers are used, the impellers shall be designed to minimize fouling with debris in the sludge and consideration shall be made to provide continuity of service during freezing weather conditions.

10.7.5 **Chemical Feed and Storage Equipment**

10.7.5.1 ***General***

Alkaline material is caustic in nature and can cause eye and tissue injury. Equipment for handling or storing alkaline material shall be designed for adequate operator safety. Storage, slaking, and feed equipment should be sealed as airtight as practical to prevent contact of alkaline material with atmospheric carbon dioxide and water vapour and to prevent the escape of dust material. All equipment and associated transfer lines or piping shall be accessible for cleaning.

10.7.5.2 ***Feed and Slaking Equipment***

The design of the feeding equipment shall be determined by the treatment plant size, type of alkaline material used, slaking required, and operator requirements. Equipment may be either of batch or automated type. Automated feeders may be of the volumetric or gravimetric type depending on accuracy, reliability, and maintenance requirements. Manually operated batch slaking of quicklime (CaO) should be avoided unless adequate protective clothing and equipment are provided. At small plants, used of hydrated lime [Ca(OH)2] is recommended over quicklime due to safety and labour-saving reasons. Feed and slaking equipment shall be sized to handle a minimum of 150% of the peak sludge flow rate including sludge that may need to be retreated due to pH decay. Duplicate units shall be provided.

10.7.5.3 *Chemical Storage Facilities*

Alkaline materials may be delivered either in bag or bulk form depending upon the amount of material used. Material delivered in bags must be stored indoors and elevated above floor level. Bags should be of the multi-wall moisture-proof type. Dry bulk storage containers must be as airtight as practical and shall contain a mechanical agitation mechanism. Storage facilities shall be sized to provide a minimum of a 30-day supply.

10.7.6 Sludge Storage

Refer to Design Section 10.11 for general design considerations for sludge storage facilities.

The design shall incorporate the following considerations for the storage of high pH stabilized sludge:

10.7.6.1 *Liquid Sludge*

Liquid high pH stabilized sludge shall not be stored in a lagoon. Said sludge shall be stored in a tank or vessel equipped with rapid sludge withdrawal mechanisms for sludge disposal or retreatment. Provisions shall be made for adding alkaline material in the storage tank. Mixing equipment in accordance with Design Section 10.7.4.2 shall also be provided in all storage tanks.

10.7.6.2 *Dewatered Sludge*

On-site storage of dewatered high pH stabilized sludge should be limited to 30 days. Provisions for rapid retreatment or disposal of dewatered sludge stored on-site shall also be made in case of sludge pH decay.

10.7.6.3 *Off-Site Storage*

There shall be no off-site storage of high pH stabilized sludge unless specifically permitted by the regulatory agency.

10.7.7 Disposal

Immediate sludge disposal methods and options are recommended to be utilized in order to reduce the sludge inventory on the treatment plant site and amount of sludge that may need to be retreated to prevent odours if sludge pH decay occurs. If the land application disposal option is utilized for high pH stabilized sludge, said sludge must be incorporated into the soil during the same day of delivery to the site.

10.8 SLUDGE DEWATERING

10.8.1 General

Sludge dewatering will often be required at sewage treatment plants prior to ultimate disposal of sludges. Since the processes differ significantly in their ability to reduce the water content of sludges, the ultimate sludge disposal method will generally have a major influence on the dewatering method most suitable for a particular sewage treatment plant. Also of influence will be the characteristics of the sludge requiring dewatering, that is, whether the sludge is raw or digested, whether the sludge contains waste activated sludge, or whether the sludge has been previously thickened. With raw sludge, the freshness of the sludge will have a significant effect on dewatering performance (septic sludge will be more difficult to dewater than fresh raw sludge).

As with thickening systems, dewatering facilities may require sludge pre-treatment in the form of sludge grinding to avoid plugging pumps, lines and plugging or damaging dewatering equipment. Also, adequate ventilation equipment will be required in buildings housing dewatering equipment.

In evaluating dewatering system alternatives, the designer must consider the capital and operating costs, including labour, parts, chemicals and energy, for each alternative as well as for the effects which each alternative will have on the sewage treatment and subsequent sludge handling and ultimate sludge disposal operations.

In considering the need for sludge dewatering facilities, the designer should evaluate the economics of the overall treatment processes, with and without facilities for sludge water content reduction. This evaluation should consider both capital and operating costs of the various plant components and sludge disposal operations affected.

Wherever possible, pilot-plant and/or bench-scale data should be used for the design of dewatering facilities. With new plants, this may not always be possible and, in such cases, empirical design parameters must be used. The following subsections outline the normal ranges for the design parameters of such equipment.

For calculating dewatering design sludge handling needs, a rational basis of design for sludge production from sludge stabilization processes shall be developed and provided to the regulatory agencies for approval on a case-by case basis.

10.8.2 Dewatering Process Compatibility with Subsequent Treatment or Disposal Techniques

Table 10.7 outlines the relationship of dewatering to other processes.

TABLE 10.7 - THE RELATIONSHIP OF DEWATERING TO OTHER SLUDGE TREATMENT PROCESSES FOR TYPICAL MUNICIPAL SLUDGES

METHOD	PRETREATMENT NORMALLY PROVIDED		NORMAL USE OF DEWATERED CAKE			
	THICKENING	CONDITIONING	LANDFILL	LAND SPREAD	HEAT DRYING	INCINERATION
ROTARY VACUUM FILTER	YES	YES	YES	YES	YES	YES
CENTRIFUGE (SOLID BOWL)	YES	YES	YES	YES	YES	YES
CENTRIFUGE (BASKET)	VARIABLE	VARIABLE	YES	YES	NO	NO
DRYING BEDS	VARIABLE	NOT USUALLY	YES	YES	NO	NO
LAGOONS	NO	NO	YES	YES	NO	NO
FILTER PRESSES	YES	YES	YES	VARIABLE	NOT USUALLY	YES
HORIZONTAL BELT FILTERS	YES	YES	YES	YES	YES	YES

10.8.3 Sludge Drying Beds

10.8.3.1 Pre-Treatment

Sludge shall be pre-treated before being air-dried by either one of the following methods:

(a) Anaerobic digesters;

(b) Aerobic digesters with provision to thicken;

(c) Digestion in aeration tanks of extended aeration plants (with long sludge age, greater than about 20 days) preferably with provision to thicken using thickeners, lagoons or by other means; or

(d) Well designed and maintained oxidation ditches with sludge age longer than about 20 days (preferably after thickening).

10.8.3.2 Chemical Conditioning

The dewatering characteristics can be considerably improved by chemical conditioning of sludge prior to treatment in beds.

Since sludge conditioning can reduce the required drying time to 1/3 or less, of the unconditioned drying time, provision should be made for the addition of conditioning chemicals, usually polymers.

10.8.3.3 *Design Criteria*

10.8.3.3.1 *Factors Influencing Design*

The design and operation of sludge drying beds depend on the following factors:

(a) Climate in the area;

(b) Sludge characteristics;

(c) Pre-treatment (such as conditioning, thickening, etc.)

(d) Sub-soil permeability.

10.8.3.3.2 *Bed Area*

Consideration should be given to the following when calculating the bed area:

a. The volume of wet sludge produced by existing and proposed processes.

b. Depth of wet sludge drawn to the drying beds. For design calculation purposes a maximum depth of 200 mm shall be utilized. For operational purposes, the depth of sludge placed on the drying bed may increase or decrease from the design depth based on the percent solids content and type of digestion utilized.

c. Total digester volume and other wet sludge storage facilities.

d. Degree of sludge thickening provided after digestion.

e. The maximum drawing depth of sludge which can be removed from the digester or other sludge storage facilities without causing process or structural problems.

f. The time required on the bed to produce a removable cake. Adequate provision shall be made for sludge dewatering and/or sludge disposal facilities for those periods of time during which outside drying of sludge on beds in hindered by weather.

g. Capacities of auxiliary dewatering facilities.

Sludge drying beds may be designed from basic principles, laboratory tests, and/or pilot plant field studies. Calculations must be presented to the reviewing authority supporting any design based on the above methods. In the absence of such calculations the minimum sludge drying bed area shall be based on the following criteria:

Type of Wastewater Treatment	Area (sq.m/capita)		
	Open Beds	Covered Beds	Combination of Open and Covered Beds
Primary Plants (No secondary treatment)	0.12	0.10	0.10
Activated Sludge (No primary treatment)	0.16	0.13	0.13
Primary and Activated Sludge	0.20	0.16	0.16

The area of the bed may be reduced by up to 50% if it is to be used solely as a back-up dewatering unit. An increase of bed area by 25% is recommended for paved beds.

10.8.3.3.3 *Percolation Type Beds*

a. Pond Bottom

The bottom of the cell should be of impervious material such as clay or asphalt.

b. Underdrains

Underdrains should at least 100 mm in diameter laid with open joints. Perforated pipe may also be used. Underdrains should be spaced 2.5 to 3.0 m apart, with a slope of one per cent, or more. Underdrains should discharge back to the secondary treatment section of the sewage treatment plant. Various pipe materials may be selected provided the material is of suitable strength and corrosion resistant.

c. Gravel

The lower course of gravel around the underdrains should be properly graded and should be 300 mm in depth, extending at least 150 mm above the top of the underdrains. It is desirable to place this in two or more layers. The top layer, of at least 75 mm in depth, should consist of gravel three mm to six mm in size.

The gravel should be graded from 25 mm on the bottom to 3 mm on the top.

d. Sand

The top course should consist of 250 to 450 mm of clean coarse sand. The effective size should range from 0.3 to 1.2 mm with a uniformity co-efficient of less than 5.0. The finished sand surface should be level.

e. Additional Dewatering Provisions

Consideration shall be given for providing a means of decanting supernatant of sludge placed on the sludge drying beds. More effective decanting of supernatant may be accomplished with polymer treatment of sludge.

10.8.3.3.4 *Impervious Type Beds*

Paved drying beds should be designed with consideration for space requirements to operate mechanical equipment for removing the dried sludge.

10.8.3.3.5 *Location*

Depending on prevailing wind directions, a minimum distance of 100 to 150 m shall be kept from open sludge drying beds and dwellings. However, the minimum maybe reduced to 60 m to 80 m for enclosed beds. The selected location for open beds shall be at least 30 m from public roads and 25 m for enclosed beds. The plant owner may be required to spray deodorants and odour masking chemicals whenever there are complaints from the population in the neighbourhood.

10.8.3.3.6 *Winter Storage*

Alternative methods of disposal should be arranged for the non-drying season which may start as early as October (or November) and end in April (or March).

10.8.3.3.7 *Dimensions*

The bed size generally should be 4.5 to 7.5 m wide with the length selected to satisfy desired bed loading volume.

10.8.3.3.8 *Depth of Sludge*

The sludge dosing depth shall generally be 200 to 300 mm for warm weather operating modes; for winter freeze drying depths of 1 to 3 m can be used depending upon the number of degree days in winter.

10.8.3.3.9 *Number of Beds*

Three beds are desirable for increased flexibility of operation. Not less than two beds shall be provided.

10.8.3.3.10 *Walls*

Walls should be watertight and extend 400 to 500 mm above and at least 150 mm below the surface. Outer walls should be extended at least 100 mm above the outside grade elevation to prevent soil from washing on to the beds.

10.8.3.3.11 *Sludge Influent*

The sludge pipe to the beds should terminate at least 300 mm above the surface and be so arranged that it will drain. Concrete splash plates for percolation type beds should be provided at sludge discharge points. One inlet pipe per cell should be provided.

10.8.3.3.12 *Sludge Removal*

Each bed shall be constructed so as to be readily and completely accessible to mechanical cleaning equipment. Concrete runways spaced to accommodate mechanical equipment shall be provided. Special attention should be given to assure adequate access to the areas adjacent to the sidewalls. Entrance ramps down to the level of the sand bed shall be provided. These ramps should be high enough to eliminate the need for an entrance end wall for the sludge bed.

Nova Scotia climatological conditions may permit 3 or 4 cycles (consisting of filling the open bed with digested sludge, drying and emptying) during the drying season. However, the number of cycles may be increased to approximately 10 with covered beds. These values are tentative and subject to revision after field observations.

10.8.3.3.13 *Covered Beds*

Consideration should be given to the design and use of covered sludge drying beds.

10.8.4 **Sludge Lagoons**

10.8.4.1 *General*

Sludge drying lagoons may be used as a substitute for drying beds for the dewatering of digested sludge. Lagoons are not suitable for dewatering untreated sludges, limed sludges, or sludges with a high strength supernatant because of their odour and nuisance potential. The performance of lagoons, like that of drying beds, is affected by climate; precipitation and low temperatures inhibit dewatering. Lagoons are most applicable in areas with high evaporation rates.

Sludge lagoons may also be used as temporary sludge storage facilities, when spreading on agricultural land cannot be carried out due to such factors as wet ground, frozen ground or snow cover.

Sludge lagoons as a means of dewatering digested sludge will be permitted only upon proof that the character of the digested sludge and the design mode of operation are such that offensive odours will not result. Where sludge lagoons are permitted, adequate provisions shall be made for other sludge dewatering facilities or sludge disposal in the event of upset or failure of the sludge digestion process.

10.8.4.2 *Design Considerations*

The design and location of sludge lagoons must take into consideration many factors, including the following:

- Possible nuisances - odours, appearance, mosquitos;
- Design - number, size, shape and depth;
- Loading factors - solids concentration of digested sludge, loading rates;
- Soil conditions - permeability of soil, need for liner, stability of berm slopes, etc.,
- Groundwater conditions - elevation of maximum groundwater level, direction of groundwater movement, location of wells in the area;
- Sludge and supernatant removal - volumes, concentrations, methods of removal, method of supernatant treatment and final sludge disposal; and
- Climatic effects - evaporation, rainfall, freezing, snowfall, temperature, solar radiation.

10.8.4.3 *Pre-Treatment*

Pre-treatment requirements for sludge lagoons are the same as those for sludge drying beds.

10.8.4.4 *Soil and Groundwater Conditions*

The soil must be reasonably porous and the bottom of the lagoons must be at least 1.2 m above the maximum ground water table. Surrounding areas shall be graded to prevent surface water entering the lagoon. In some critical instances, the reviewing authority may require a lagoon to be lined with plastic or rubber material.

10.8.4.5 *Depth*

Lagoons should be at least 1 m in depth while maintaining a minimum of 0.6 m of freeboard.

10.8.4.6 *Seal*

Adequate provisions shall be made to seal the sludge lagoon bottom and embankments in accordance with the requirements of Design Section 6.4.6. to prevent leaching into adjacent soils or ground water.

10.8.4.7 *Area*

The area required will depend on local climatic conditions. Not less than two lagoons should be provided.

10.8.4.8 *Location*

Consideration shall be given to prevent pollution of ground and surface water. Adequate isolation shall be provided to avoid nuisance production.

10.8.4.9 *Cycle Time and Sludge Removal*

The cycle time for lagoons varies from several months to several years. Typically, sludge is pumped to the lagoon for 18 months and then the lagoon is rested for six months.

Sludge is removed mechanically, usually at a moisture content of about 70 percent.

10.8.5 Mechanical Dewatering Facilities

10.8.5.1 *General*

Provisions shall be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulation beyond storage capacity. If it is proposed to dewater the sludge by mechanical methods such as rotary vacuum filters, centrifuges, filter presses or belt filters, a detailed description of the process and design data shall accompany the plans.

Unless standby facilities are available, adequate storage facilities shall be provided. The storage capacity should be sufficient to handle at least 4 days of sludge production volume.

10.8.5.2 *Performance of Mechanical Dewatering Methods*

Table 10.8 outlines the solids capture, solids concentrations normally achieved and energy requirements for various mechanical dewatering methods.

TABLE 10.8 - SLUDGE DEWATERING METHODS AND PERFORMANCE WITH VARIOUS SLUDGE TYPES

DEWATERING METHOD	SOLIDS CAPTURE (%)	SOLIDS CONCENTRATIONS NORMALLY ACHIEVED (1)	MEDIAN ENERGY REQUIRED (MJ/DRY TONNE) (2)
VACUUM FILTER	90 - 95	RAW PRIMARY + WAS (10-25%) DIGESTED PRIMARY + WAS (15-20%) WAS (8-12%)	1080
FILTER PRESS	90 - 95	RAW PRIMARY + WAS (30-50%) DIGESTED PRIMARY + WAS (35-50%) WAS (25-50%)	360
CENTRIFUGE (SOLID BOWL)	95 - 99	RAW OR DIGESTED PRIMARY + WAS (15-25%) WAS (12-15%)	360
BELT FILTER	85 - 95	RAW OR DIGESTED PRIMARY + WAS (14-25%) WAS (10-15%)	130

1. INCLUDING CONDITIONING CHEMICALS, IF REQUIRED.
2. MJ/DRY TONNE - DENOTES MEGAJOULES PER DRY TONNE OF SLUDGE THROUGHOUT.

10.8.5.3 Number of Units

With sludge dewatering equipment, multiple units will generally be required unless satisfactory sludge storage facilities or alternate sludge disposal methods are available for use during periods of equipment repair. Often the need for full standby units will be unnecessary if the remaining duty units can be operated for additional shifts in the event of equipment breakdown.

There shall be a back-up pump and filtrate pump installed for each vacuum filter.

10.8.5.4 Ventilation

Adequate facilities shall be provided for ventilation of the dewatering area. The exhaust air should be properly conditioned to avoid odour nuisance.

10.8.5.5 Chemical Handling Enclosures

Lime-mixing facilities should be completely enclosed to prevent the escape of lime dust. Chemical handling equipment should be automated to eliminate the manual lifting requirement.

10.8.5.6 Drainage and Filtrate Disposal

Drainage from beds or filtrate from dewatering units shall be returned to the sewage treatment process at appropriate points.

10.8.5.7 Other Dewatering Facilities

If it is proposed to dewater sludge by mechanical means, other than those outlined below, a detailed description of the process and design shall accompany the plans.

10.8.5.8 Vacuum Filters

Of primary importance with vacuum filters is the solids concentration of sludge fed to the units. With all other operating variables remaining constant, increases in filtration rates vary in direct proportion to feed solids. Sludge thickening prior to vacuum filters is therefore extremely important. Higher concentrations in the sludge feed also result in lower filtrate solids.

Vacuum filtration systems should be designed in accordance with the following parameters:

a. Sludge feed pumps

- Variable capacity;

b. Vacuum pumps

- Generally one per machine with capacity of 10 L/m^2/s at 65 kPa or more, vacuum;

c. Vacuum receiver

- Generally one per machine; max. air velocity 0.8 to 1.5 m/s; air retention time 2-3 minutes; filtrate retention time 4-5 minutes; all lines shall slope downward to the receiver from the vacuum filter.

d. Filtrate pumps

- Generally self-priming centrifugal; suction capacity greater than vacuum pump, 65 to 85 kPa vacuum; with flooded pump suctions; with check valve on the discharge side to minimize air leakage into the system; pumps must be sized for the maximum expected sludge drainage rates (usually produced by polymers);

e. Sludge flocculation tank

- Constructed of corrosion-resistant materials; with slow speed variable drive mixer, detention time 2-4 minutes with ferric and lime (with polymers shorter time may be used);

f. Wash water;

- Filtered final effluent generally used;

g. Sludge measurement;

- Should be provided unless measured elsewhere in plant;

h. Solids loading rate;

- 7-14 g/m^2/s for raw primary; 2.75-7 g/m^2/s for raw primary + WAS; 4-7 g/m^2/s for digested primary + WAS; not considered practical for use with WAS alone..

10.8.5.9 *Filter Presses*

As with vacuum filters, the capacity of filter presses is greatly affected by the initial solids concentration. With low feed solids, chemical requirements increase significantly.

Sludge, thickening should therefore be considered as a pre-treatment step.

Filter press systems should be designed in accordance with the following guidelines:

a. Sludge conditioning tank

- Detention time maximum 20 minutes at peak pumpage rate;

b. Feed pumps

- Variable capacity to allow pressures to be increased gradually, without underfeeding or overfeeding sludge; pumps should be of a type to minimize floc shear; pumps must deliver high volume at low head initially and low volume at high head during latter part of cycle; ram or piston pumps, progressing cavity pumps or double diaphragm pumps are generally used;

c. Cake handling

- Filter press must be elevated above cake conveyance system to allow free fall; cake can be discharged directly to trucks, into dumper boxes, or onto conveyors (usually cable cake breakers may be needed);

d. Cycle times

- 1.5 to 6 h (normally 1.5 to 3 h); and

e. Operating pressures

- Usually 700 to 1400 kPa, but may be as high as 1750 kPa. The operating pressure shall not exceed 1000 to 1050 kPa, if polymer is applied as the conditioning agent.

10.8.5.10 Solid Bowl Centrifuges

Bowl length/diameter ratios of 2.5 to 4.0 should be provided to ensure adequate settling time and surface area. Bowl angles must be kept shallow.

The bowl flow pattern can be either counter-current or concurrent. Pool depth can be varied by adjustable weirs.

Conveyor design and speed will affect the efficiency of solids removal. Differential speed must be kept low enough to minimize turbulence and internal wear yet high enough to provide sufficient solids handling capacity.

For most wastewater sludges, the capacity of the centrifuge will be limited by the clarification capacity (hydraulic capacity) and therefore the solids concentration. Increasing the feed solids will increase the solids handling capacity. Thickening should, therefore, be considered as a pre-treatment operation.

Since temperature affects the viscosity of sludges, if the temperatures will vary appreciably (as with aerobic digestion), the required centrifuge capacity should be determined for the lowest temperature expected.

Other general design guidelines for solid bowl centrifuges are as follows:

a. Feed pump

- Sludge feed should be continuous; pumps should be variable flow type; one pump should be provided per centrifuge for multiple centrifuge systems; chemical dosage should vary with the pumpage rate;

b. Sludge pre-treatment

- Depending upon the sewage treatment process, grit removal, screening or maceration may be required for the feed sludge stream;

c. Solids capture

- 85 - 95 percent is generally desirable;

d. Machine materials

- Generally carbon steel or stainless steel; parts subject to wear should be protected with hard facing materials such as a tungsten carbide material;

e. Machine foundations

- Foundations must be capable of absorbing the vibratory loads;

f. Provision for Maintenance

- Sufficient space must be provided around the machine(s) to permit disassembly; an overhead hoist should be provided; hot and cold water supplies will be needed to permit flushing out the machine; drainage facilities will be necessary to handle wash water.

10.8.5.11 ***Belt Filter Presses***

Most types of waste water sludges can be dewatered with belt filter presses and the results achieved are generally superior to those of vacuum filters.

Chemical conditioning is generally accomplished with polymer addition.

Solids handling capabilities are likely to range from 50 g/m/s (based on belt width) for excess activated sludge to 330 g/m/s for primary sludge.

10.9 SLUDGE PUMPS AND PIPING

10.9.1 Sludge Pumps

10.9.1.1 General Sludge Pumping Requirements

Table 10.9 outlines general sludge pumping requirements for various sludge types.

TABLE 10.9 - GENERAL SLUDGE PUMPING REQUIREMENTS

SLUDGE SOURCE	SLURRY (% TOTAL SOLIDS)	STATIC HEAD (m)	TDH (m)	ABRASIVE SERVICE	DUTY
PRE-TREATMENT-GRIT	0.5 - 10.0	0 - 1.5 (GRAVITY)	1.5 - 3	YES - HIGH	HEAVY
PRIMARY SEDIMENTATION					
UNTHICKENED	0.2 - 2.0	3 - 12	10 - 200	YES	MEDIUM
THICKENED	4.0 - 10.0	3 - 12	12 - 25	YES	HEAVY
SECONDARY SEDIMENTATION (FOR RECIRCULATION)	0.5 - 2.0	1 - 2	3 - 4.5	NO	LIGHT
SECONDARY SEDIMENTATION (FOR THICKENING)	0.5 - 2.0	1.2 - 2.4	3 - 4.5	NO	LIGHT
THICKENER	5 - 10	6 - 12	25 - 45	YES/NO*	HEAVY
UNDERFLOW	5 - 10	60 - 120**	75 - 170	YES/NO*	VERY HEAVY
DIGESTER					
RECIRCULATION	3 - 10	0 - 1.5	2.4 - 3.6	NO	MEDIUM
UNDERFLOW	3 - 10	0 - 6	15 - 30	YES/NO*	VERY HEAVY
CHEMICALLY PRODUCED SLUDGES:					
ALUM/FERRIC - PRIMARY	0.5 - 310	3 - 12	9 - 20	NO	LIGHT
LIME - PRIMARY	1.0 - 6.0	3 - 12	9 - 25	NO	MEDIUM
LIME - SECONDARY	2.0 - 15.0	3 - 12	9 - 25	NO	MEDIUM
INCINERATOR SLURRIES	0.5 - 10	0 - 15	6 - 30	YES- HIGH	HEAVY

* DEPENDS ON DEGRITTING EFFICIENCY
** HIGH PRESSURE FOR HEAT TREATMENT

10.9.1.2 Capacity

Pump capacities should be adequate but not excessive. Provision for varying pump capacity is desirable.

10.9.1.3 *Duplicate Units*

Duplicate units shall be provided where failure of one unit would seriously hamper plant operation.

10.9.1.4 *Type*

Plunger pumps, screw feed pumps or other types of pumps with demonstrated solids handling capability should be provided for handling raw sludge. Where centrifugal pumps are used, a parallel positive displacement pump should be provided as an alternate to pump heavy sludge concentrations, such as primary or thickened sludge, that may exceed the pumping head of the centrifugal pump.

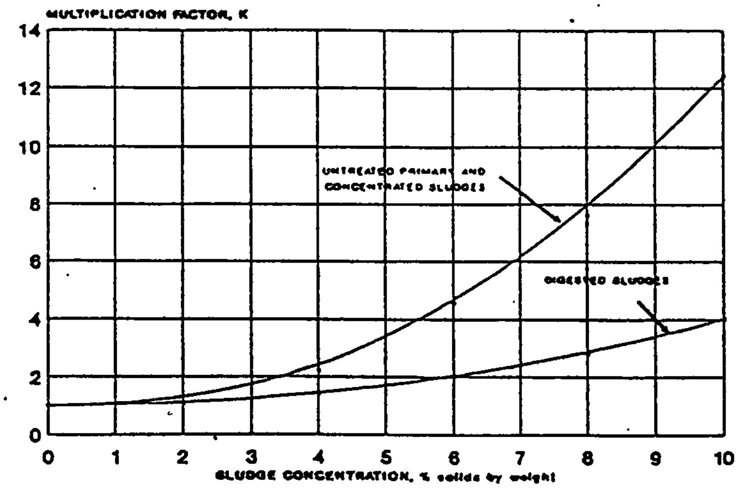
10.9.1.5 *Minimum Head*

A minimum positive head of 600 mm shall be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps. Maximum suction lifts should not exceed three m for plunger pumps.

10.9.1.6 *Head Loss*

Figure 10.1 shows the multiplication factor to apply to the friction losses for turbulent flow for clean water to calculate the friction losses for untreated primary and concentrated sludges and digested sludge. Use of Figure 10.1 will often provide sufficiently accurate results for design, especially at solids concentrations below 3 percent. However, as pipe length, percent total solids and percent volatile solids increase, more elaborate methods may have to be used to calculate the friction losses with sufficient accuracy.

FIGURE 10.1
APPROXIMATE FRICTION HEAD LOSS
FOR LAMINAR FLOW OF SLUDGE



NOTES:

1. Multiply loss with clean water by K to estimate friction loss under laminar conditions (see text).
2. The Information on this figure has been extracted from EPA 625/1-79-011 "Process Design Manual for Sludge Treatment and Disposal:, September 1979.

10.9.1.7 *Sampling Facilities*

Unless sludge sampling facilities are otherwise provided, quick closing sampling valves shall be installed at the sludge pumps. The size of valve and piping should be at least 40 mm and terminate at a suitable sized sampling sink or floor drain.

10.9.2 Sludge Piping

10.9.2.1 *Size and Head*

Sludge withdrawal piping should have a minimum diameter of 200 mm for gravity withdrawal and 150 mm for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe should be adequate to provide at least 1.0 m/s velocity. With sludge pumpage velocities of 0.9 to 1.5 m/s should be developed. For heavier sludges and grease, velocities of 1.5 to 2.4 m/s are needed.

10.9.2.2 *Slope*

Gravity piping should be laid on uniform grade and alignment. The slope on gravity discharge piping should not be less than three percent. Provisions should be made for draining and flushing discharge lines.

10.9.2.3 *Supports*

Special consideration should be given to the corrosion resistance and continuing stability of supporting systems for piping located inside the digestion tank.

10.10 SLUDGE UTILIZATION ON LAND

10.10.1 General

The program of land spreading of sludge must be evaluated as an integral system which includes stabilization, storage, transportation, application, soil, crop and groundwater. The following guidelines were formulated to provide the criteria of municipal sludge utilization on land. Sewage sludge and septage is useful to crop and soil by providing nutrients and organic matter.

Sewage sludge and septage contains heavy metals and other substances which could affect soil productivity and the quality of food. Sufficient information is not available to completely evaluate the deleterious effects. The purpose of the guidelines is to indicate the acceptable method of sludge utilization on land surface, based on current knowledge. It is recognized that these guidelines should be revised as more information becomes available.

10.10.2 General Limitations to be Observed

10.10.2.1 ***Stabilized Sludge***

Only stabilized sludge shall be surface applied to farmland or pasture. Stabilized sludge is defined as processed sludge in which the organic and bacterial contents of raw sludge are reduced to levels deemed necessary by the regulatory agency to prevent nuisance odours and public health hazards. Any process which produces sludge equivalent in quality to the above in terms of public health factors and odour potential may be accepted. Additional treatment would be required to further reduce pathogens when the sludge is to be spread on dairy pastures and other crops which are in the human food chain.

10.10.2.2 ***Raw Vegetables***

Sludge should not be applied to land which is used for growing food crops to be eaten raw, such as leafed vegetables and root crops.

10.10.2.3 ***Minimum pH***

No sludge shall be applied on land if the soil pH is less than 6.0 at the time the sludge is applied. The soil pH should range between 6.0 and 6.8. The pH shall be maintained above 6.0 for at least two years following the end of sludge application.

10.10.2.4 Persistent Organic Chemicals

Sufficient information is not available to establish criteria of sludge spreading in regard to persistent organic chemicals, such as pesticides and polychlorinated biphyenyls (PCB). However, if there is a known source in the sewer system service area which discharges or discharged in the past such chemicals, the sludge should be analyzed for such chemicals and the regulatory agency shall be consulted for recommendations concerning sludge spreading.

10.10.3 SITE SELECTION

10.10.3.1 General

By proper selection of the sludge application site, the nuisance potential and public health hazard should be minimized. The following items should be considered and the regulatory agency should be consulted for specific limits:

a. land ownership information;

b. groundwater table and bedrock location;

c. location of dwellings, roads and public access;

d. location of wells, springs, creeks, streams and flood plains;

e. slope of land surface;

f. soil characteristics;

g. climatological information;

h. land use plan; and

i. road weight restrictions.

10.10.3.2 Site Location

The following restrictions shall apply to the location of a proposed sludge to land application site:

a. The site should be remote from surface water courses. The minimum distance between the site and the high water mark of the surface water course should be determined by the land slope as follows:

TABLE 10.10 - Minimum Distance to Watercourse		
Maximum Sustained Slope	For Sludge Application During May to November inclusive	For Sludge Application During December to April inclusive
0 to 3%	100 m	360 m
3 to 6%	125 m	No Sludge to be Applied
6 to 8%	180 m	No Sludge to be Applied
Greater than 8%	No Sludge to be Applied unless special conditions exist	No Sludge to be Applied

b. The site shall be located a minimum distance from certain physical features, as specified in the following table:

TABLE 10.11 - MINIMUM DISTANCE TO PHYSICAL FEATURES	
Type of Feature	Minimum Setback Distance
Public Wells	150 m **
Private Wells	90 m **
Property Line	77 m *
Bedrock Outcrops	7 m *
Dwellings	90 m **
Uninhabited Buildings	30 m
Perennial Water Bodies & Watercourses	90 m
Intermittent Water Bodies & Watercourses	60 m
Swales and Man-Made Drainage Ditches	14 m
Primary & Secondary Roads	30 m *
Unimproved Dirt Roads	7 m *

NOTE: * 100 m setback required for spray irrigation areas
** 300 m setback required for storage lagoons and spray irrigation areas

c. The site shall be so located that the maximum level of the groundwater table at the site is at a sufficient distance below the surface to prevent the impairment of groundwater in aquifers as determined by the permeability of the soil;

d. No processed organic waste shall be applied to the site during any period in which conditions are such that surface runoff is likely to occur taking into account land slope, soil permeability and the climatic conditions of the area;

e. The site shall be established only on land that is, or is intended to be, used for pasture, fallow, the growing of forage crops, scrub lands, or tree plantations.

   i) during the current growing season, or

   ii) where application of the processed organic waste is made sometime after the current growing season, to the end of the subsequent growing season; and

f. Berms and dykes of low permeability shall be constructed on the site where necessary to isolate the site and effectively prevent the egress of contaminants.

g. No sewage sludge handling facility should be located on a flood plain, an area which is inundated by a flood that has a 1% or greater change in recurring in any year, or a flood of a magnitude equalled or exceeded once in 100 years on the average.

h. No sewage sludge handling facility should be installed within the area of any municipal or city watershed unless water treatment consists of chemical precipitation.

i. A sewage sludge handling facility should not be located over land areas with a seasonal high water table at less than 450 mm below the ground surface, or with bedrock at less than 900 mm.

10.10.3.3 Land Characteristics

The following restrictions shall apply to the land characteristics of a proposed sludge to land application site:

(a) The land slope and soil permeability will determine the time of year that sludge may be applied.

TABLE 10.12 - SLUDGE APPLICATION PERIODS		
Maximum Sustained Slope	Soil Permeability	Allowable Duration of Application
0 to 3%	any	12 mon/yr.
3 to 6%	rapid to moderately rapid ($>5x10^{-5}$ m/s to $8x10^{-6}$ m/s)	7 mon/yr. (May to November)
	($2x10^{-6}$ m/s to $5x10^{-7}$ m/s) moderate to slow	6 mon/yr. (May to October)
6 to 8%	($>5x10^{-5}$ m/s to $8x10^{-6}$ m/s) rapid to moderately rapid	7 mon/yr. (May to November)
	($2x10^{-6}$ m/s to 5x 10^{-7} m/s) moderate to slow	6 mon/yr. (May to October)
Greater than 8%	any	No sludge applications unless warranted by special conditions

b. The ground water table during sludge application should be not less than 1 m from the surface for soils with moderate to slow permeability. For soils with rapid to moderately rapid permeability the groundwater table should be not less than 1.5 m from the surface; and

c. Where sludge application is carried out by tank truck, untiled land should be given preference to tiled land. Where tiled land is used the sludge hauling contractor should request instructions from the landowner, with regards to minimizing the possibility of damage to the tile system.

10.10.4 Sludge Application Rates

10.10.4.1 Nitrogen Restrictions

The rate of sewage sludge application is restricted to 5.6 tonnes/hectare of dry sludge solids content. This provides approximately 160 kilograms/hectare of total nitrogen which is adequate for most grass crops during the year of application.

10.10.4.2 Phosphorus Restrictions

Due to the phosphorus content of digested sewage sludges and the upperlimits of phosphorus acceptable in the soil, the applications indicated in Design Section 10.9.4.1 may only be made once every two years. The phosphorus balance in the soil limits the application rates even when sludge is applied to crops with higher annual nitrogen requirements such as corn. In these cases ammonium nitrate fertilizer should be used in addition to the sludge.

10.10.4.3 *Additive Metal Loading Restrictions*

Unrestricted addition of metals to agricultural soils will result in both elevated metal content of the crops and plant toxicity. The following restrictions (with a built in safety factor) are designed to control this potential problem.

The following table lists the maximum permissable metal addition to soil of <u>anaerobically</u> digested sewage sludges:

TABLE 10.13 - METAL LOADING RESTRICTIONS FOR ANAEROBICALLY DIGESTED SLUDGES

Metal	Maximum Acceptable Metal Addition to Soil (kg/ha)
As	14
Cd	1.6
Co	30
Cr	210
Cu	150
Hg	0.8
Mo	4
Ni	32
Pb	90
Se	2.4
Zn	330

The following table lists the maximum permissable metal concentrations in <u>aerobically</u> digested sewage sludges:

TABLE 10.14 - MAXIMUM PERMISSABLE METAL CONCENTRATIONS IN AEROBICALLY DIGESTED SLUDGES

Metal	Maximum Permissable Metal Concentration (mg/kg)
As	170
Cd	34
Co	340
Cr	2800
Cu	1700
Hg	11
Mo	94
Ni	420
Pb	1100
Se	34
Zn	4200

10.10.5 *Sludge Application on Forested Land*

Disposal of sludge on forested land is considerably less hazardous than on cropland in terms of heavy metal toxicity unless the land is to be converted to cropland. For the allowable sludge loading the regulatory agency should be consulted.

10.10.6 **Management of Spreading Operation**

10.10.6.1 *Hauling Equipment*

The sludge hauling equipment should be designed to prevent spillage, odour and other public nuisance.

10.10.6.2 *Valve Control*

The spreading tank truck should be provided with a control so that the discharge valve can be opened and closed by the driver while the vehicle is in motion. The spreading valve should be of the "fail-safe" type (i.e., self-closing) or an additional manual stand-by valve should be employed to prevent uncontrolled spreading or spillage.

10.10.6.3 *Sludge Storage*

Sufficient sludge storage capacity shall be provided for periods of inclement weather and equipment failure. The storage facilities shall be designed, located and operated so as to avoid nuisance conditions.

10.10.6.4 *Spreading methods*

The selection of spreading methods depends on the sludge characteristics, environmental factors and others. When control of odour nuisance and runoff is required, immediate incorporation of sludge after spreading or subsurface injection should be considered. When such a method is utilized, an adjustment in the reduced rate of ammonia loss into the atmosphere should be considered in the computation for nitrogen balance.

The sludge should be spread uniformly over the surface when tank truck spreading, ridge and furrow irrigation or other methods are used. Sewage sludge application should not be made during or immediately after rainfall.

Proposals for subsurface application of sludge shall include for review a description of the equipment program for application.

Spray systems, except for downward directed types, will not ordinarily be approved.

10.10.6.5 *Boundary Demarcation*

The boundaries of the site shall be marked (i.e., with stakes at corners) as to avoid confusion regarding the location of the site during sludge application. The markers should be maintained until the end of the current growing season.

10.10.6.6 *Public Access*

Public access to a land application site should be controlled by either positive barriers or remoteness of the site.

10.10.6.7 *Monitoring and Reporting*

The requirements of the regulatory agency on the monitoring and reporting of the sludge spreading operation should be followed. As a minimum, the producer of sludge should regularly collect and record information on the sludge and soil characteristics and the volume of sludge spread on a particular site.

10.10.6.8 *Land Restrictions*

No vegetable crops may be grown in soils during the calendar year of the most recent sewage sludge application.

No animal grazing may occur on lands during the calendar year of the most recent sewage sludge application.

10.11 SLUDGE STORAGE

10.11.1 General

Sludge storage facilities shall be provided at all mechanical treatment plants. Appropriate storage facilities may consist of any combination of drying beds, lagoons, separate tanks, additional volume in sludge stabilization units, pad area or other means to store either liquid or dried sludge.

The design shall provide for odour control in sludge storage tanks and lagoons including aeration, covering or other appropriate means.

10.11.2 Volume

Rational calculations justifying the number of days of storage to be provided shall be submitted and shall be based on the total sludge handling and disposal system. Sludge production values for stabilization processes should be justified in the basis of design. If the land application method of sludge disposal is the only means of disposal utilized at a treatment plant, storage shall be provided based on considerations including at least the following items:

a. Inclement weather effects on access to the application land;

b. Temperatures including frozen ground and stored sludge cake conditions;

c. Haul road restrictions including spring thawing conditions;

d. Area seasonal rainfall patterns;

e. Cropping practices on available land;

f. Potential for increased sludge volumes from industrial sources during the design life of the plant; and

g. Available area for expanding sludge storage.

A minimum range of 120 to 180 days storage should be provided for the design life of the plant unless a different period is approved by the regulatory agency.

10.12 SLUDGE DISPOSAL METHODS

When other sludge disposal methods, such as incineration, lagoons and landfill, are considered, pertinent requirements from the regulatory agency shall be followed.

10.12.1 Sanitary Landfill

Sanitary landfilling of sludge, either separately or along with municipal solid waste, can be an acceptable means of ultimate sludge disposal.

The sludge must be stabilized prior to landfilling and daily soil cover must be provided.

Site selection must conform to the guidelines and criteria adopted by the regulatory agency. Particular attention is drawn to surface and groundwater protection, availability to on-site cover material and conformation to land use planning.

The site must be operated and maintained in accordance with the guidelines and regulations of the regulatory agency for sanitary landfill operation. Particular attention is drawn to the leachate and runoff of the heavy metals, persistent organics, pathogens and nitrates.

10.12.2 Incineration

Sludge incineration can be achieved in a multiple-hearth furnace.

Particular attention is drawn to proper air pollution control of the stack gases to conform to the regulations of the regulatory agency.

Sludge dewatering is required prior to incineration.

10.12.3 Land Reclamation

Sewage sludge can be used to reclaim strip-mine spoils or other low-quality land. Particular attention is drawn to the potential for water contamination and excessive accumulation of trace elements.

10.12.4 Energy/Resource Recovery

Energy and resource recovery processes include (1) recovery and recycling of marketable constituents of sludge or sludge incinerator ash, (2) co-incineration of sludge with combustible solid waste to generate power or steam or (3) pyrolysis of sludge to produce useful by-products such as fuel gases, oils, tars or activated charcoal. If such techniques are used, a detailed description of the process and design data shall accompany the plans.

10.13 SLUDGE TREATMENT ALTERNATIVES FOR PATHOGEN REDUCTION

10.13.1 General

The USEPA published a new regulation, 40 CFR-Part 503, in 1993. This regulation addresses the beneficial use and disposal of biosolids generated from the treatment of municipal sewage sludge. The regulation covers general provisions, land application, surface disposal, pathogen reduction, vector attraction reduction, and incineration. The section of the regulation that may impact Atlantic Canada is that, as a result of the classification of digested sludge into Class A or Class B and the corresponding restrictions placed on their disposal, processes to further reduce pathogens (PFRP's) are being developed and marketed.

The purpose of this section will be to describe some of the sludge digestion methods and PFRP's that have become popular in the US as a result of Rule 503. These methods may have application in Atlantic Canada wherever a need exists for a high quality end product due to restrictions that may exist for final disposal.

10.13.2 Processes to Further Reduce Pathogens (PFRP)

Unstabilized sludge contains putrescible organic substances, as well as pathogenic forms of bacteria, viruses, worm eggs, and the like. Sludge treatment processes that are classified as processes to further reduce pathogens must reduce both the organics and pathogens to set levels. PFRP alternatives include composting, heat drying, heat treatment, autothermal thermophilic aerobic digestion, irradiation, and pasteurization. The most applicable of the above processes will be described here.

10.13.2.1 Composting

Composting is a process in which organic material undergoes biological degradation to a stable end product. Sludge that has been composted properly is a sanitary, nuisance-free, humus-like material. Approximately 20 to 30 percent of the volatile solids are converted to carbon dioxide and water. As the organic material in the sludge decomposes, the compost heats to temperatures in the pasteurization range of 50 to 70^0 C, and enteric pathogenic organisms are destroyed. A properly composted sludge may be used as a soil conditioner in agricultural or horticultural applications or for final disposal, subject to any limitations based on constituents in the sludge.

Most composting operations consist of the following basic steps: (1) mixing dewatered sludge with an amendment and/or a bulking agent: (2) aerating the compost pile either by the addition of air, by mechanical turning, or by both; (3) recovery of the bulking agent (if practicable); (4) further curing and storage; and (5) final disposal. An amendment is an organic material added to the feed substrate, primarily to reduce the bulk weight and increase the air voids for proper aeration. Amendments can also be used to increase the quantity of degradable organics in the mixture. Commonly used amendments are sawdust, straw, recycled compost and rice hulls. A bulking agent is an organic or inorganic material used to provide structural support and to increase the porosity of the mixture for effective aeration. Wood chips are the most commonly used bulking agents and can be recovered and reused. Aeration is required not only to supply oxygen, but to control the composting temperature and remove excess moisture.

Three major types of composting systems used are the aerated static pile, windrow, and in-vessel (enclosed mechanical) systems.

10.13.2.1.1 *Aerated Static Pile*

The aerated static pile system consists of a grid of aeration or exhaust piping over which a mixture of dewatered sludge and bulking agent is placed. In a typical static pile system, the bulking agent consists of wood chips, which are mixed with the dewatered sludge by a pug mill type or rotating drum mixer or by movable equipment such as a front-end loader. Material is composted for 21 to 28 days and is typically cured for another 30 days of longer. Typical pile heights are about 2 to 2.5 m. A layer of screened compost is often placed on top of the pile for insulation. Disposable corrugated plastic drainage pipes commonly used for air supply and each individual pile is recommended to have an individual blower for more effective aeration control. Screening of the cured compost is usually done to reduce the quantity of the end product requiring ultimate disposal and to recover the bulking agent. For improved process and odour control, many new facilities cover or enclose all or significant portions of the system.

10.13.2.1.2 *Windrow*

In a windrow system, the mixing and screening operations are similar to those for the aerated static pile operation. Windrows are constructed from 1 to 2 m high and 2 to 4.3 m at the base. The rows are turned and mixed periodically during the composting period. Supplemental mechanical aeration is used in some applications. Under typical operating conditions, the windrows are turned a minimum of five times while the temperature is maintained at or above 55 °C. Turning of the windrows is often accompanied by the release of offensive odours. The composting period is about 21 to 28 d. In recent years, specialized equipment has been developed to mix the sludge and the bulking agent and to turn the composting windrows. Some windrow operations are covered or enclosed, similar to aerated static piles.

10.13.2.1.3 *In-Vessel Composting Systems*

In-vessel composting is accomplished inside an enclosed container or vessel. Mechanical systems are designed to minimize odours and process time by controlling environmental conditions such as air flow, temperature, and oxygen concentration.

10.13.2.1.4 *Design Considerations*

The factors that must be considered in the design of a composting system are presented in the following table:

TABLE 10.15 - DESIGN CONSIDERATIONS FOR AEROBIC SLUDGE COMPOSTING PROCESSES

ITEM	COMMENT
Type of Sludge	Both untreated and digested sludge can be composted successfully. Untreated sludge has a greater potential for odors, particularly for windrow systems. Untreated sludge has more energy available, will degrade more readily, and has a higher oxygen demand.
Amendments and Bulking Agents	Amendment and bulking agent characteristics, such as moisture content, particle size, and available carbon, affect the process and quality of the product. Bulking agents should be readily available. Wood chips, sawdust, recycled compost, and straw have been used.
Carbon : Nitrogen Ratio	The initial C:N ratio should be in the range of 25:1 to 35:1 by weight. Carbon should be checked to ensure it is easily biodegradable.
Volatile Solids	The volatile solids of the composting mix should be greater than 50 percent.
Air Requirements	Air with at least 50 percent of the oxygen remaining should reach all parts of the composting material for optimum results, especially in mechanical systems.
Moisture Content	Moisture content of the composting mixture should not be greater than 60 percent for static pile and windrow composting and not greater than 65 percent for in-vessel composting.
pH	pH of the composting mixture should generally be in the range of 6 to 9.
Temperature	The optimum temperature for biological stabilization is between 45 and 55 °C. For best results, the temperature should be maintained between 50 and 55 °C for the first few days and between 55 and 60 °C for the remainder of the composting period. If the temperatures are allowed to increase beyond 60 °C for a significant period of time, biological activity will be reduced.
Mixing and Turning	To prevent drying, caking, and air channelling, material in the process of being composted should be mixed or turned on a regular schedule as required. Frequency of mixing or turning will depend on the type of composting operation.
Heavy Metals and Trace Organics	Heavy metals and trace organics in the sludge and finished compost should be monitored to ensure that the concentrations do not exceed the applicable regulations for end use of the product.
Site Constraints	Factors to be considered in selecting a site include available area, access, proximity to treatment plant and other land uses, climatic conditions, and availability of buffer zone.

10.13.2.1.5 Co-Composting with Solid Wastes

Co-composting of sludge and municipal solid wastes may not require sludge dewatering. Feed sludges may have a solids content ranging from 5 to 12 percent. A 2 to 1 mixture of solid wastes to sludge is recommended as a minimum. The solid wastes should be presorted and pulverized in a hammermill prior to mixing with sludge.

10.13.2.2 Autothermal Thermophilic Aerobic Digestion (ATAD)

10.13.2.2.1 General

With an adequate supply of oxygen, microorganisms, nutrients, and biodegradable organic material, autothermal aerobic digestion can degrade complex organic substances into end products including carbon dioxide and water. Some of the energy released by microbial degradation is used to form new cellular material; much of it is released as heat. Typical biological heat production values reported or assumed range from 14,190 to 14,650 kJ/kg O_2. The carbonaceous oxygen requirements vary, but are often considered to be 1.42 kg O_2/kg volatile suspended solids (VSS) oxidized. In autothermal thermophilic aerobic digestion, the heat released by the digestion process is the major heat source used to achieve the desired operating temperature.

Autothermal conditions result from an adequately thickened sludge feed, a suitably insulated reactor, good mixing, and heat loss to an acceptable level.

10.13.2.2.2 *Sludge Feed Source and Thickening Requirements*

Autothermal thermophilic aerobic digestion (ATAD) processes thicken the sludge prior to digestion to minimize the size of the digestion tanks and to limit the energy requirements for mixing and heating.

A sludge in an ATAD system is adequate to support process temperature requirements if it is thickened to 4-6% TSS, of which at least 2.5% is mostly biodegradable volatile solids. Gravity thickening can usually achieve this concentration. Some plants also successfully co-thicken the waste-activated sludge with the primary solids and thereby avoid the need for a separate sludge thickener.

Sludge form plants without primary clarifiers and with activated sludge food-to-mass ratio (F/M) loadings as low as 0.1 to 0.15 kg BOD_5/kg TVSS still seems to be suitable for ATAD.

10.13.2.2.3 *Detention Time*

To satisfy the process requirements for destruction of pathogens and total organic solids, the design hydraulic detention time for ATAD systems is established at 5 to 6 d (2.5 to 3 d per reactor). Sixty percent of the volatile solids destruction occurs in the first reactor.

10.13.2.2.4 *Feed Cycle and Isolated Reaction Time*

Batch Feeding is Established by design intent and is reflected in the sizing of the sludge feed pump(s). The feed sludge pumping system is sized to deliver the daily thickened sludge volume to the reactor in less than 1 hour. Since all the sludge is pumped within a 1 hour period, the reactors are isolated for the remaining 23 hours during each day. This undisturbed reaction time is considered an important factor in attaining a high degree of pathogen destruction.

10.13.2.2.5 *Aeration and Mixing*

Typical design ranges for empirical aeration/mixing parameters include:

Specific power:	85-105 W/m^3 of active reactor volume
Air Input:	4 m^3/hr/m^3 of active reactor volume
Energy requirement:	9-15 kWh/m^3 of sludge throughput

10.13.2.2.6 *Temperature and pH*

An average temperature of 55 °C in the second reactor is used for design purposes. The temperature in the second reactor can exceed 55 °C. However, to prevent resolubilization of organics, the temperature should not exceed 65 °C.

The design areas that most affect operating temperature include the efficiency of the aeration system, reactor insulation, foam management in the reactor, and sludge prethickening.

Generally, process pH does not have to be controlled by special design considerations. The thermophilic operating temperatures of the reactors suppress nitrification in the process. Consequently, the pH depressions that could occur in a nitrifying environment are not experienced. With a feed sludge pH of 6.5, pH values in the first reactor are typically near 7.2 and may approach 8.0 in the second reactor.

10.13.2.2.7 *Foam Control*

The foam layer in the treatment reactor plays an important role in the ATAD process, though this role has not been fully evaluated. The foam layer appears to improve oxygen utilization, enhance the biological activity, and provide insulation, but it retards the amount of air entering the reactor. The amount of foam should be optimized and not eliminated.

Treatment reactors are sized to accommodate about 0.5 to 1.0 m of freeboard, which is partially used as volume for foam development and control. Control consists of densifying the foam (i.e., breaking up the large foam bubbles) to form a compact layer floating above the liquid surface of the reactor.

10.13.2.2.8 *Post Thickening / Dewatering*

In general, the gravity thickening performance of the hot effluent sludge is poor immediately after treatment, due to the thermal convection currents that occur in a thickening tank. If the sludge is allowed to cool in the post-thickening/storage tank or additional heat exchangers exist that cool the sludge down, thickening performance is usually satisfactory. Old Imhoff tanks have been very suitable for post-thickening. Values of 6-9% TS are typically achieved.

10.13.2.2.9 *Detailed Design Manual*

The following sources contain detailed design information for natural wastewater treatment systems:

U.S. Environmental Protection Agency: *Autothermal Thermophilic Aerobic Digestion of Municipal Wastewater Sludge*, EPA 625/ 10-90-007, Washington, DC, 1990.

10.13.2.3 *Heat Drying*

Heat drying of sludge involves the supply of auxiliary heat to mechanical drying processes in order to increase the vapour holding capacity of the ambient air and to provide the latent heat necessary for evaporation. Temperatures of greater than 80 °C are required in this process.

10.13.2.4 *Heat Treatment*

Heat treatment is a continuous process in which sludge is heated in a pressure vessel to temperatures up to 260 °C for approximately 30 minutes. This serves as both a stabilization process and a conditioning process. It conditions the sludge by rendering the solids capable of being dewatered without the use of chemicals. When the sludge is subjected to the high temperatures and pressures, the thermal activity releases bound water and results in the coagulation of solids. In addition, hydrolysis of proteinaceous materials occurs, resulting in cell destruction and release of soluble organic compounds and ammonia nitrogen.

10.13.3 **Restrictions for Sludge Utilization on Land**

Sludge that has been treated by a PFRP may have less restrictions placed on its disposal if it can be shown that the levels of pathogens and VSS have been reduced to the satisfaction of the regulatory authority.

Environment Canada Environnement Canada

Atlantic Canada Standards and Guidelines Manual

Operations Section

New Nouveau Brunswick

OPERATIONS SECTION

This section of the manual is intended to present minimum required operations standards and guidelines for all new or modified sewerage systems. In the event that a particular Municipality has incorporated its own operations criteria, the most stringent of the two procedures shall govern.

1.1 PLANT CLASSIFICATION

All new or expanded municipal sewage treatment plants and collection systems within Atlantic Canada should be classified. Classification is mandatory in the province of Nova Scotia. Classification criteria and requirements are described in Policy Section 3.1.

1.2 OPERATOR CLASSIFICATION

All owners of municipal wastewater facilities within Atlantic Canada should have one or more certified operators at the same level, or higher, as the facility classification. Classification criteria and requirements are described in Policy Section 3.2. These requirements will be mandatory in Nova Scotia as of January 1, 1997, for Class I facilities; as of January 1, 1998, for Class II facilities; as of January 1,1999, for Class III facilities; and as of January 1, 2000, for Class IV facilities. In New Brunswick, Newfoundland, and Prince Edward Island, certification requirements are being administered under a voluntary certification program. If and when operator certification becomes mandatory in these provinces, levels achieved under the voluntary program will still be valid.

1.3 OPERATOR TRAINING

"Continuing Education Units" - Specialized operator training courses, seminars, workshops, approved technical conferences, etc., may be substituted for experience requirements (either operating or DRC), subject to the 50 per cent limitation previously described in Policy Section 3.2. Calculation will be based on Continuing Education Units (CEU's) with 45 considered equal to 1 year.

Operating staff should be given an opportunity to continually upgrade their experience and knowledge in the operation and maintenance of wastewater treatment facilities. They should be encouraged to participate in seminars, courses, and demonstrations sponsored by Federal, Provincial and other agencies which are likely to improve their overall operating capability.

2.1 OPERATION AND MAINTENANCE MANHOURS

Figure 2.1 outlines overall manpower requirements for each class of wastewater treatment facility over a wide range of average design flows. The information presented is to assist those seeking to project future wastewater treatment plant staffing requirements as a basis for planning of manpower training programs. The data can also be used as planning a guide for staffing requirements for individual conventional treatment plants, provided recognition is given to the "average" nature of the estimating data, and judgement is applied regarding specific local circumstances.

2.2 REQUISITE SKILLS

Individual wastewater treatment personnel may generally be classed into one of the following groups:

(a) Supervisory personnel;
(b) Operating personnel;
(c) Maintenance personnel; or
(d) Laboratory technical.

Figure 2.2 presents an organizational chart for a hypothetical wastewater treatment plant, and outlines these four general classes. This figure also illustrates the relative positions of personnel of differing responsibilities.

The following skill requirements are minimal for successful performance of specific required duties. These are only a guide and additional requirements for the particular plant location should be analyzed.

- Supervisory Personnel (level of ability depends on size and type of plant - at least high school education or equivalent, should display better than average ability to:

  1. Use and manipulate basic arithmetic and geometry.
  2. Think in terms of general chemistry and physical sciences.
  3. Understand biological and biochemical actions.
  4. Grasp meaning of written communications.
  5. Express thoughts clearly and effectively, both verbally and in writing.

  In addition, supervisory personnel are often responsible for:

  1. Public relations
  2. Bookkeeping
  3. Analysis and presentation of data
  4. Budget requests
  5. Report writing
  6. Personnel
  7. Safety educational program
  8. Contracts, specifications and codes
  9. Estimates and costs
  10. Plant Library

FIGURE 2.1
MANPOWER REQUIREMENTS vs. PLANT SIZE

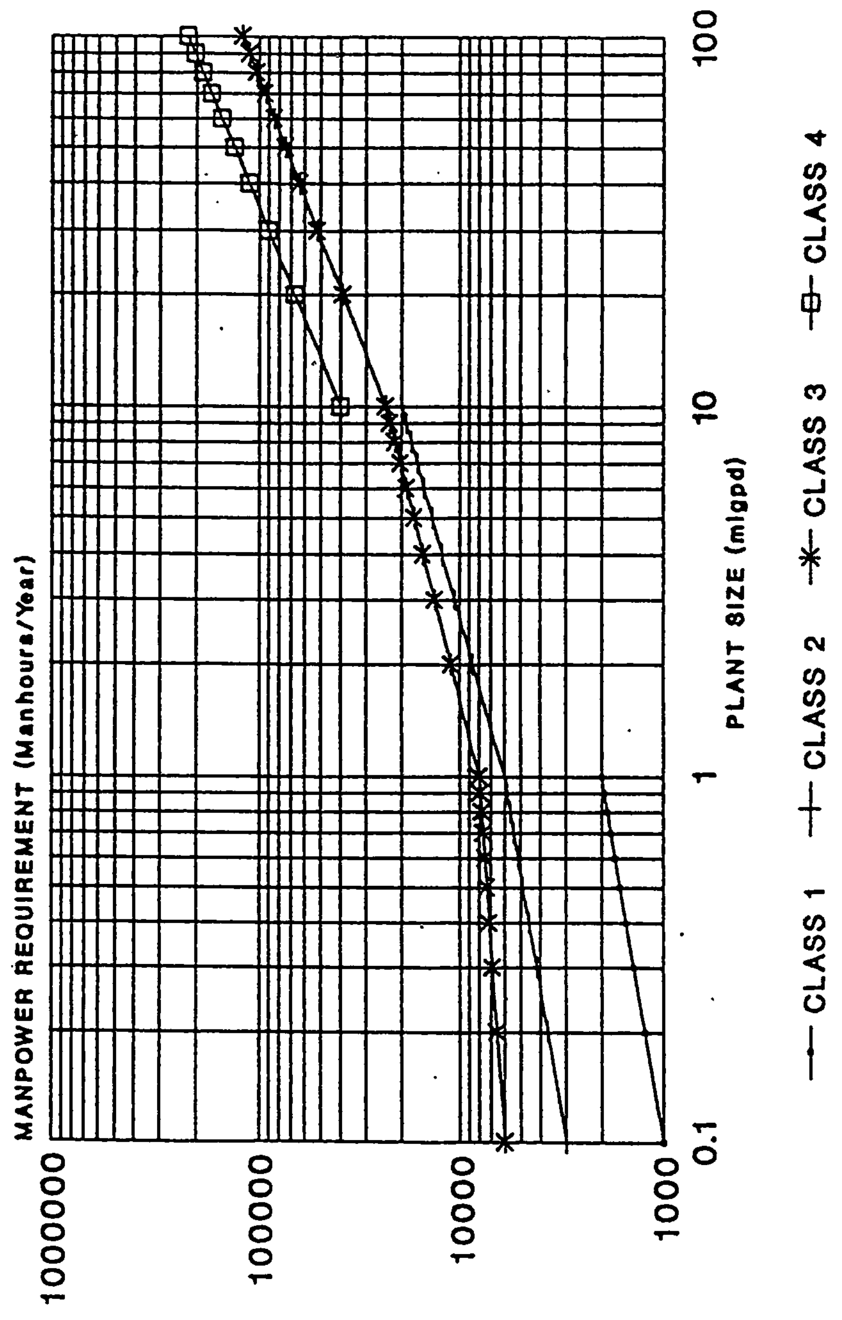
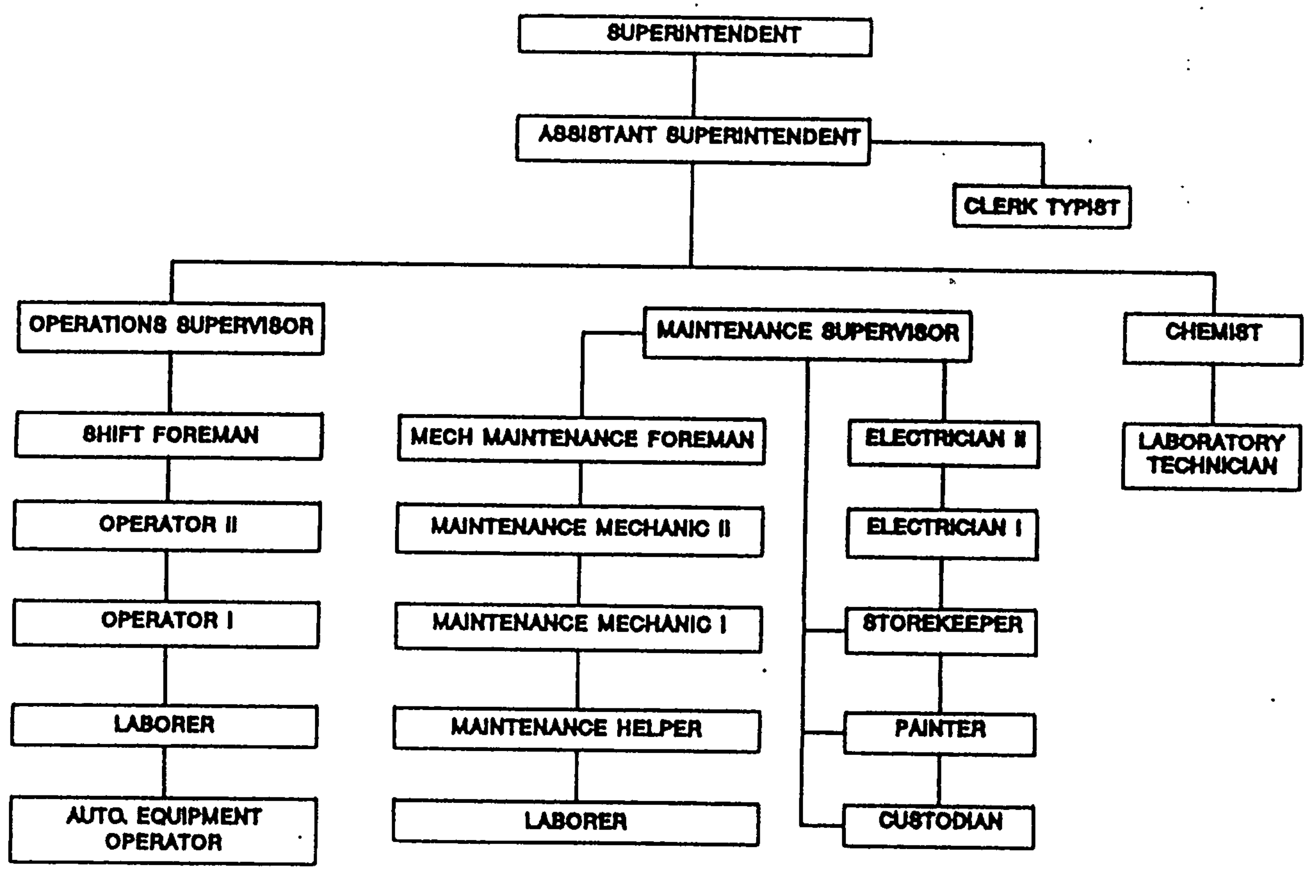


FIGURE 2.2
ORGANIZATIONAL CHART
CONVENTIONAL WASTEWATER TREATMENT PLANT



- Laboratory Technicians - require training in laboratory procedures and mathematics

- Operating Personnel - require training in:

  1. Fundamentals of wastewater treatment processes, including chemistry and biology.

- Maintenance Personnel - must be familiar with and capable of:

  1. Mechanical repairs
  2. Electrical and electronic repairs.

2.3 JOB DESCRIPTIONS

Job descriptions for the types of personnel commonly employed for the operation and maintenance of conventional wastewater treatment systems are defined in the USEPA Manual "Estimating Costs and Manpower Requirements for Conventional Wastewater Treatment Facilities", contract No. 14-12-462.

A job description for a specific occupation may include details from several of the above categories depending upon the flexibility required. However, a good job description should include but is not necessarily limited to the following:

- List items or processes that an individual must operate.
- State if monitoring of gauges or meters is required.
- Discuss interpreting of any meter or gauge readings for process control actions.
- List any logs or records to be maintained.
- Outline any maintenance duties required.
- State any other title that an individual might carry.
- Discuss decision making requirements.
- State responsibilities and authority given to an individual in the job being described.
- List any report or budget functions that must be performed.
- Discuss any supervisory or inspection functions.

3.1 GENERAL

The requirements for treatment process control will depend on the size of plant and types of process employed. In general, treatment process control should provide safe and efficient manual and automatic operation of all parts of the plant, with minimal operator effort, and all automatic controls should be provided with manual back-up systems.

In making the decisions relating to treatment process control, the following factors should be considered:

- plant size;
- effluent requirements;
- plant process complexity;
- hours in day plant will be manned;
- potential chemical and energy savings with automation;
- reliability of primary devices for parameter measurement;
- preferred location for primary device;
- parameters with useful significance to process;
- equipment which should be controlled manually;
- equipment which should be remotely controlled;
- equipment which should be locally controlled;
- data requiring display at the control centre;
- indication, totalization and recording functions necessary to the overall process

3.2 REMOTE CONTROL vs. LOCAL CONTROL

Where some parts of a plant may be operated or controlled from a remote location, local control stations should be provided and shall include the provision for preventing operation of the equipment from the remote location. Consideration should be given to providing communication via intercom between remote stations and the local stations. In some cases, the use of television equipment may be justified to provide scanning centres as well as process equipment. Decisions will have to be made by the designer as to which equipment will be controlled locally and which will be controlled from a remote location, and whether control will be automatic or manual.

3.2.1 Supervisory Control and Data Acquisition (SCADA)

At wastewater treatment plants, SCADA systems can be used to control and monitor wastewater collection systems. SCADA systems operate using modems over voice-grade phone lines, radio systems, direct burial cable, or cable TV. If radio-based telemetry systems are used, special attention should be given to the design and layout to eliminate any potential for radio frequency interference (RFI).

Interface to the plant control system ranges from a simple contact closure to a sophisticated digital link with a special protocol requiring special software to be written and supported by the plant control system vendor. Special software should be avoided because it may be difficult to get support from the vendor once the project has been accepted.

3.3 LABORATORY CONTROL

3.3.1 Parameters Requiring Measurement

For proper operation of larger sewage treatment plants, the following parameters should be measured (however for smaller plants some of the parameters could be omitted):

- sewage flow rates, including raw sewage, by-passed flows, and flows through plant subsections (flow trains);
- chlorine dosage and chlorine residual;
- sludge pumpage, including raw, digested sludges and activated sludge return;
- digester supernatant flows;
- chemical dosage;
- digester gas production and utilization;
- anaerobic digester temperature; and
- hazardous gas levels.

Auxiliary instrumentation is desirable to measure the following parameters:

- air flow;
- mixed liquor dissolved oxygen concentrations;
- sludge blanket levels;
- sludge concentrations.

3.3.2 Sampling

3.3.2.1 General

Quantity and quality data is required to effectively control the various unit operations such as pumping, sludge loading on digesters, digester heating, sludge disposal operations and chlorination feed rates. In addition, this data is required to distribute charges for treatment among the various municipal districts and industries involved. The recorded data will also be extremely helpful in the design of future treatment facilities as the plant is expanded. Sampling and testing of the treatment plant effluent will not only provide an indication of plant efficiency but will also ensure that the effluent quality is within acceptable guidelines and will facilitate the calculation of the effect of the effluent on the receiving waters.

3.3.2.2 Sampling Location Points

The location of appropriate sampling points must be established independently for each treatment plant as conditions vary from one plant to another. However, certain general principles are common to all plant sampling surveys and some of these principles are listed below as guidelines to establishing a sampling program:

- Samples should be taken at locations where the wastewater or sludge is as completely mixed as possible;
- Particles greater than one-quarter inch in diameter should be excluded when sampling;

- Any floating materials, growths, deposits, etc., which may have collected at a sampling location should not be included when sampling;
- If samples are to be kept for an hour or more prior to testing, they should be immersed in ice water to retard bacterial action;
- Proper sampling equipment should be provided and safety precautions should be exercised during all sampling;
- Consideration should be given to the relationship between the plant's daily flow variation and detention time through the units so that influent and effluent samples relate to the same waste.

3.3.2.3 *Frequency of Sampling*

The frequency of sampling will depend upon the variability of the waste stream under consideration as well as practical limitations associated with the treatment plant size, loading, staff and hours of supervision. However, continuing routine sampling to monitor plant performance and effluent quality should be undertaken on a regularly scheduled basis. More intensive sampling and testing may be required to assess unit operation performance and the effect of corrective action in the event of an upset.

It is important to point out that the size of a treatment plant is not necessarily indicative of the number and frequency of tests and analyses performed. Rather this should be determined by the seriousness of the possible effects of the treatment plant effluent on the receiving stream or body of water.

Figure 3.1 presents a sample format for a Laboratory Sampling Program.

3.3.3 Tests and Procedures

Although wastewater treatment plants may vary in size and degree of treatment, there are specific basic tests that are applicable to any plant which provide information required for process control. The following list places in order of importance the samples and analyses required within these plants.

Influent or Raw Sewage

a) settleable solids
b) total solids
c) suspended solids
d) volatile suspended solids
e) BOD
f) COD
g) pH
h) phosphates
i) nitrates
j) chlorides

FIGURE 3.1
SAMPLE LABORATORY TESTING PROGRAM

	SETTLEABLE SOLIDS	SUSPENDED SOLIDS	BOD	CHLORINE RESIDUAL	GREASE	TOTAL DISSOLVED SOLIDS	COLIFORM ORGANISMS	VOLATILE SUSPENDED SOLIDS	DISSOLVED OXYGEN	TOTAL SOLIDS	TOTAL VOLATILE SOLIDS	pH
RAW SEWAGE	C / D	C / D	C / D			C / W		C / D		C / W	C / W	
PRIMARY EFFLUENT	C / D	C / D	C / D					C / D		C / W	C / W	
SECONDARY EFFLUENT	C / D	C / D	C / D		C / W			C / D		C / W	C / W	
CHLORINE CONTACT TANK				G / *								
MIXED LIQUOR		C / D										
PLANT EFFLUENT			C / W	G / D2		C / W	C / W		G / D			
RAW SLUDGE										C / W	C / W	C / W
DIGESTED SLUDGE										G / W	G / W	G / W

LEGEND

TYPE OF SAMPLE
C - COMPOSITE SAMPLE
G - GRAB SAMPLE
* - EVERY 4 HOURS

FREQUENCY
D - DAILY
W - WEEKLY
D2 - TWICE DAILY

TYPE OF SAMPLE / FREQUENCY

Grit

a) moisture content
b) dry solids
c) volatile solids
d) sieve tests

Primary Effluent

a) total solids
b) suspended solids
c) volatile suspended solids
d) BOD
e) pH
f) COD
g) total phosphate
h) orthophosphate

Aeration Section

a) half-hour settling test of mixed liquor
b) suspended solids in mixed liquor
c) volatile suspended solids in mixed liquor
d) sludge volume index
e) dissolved oxygen
f) pH
g) solids in return and waste activated sludge

Secondary Effluent

a) total solids
b) suspended solids
c) volatile suspended solids
d) BOD
e) pH
f) COD
g) total phosphate
h) orthophosphate

Chlorine Contact Tank

a) chlorine residual
b) fecal coliform bacterial count

Final Effluent

a) total solids
b) suspended solids
c) volatile suspended solids

d) BOD
e) chlorine residual
f) fecal coliform bacterial count
g) dissolved oxygen (DO)
h) pH
i) COD
j) total phosphate
k) orthophosphate
l) ammonia

Raw Sludge

a) pH
b) dry solids
c) volatile solids

Waste Activated Sludge Thickening

a) solids in feed sludge
b) solids in discharge sludge
c) suspended solids in filtrate or centrate
d) percent volatile in suspended solids of filtrate or centrate

Digested Sludge and Digester Supernatant

a) pH
b) total solids
c) volatile solids
d) volatile acids
e) alkalinity

Digester Gas

a) percent methane
b) gas production

Cake from Vacuum Filter or Centrifuge

a) total solids
b) volatile solids
c) phosphates
d) nitrates

Filtrate or Centrate

a) pH
b) total solids
c) suspended solids
d) volatile suspended solids

Incinerator Ash

a) dry solids
b) volatile solids

Lagoons, Oxidation Ponds and Community Septic Plants

Facilities of this nature, usually serving small communities, are not generally subject to operator control. As a result relatively little laboratory facilities are provided and sampling cannot be extensive.

Influent or Raw Sewage

a) pH
b) suspended solids
c) volatile suspended solids
d) BOD

Lagoon Contents

a) DO
b) temperature
c) pH

Effluent

a) pH
b) suspended solids
c) volatile suspended solids
d) BOD
e) coliform bacterial count
f) chlorine residual

For lagoons and oxidation ponds it is most important that careful observation of the condition of the lagoon should be noted and recorded, particularly the presence of colour, algae or odours.

3.4 PROCESS CONTROL TECHNIQUES

There are two main types of process control techniques within a wastewater treatment plant. These include manual control and on-line control. Under the manual control system there is limited automatic control and the operator is responsible for decisions and actions. On-line control involves a multi-purpose computerized system with limited scope for modification or a dedicated purpose system with standard hardware and customized software.

Whether process control involves manual or on-line control, or a combination of both, the operation and maintenance manual shall fully describe specific process control techniques.

3.5 OWNER/OPERATOR RESPONSIBILITY

Apart from those issues outlined in Policy Section 3.3.1, the owner/operator of a wastewater treatment or collection facility shall be responsible for the sampling and analysis requirements for the proper operational control of the facility. These requirements shall be in accordance with Operations Section 3, and shall ensure the proper control of day-to-day operations of the system.

3.6 REGULATORY AGENCIES' RESPONSIBILITY

The regulatory agencies are only responsible for compliance enforcement. They shall not be responsible for any aspect of process control at any wastewater treatment or collection facility.

3.7 REFERENCES

The following is a list of references which will assist operating staff in performing the necessary sampling, laboratory and control procedures to effectively operate a treatment system:

1. "Standard Methods for the Examination of Water and Sewage," APHA, AWWA, WPCF;
2. EPA publication 6003 "Methods for Chemical Analysis of Water and Wastes";
3. WPCF Manual of Practice No. 18, "Simplified Laboratory Procedures for Wastewater Examination";
4. WPCF Manual of Practice No. 11, "Operation of Wastewater Treatment Plants";
5. "Laboratory Procedures for Wastewater Treatment Plant Operators", New York State Department of Health;
6. "Manual of Instruction for Sewage Treatment Plant Operators", New York State Department of Health;
7. "Chemistry for Sanitary Engineers", Sawyer, McGraw-Hill;
8. "Methods for Chemical Analysis of Water and Wastewater", EPS Surveillance Report 5-AR-73-16;
9. EPA Publication 6001 "Handbook for Analytical Quality Control in Water and Wastewater Laboratories";
10. EPA Publication, "Procedures for Evaluating Performance of Wastewater Treatment Plants", Contract No. 68-01-0107;

11. EPA Publication, "Estimating Laboratory Needs for Municipal Facilities", Contract No. 68-01-0328.

12. "Manual on Wastewater Sampling Practice", The Canadian Institute on Pollution Control;

13. EPA Publication, "Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities", Contract No. 68-01-4418;

14. EPA Publication, "Process Control Manual for Aerobic Biological Wastewater Treatment Facilities", EPA-430/9-77-006.

4.1 USE OF MANUALS

The purpose of an O & M Manual is to give treatment system personnel the proper understanding, techniques and references necessary to efficiently operate their facilities. The O & M Manual should help to ensure the performance record of a treatment system remains high. The manual should thus serve as a tool for operating and maintenance personnel of the plant.

4.2 RECOMMENDED FORMAT

4.2.1 General

The formats presented in this section are intended to be a flexible guide for the preparation of an O & M Manual for a wastewater treatment system and wastewater pumping stations and/or pipelines. They can be modified to fit the particular system at hand. It is anticipated that these formats can be used in most cases. If manual preparation follows these formats, the review process will be greatly accelerated.

Each of the twelve (12) chapters and the appendices in the suggested guide is addressed in the reference manual: "Consideration for Preparation of Operation and Maintenance Manuals" (US EPA 430/9-74-001). Detailed descriptions of the type information required in that respective chapter of the O & M Manual are given.

It should be remembered that the O & M Manual will provide assistance in developing standard operating procedures for each system. The adequacy of these procedures plays a major role in determining how well the system will operate. The O & M Manual should provide the necessary information to insure these standard operating procedures can be readily developed. Once an acceptable set of procedures has been established, the O & M Manual becomes a reference book for the entire treatment system.

4.2.2 Suggested Guide and Checklist for an Operation and Maintenance Manual for Municipal Wastewater Treatment Facilities

Chapter I - Introduction

Manual User Guide
Table of Contents

A. **Operation and managerial responsibility**

1. Operator responsibility

   a) General - outline responsibilities

      (1) Know proper operational procedures
      (2) Keep accurate records
      (3) Properly manage operating funds

(4) Keep supervisors informed
(5) Keep informed of current O & M practices.

b) List short courses available.

c) Provide suggested list of journals/periodicals related to municipal wastewater treatment.

2. Treatment system management responsibility - outline responsibilities.

a) Maintain efficient plant operation and maintenance

b) Maintain adequate records

c) Establish staff requirements, prepare job descriptions and assign personnel

d) Provide good working conditions

e) Establish operator training program

f) Provide incentives for employees

g) Maintain good public relations

h) Prepare budgets and reports

i) Plan for future facility needs

j) Develop standard operating procedures.

B. Type of treatment and treatment requirements/effluent limitations

1. Type of treatment - Describe major process

a) Primary
b) Secondary - RBC, trickling filter
c) Secondary - activated sludge
d) Other

2. Treatment requirements/effluent limitations - state whether monthly or yearly averages are used

a) Biochemical oxygen demand (BOD)
b) Suspended solids concentrations
c) pH
d) Other

C. Description of plant type and flow pattern

1. Plant type - Briefly describe individual units

   a) Pretreatment
   b) Primary treatment
   c) Secondary treatment
   d) Disinfection
   e) Sludge handling

2. Flow Pattern

   a) Include a basic flow diagram
   b) Bypasses and alternate flow paths can generally be omitted from this introductory diagram.

Chapter II Permits and Standards

Table of Contents

A. Discharge permit and permit requirements

1. Give permit number
2. Give renewal date if applicable
3. List permit requirements
4. Include permit application guidelines
5. Copy of permit sections dealing with municipal wastewater discharge permits should be included

B. Reporting procedure for spills of raw or inadequately treated wastewater.

1. Include copies of permit sections requiring reporting of bypass/spill condition.

   a) Discuss owner's responsibilities
   b) Discuss penalties

2. Outline reporting procedure to include telephone numbers and sample report format.

C. Water Quality Standards

1. Include a copy of Provincial quality standards for receiving waters of treatment plant's effluent
2. Include a copy of Provincial receiving waters classification system.

Chapter III. Description, Operation and Control of Wastewater Treatment Facilities

Table of Contents

A. General - Each major wastewater treatment unit/process should be discussed separately with respect to the following considerations:

1. Description

a) Provide a brief general description with each major treatment unit/process discussed.

1) Pretreatment
2) Primary sedimentation
3) Biological process
4) Secondary sedimentation
5) Disinfection
6) Other

b) The description should physically trace the wastewater through the unit/process and comment on design efficiency.

2. Relationship to adjacent units

a) Give type and function of any or all preceding units/processes as they relate to unit/process being considered.

b) Give type and function of any or all following units/processes as they relate to unit/process being considered.

3. Classification and Control

a) Classification - Briefly describe relation to similar units/processes

1) Standard/conventional
2) Modified
3) Other

b) Control - give methods of controlling unit/process

1) Flow to plant
2) Recirculation pumps
3) Air supply
4) Sludge return/wasting rates
5) Other (physical and process controls)

4. Major components

   a) List all components within the unit/process
   b) List all major mechanical equipment items within the unit/process
   c) Other

5. Common operating problems

   a) State problems that might occur in unit/process
   b) List probable causes
   c) Discuss control/prevention techniques

6. Laboratory Controls

   a) List tests and give expected ranges for test results
   b) Give relation between test results and treatment unit/process operation

7. Start-up - give start-up technique

B. Specific Plant Operation

1. Normal Operation

   a) Discuss the normal operation of each unit/process. This discussion should include the following information as it may apply to the particular unit/process

      1) Valve positions
      2) Sluice gate settings
      3) Weir elevations
      4) Sludge rake speeds
      5) Pump settings
      6) Recirculation rates
      7) MLSS concentrations
      8) Other

2. Alternate Operation

   a) List alternate modes of operation
   b) Provide discussion and schematics to illustrate alternate operations.

3. Emergency Operations and Failsafe Features

   a) Discuss emergency operating procedures for potential emergency conditions
   b) List failsafe features
   c) Describe operation of failsafe features.

Chapter IV Description, Operation and Control of Sludge Handling Facilities

Table of Contents

A. General - each major sludge handling unit/process should be discussed separately with respect to the following considerations:

1. Description

a) Provide a brief general description with each major unit/process discussed.

1) Concentration/thickening
2) Digestion
3) Conditioning
4) Dewatering/drying
5) Incineration
6) Wet oxidation
7) Disposal
8) Other

b) The description should physically trace the sludge through the unit/process and comment on how the character of the sludge is altered.

2. Relationship to adjacent units

a) Describe type and function of any or all preceding units/processes as they relate to unit/process being considered

b) Describe type and function of any or all following units/processes as they relate to process being considered.

3. Classification and control

a) Classification - Describe relation to similar units/processes

1) Standard/conventional
2) Modified
3) Other

b) Control - Give methods of controlling unit/process

1) Recirculation pumps
2) Aerobic digestion air supply
3) Conditioning chemicals
4) Temperature
5) Other

4. Major components
    a) List all components within the unit/process
    b) List all major mechanical equipment items within the unit/process
    c) Other

5. Common operating problems
    a) State problem that might occur in unit/process
    b) List probable causes
    c) Discuss control/prevention techniques

6. Laboratory controls
    a) List tests and give expected ranges for test results
    b) Give relation between test results and treatment process operation

7. Start-up - give start-up techniques

B. Specific Plant Operation

1. Normal operation
    a) Discuss the normal operation of each unit/process. This discussion should include the following information as it may apply to the particular unit/process
        1) Valve positions
        2) Heat requirements
        3) Sludge blanket depths
        4) Sludge pumping schedule
        5) Sludge collector/stirring speeds
        6) Vacuum filter hours of operation
        7) Other

2. Alternate Operation
    a) List alternate modes of operation
    b) Provide discussion and schematics to illustrate alternate operations

3. Emergency operations and failsafe features
    a) Discuss emergency operating procedures for potential emergency conditions
    b) List failsafe features
    c) Describe operation of failsafe features.

Chapter V - Personnel

Table of Contents

A. Manpower Requirements/Staff - List personnel required

1. Supervisors
2. Administrative
3. Operational
4. Maintenance

B. Qualifications

1. For each job title give:

   a) Training
   b) Experience
   c) Skills required
   d) Certificate required

C. Certification Program

1. Include copy of permit section regarding training courses required.

2. Discuss pertinent aspects of operator certification as they apply to the facility at hand.

Chapter VI. Laboratory Testing

Table of Contents

A. Purpose - to discuss purpose of laboratory testing

1. Essential to treatment process control
2. Provides an operating record for treatment system
3. Aids in problem analysis and prevention.

B. Sampling

1. Give grab sample definition
2. Give composite sample definition
3. Outline a sampling program for the treatment system

C. Laboratory References - List pertinent references

1. WPCF MOP No. 18, Simplified Laboratory Procedures for Wastewater Examination
2. Process Control Laboratory Course, WPCF and Environment Canada

3. Standard Methods for the Examination of Water and Sewage
4. Other

D. **Interpretation of Laboratory Tests - give brief definition and sanitary engineering application for all tests**

1. pH
2. Dissolved oxygen (DO)
3. Biochemical oxygen demand (BOD)
4. Settleable and suspended solids - discuss importance of solids balance
5. Chlorine residual
6. Other

E. **Sample Laboratory Worksheets - give instructions for completing sample forms**

1. Solids determinations
2. BOD determinations
3. Other

Chapter VII. Records

Table of Contents

A. **Process Operations/Daily Operating Log - provide sample form and discuss features**

1. Weather conditions
2. Facility influent flow
3. Recirculation rate
4. Grit removed
5. Sludge handling data
6. Status of secondary treatment process
7. Operators on duty
8. Complaints
9. Plant visitors
10. Power consumption
11. Chemicals used
12. Unusual conditions (operational and maintenance)
13. Routine operational duties

B. **Laboratory - Comprehensive discussion of laboratory records should be included under laboratory controls chapter of the manual**

C. **Monthly Report to Provincial Agencies**

1. Provide sample form
2. Give instructions for completing

3. Outline techniques for maximum utilization of forms to eliminate using any supplemental forms
4. Tell when and where to submit completed forms

D. **Annual Report**

1. Designate individual responsible for preparing report
2. State whether calendar or fiscal year summary
3. Give sample report format:
   a) Annual summary of operating data
   b) Annual summary of management data
   4. Provide coordinating instructions with financial arm of parent governmental body

E. **Maintenance - Comprehensive discussion of maintenance records should be included under maintenance chapter of manual**

F. **Operating Costs and Record Keeping - list and discuss each major cost group and record keeping procedure for each**

1. Labour:
   a) Operation
   b) Administration
   c) Maintenance

2. Utilities:
   a) Electricity
   b) Fuel oil
   c) Potable water
   d) Telephone
   e) Other

3. Chemicals (Process only):
   a) Lime
   b) Alum
   c) Chlorine
   d) Other

4. Supplies:
   a) Laboratory chemicals
   b) Cleaning materials
   c) Maintenance materials
   d) Other expendable items

G. **Personnel Records**

H. **Emergency Conditions Record**

1. Bypass report
2. Deteriorated effluent record
3. Other

Chapter VIII. Maintenance

Table of Contents

A. **General**

1. State purpose of maintenance system
2. Outline scope of recommended maintenance system
3. List basic features:
   a) Equipment record system
   b) Planning and scheduling
   c) Storeroom and inventory system
   d) Maintenance personnel
   e) Costs and budgets for maintenance operations

B. **Equipment Record Systems**

1. Describe equipment numbering system
2. Outline equipment catalog
3. Discuss the type of information and equipment data which should be maintained
4. Provide instructions on preparing and filing information in the record system
5. Describe data retrieval system
6. Provide completed equipment nameplate data cards for each item of equipment
7. Other

C. **Planning and Scheduling**

1. Provide guidelines for preventive maintenance and corrective maintenance tasks
2. Describe schedule chart board
3. Outline work order system:
   a) Provide sample forms
   b) Describe work order log

4. Discuss contract maintenance work
5. Other

D. Storeroom and Inventory System

1. Recommend spare parts/components to be maintained
2. Outline stockroom inventory procedures:
   a) Numbering system for all items
   b) Sample withdrawal slip
   c) Maximum/minimum quantities to be maintained
   d) Record system
3. Discuss purchase orders
4. Other

E. Maintenance Personnel

1. Outline maintenance staff
2. Review maintenance staff capabilities and limitations

F. Cost and Budgets for Maintenance Operations

1. Discuss importance of separation of maintenance costs:
   a) Preventive maintenance
   b) Corrective maintenance
   c) Major repairs or alterations
2. Suggest a cost accounting system for storeroom stock, special purchase items and man-hours
3. Other

G. Miscellaneous Maintenance Records

1. Provide sample preventive/corrective maintenance log
2. Give breakdown report format
3. Other

H. Housekeeping - discuss housekeeping activities

1. Yard work
2. Painting
3. General Cleaning
4. Other

I. Special Tools and Equipment

1. Outline tool room procedures:
   a) Tool inventory
   b) Tool check control system

2. Discuss use of tool boards:
    a) Special/frequently used tools
    b) Location of boards

3. Give maintenance skills required for all special tools

J. **Lubrication**

1. Give lubrication specifications
2. Provide interchangeable lubricants chart
3. Discuss use of color coded lubrication tags for all equipment
4. Give sample consumption/inventory records
5. Outline sample lubrication route

K. **Major Equipment Information**

1. List all major equipment items:
    a) Comminutors
    b) Grit chambers
    c) Sedimentation tanks
    d) Aerators
    e) Pumps
    f) Digesters
    g) Drying beds
    h) Lagoons
    i) Other

2. Outline basic maintenance considerations for all major electrical and mechanical equipment items
3. Outline procedure for ordering parts/components or new items

L. **Warranty Provisions**

1. List all guaranteed equipment
2. Give guarantee period for each piece of equipment
3. Discuss pertinent features of each guarantee

M. **Contract Maintenance**

1. Provide list of suggested contract jobs
2. Provide list of suggested contractors

Chapter IX. Emergency Operating and Response Program

Table of Contents

A. Give results of vulnerability analysis of system
B. List methods to reduce system vulnerability
C. List mutual aid agreements

D. Include emergency equipment inventory
E. Give method of preserving treatment system records
F. Include industrial waste inventory/monitoring system
G. Give coordinating instructions for local police and fire departments
H. Define responsibilities of treatment system personnel
I. Designate an emergency response center
J. List auxiliary personnel requirements
K. Provide a mechanism for ensuring plan s updated periodically

Chapter X. Safety

Table of Contents

A. General

1. Management's responsibility - discuss responsibilities:
   a) Communicate safety information to employees
   b) Eliminate hazardous working conditions
   c) Motivate employees to be safety minded
   d) Other

2. Emergency telephone numbers - provide a list of all numbers:
   a) Hospital
   b) Fire station
   c) Ambulance Service
   d) Chlorine supplier
   e) Other

B. Sewers - discuss safety aspects of sewer maintenance

1. Work site protection
2. Gas testing equipment
3. Non-sparking tools
4. Other

C. Electrical Hazards

1. Discuss grounding of electric tools
2. Outline first aid for electric shock victim
3. Designate authorized personnel to perform electrical repairs
4. Other

D. Mechanical Equipment Hazards

1. Discuss equipment guards
2. Discuss noise level considerations
3. Designate authorized personnel to perform mechanical repairs
4. Other

E. **Explosion and Fire Hazards**

1. Discuss storage of flammable materials
2. Give type and location of fire extinguishers
3. Discuss use of flammable vapor detectors
4. Outline hazards associated with digester gases
5. Other

F. **Bacterial Infection (Health Hazards)**

1. State policy on tetanus shots
2. Outline personal hygiene considerations
3. State policy on care of cuts and other injuries
4. Other

G. **Chlorine Hazards**

1. Discuss cylinder handling
2. Outline procedure for testing for and responding to leaks
3. Describe self-contained breathing apparatus use
4. Other

H. **Oxygen Deficiency and Noxious Gases**

1. Outline noxious gas testing procedures
2. Discuss ventilating equipment
3. Provide tabulation of common gases encountered in wastewater treatment systems
4. Other

I. **Laboratory Hazards**

1. Discuss volatile materials handling
2. Describe protective clothing and devices
3. Discuss proper ventilation
4. Other

J. **Safety Equipment - list safety equipment required**

1. First aid kits
2. Fire extinguishers
3. Gas masks/air packs
4. Protective clothing and hard hats
5. Safety harnesses
6. Other

K. Process Chemical Handling - discuss procedures for all chemicals used

1. Alum
2. Lime
3. Ferric Chloride
4. Ferrous Sulfate

L. References - list pertinent safety references

1. WPCF MOP #1 - Safety in Wastewater Works
2. WPCF MOP #18 - Operations of Wastewater Treatment Plants
3. Chlorine Institute, Chlorine Manual
4. EPA Manual - Safety in the Design, Operation and Maintenance of Wastewater treatment Works, Contract No. 68-01-0324
5. Other

Chapter XI. Utilities

Table of Contents

A. General

1. Give name of utility company
2. List contact men within utility company:
   a) Routine contact
   b) Emergency contact
3. Discuss reliability of service
4. Give any cost information available

B. Electrical

1. Give voltage of service adjacent to facility
2. Give reduced voltage entering facility
3. Discuss stand-by power from second source

C. Telephone

1. Outline telephone communications system within treatment system
2. Discuss any alarm systems that utilize telephone wires

D. Natural Gas

1. Give cubic feet of gas per hour
2. Give normal operating pressure
3. Give size of gas line

E. Water

1. Give size of waterline
2. Give normal operating pressure
3. Discuss any backflow preventer prevention systems present

F. Fuel Oil

1. List capacities of storage tanks
2. Outline program to insure adequate supplies of fuel oil are always on hand
3. List potential suppliers

Chapter XII. Electrical System - describe the Electrical System

Table of Contents

A. General

1. Schematic diagrams
2. Tables
3. Manufacturer's literature
4. Shop drawings
5. Designer's notes

B. Power Source

1. Give name of electrical utility company
2. Give characteristics of primary distribution line
3. Describe main transformer and state ownership
4. Discuss protective devices
5. Give maximum available short-circuit current at point(s) of service from utility company

C. Power Distribution System

1. Describe service entrance equipment
2. Describe motor control centers and control panels
3. Provide tabulations indicating power wiring from and loads fed by major electrical components

D. Control and Monitoring System

1. Provide tabulations of type of controls present and process equipment involved
2. Provide schematic diagrams

E. **Alternate Power Source**

1. Describe power source
2. Describe any duplicate equipment in the power distribution system.

Appendices

Table of Contents

A. **Schematics - provide as required**

1. Basic flow diagrams
2. Process flow sheets
3. Bypass piping diagrams
4. Hydraulic profile
5. Other

B. **Valve Indices - describe all major valves**

1. Function
2. Type/size
3. Location
4. Identification

C. **Sample Forms - provide as required**

1. Daily Operating Log
2. Equipment Data Cards
3. Maintenance Work Order
4. Purchase Order
5. Accident Report Form
6. Provincial Reports
7. Other

D. **Chemicals Used in Plant**

1. List all chemicals
2. Give safety precautions and outline storage considerations in Safety Chapter of Manual
3. List suppliers
4. Provide reorder schedule

E. **Chemicals Used in Laboratory**

1. Give common name
2. Give chemical formula
3. List suppliers

F. **Emergency Operating and Response Program - provide as required**

1. Schematic diagrams
2. Sample forms

G. **Detailed Design Criteria - tabulate criteria**

1. Population served
2. Wastewater volume/strength:
   a) Present/future
   b) Domestic
   c) Industrial
3. Quantities of screenings, grit and sludge removed per thousand cubic meters of wastewater treated
4. Unit sizes and capacities
5. Hydraulic and organic loadings
6. Detention times
7. Pumping characteristics
8. Sludge treatment and disposal data

H. **Equipment Suppliers**

1. Give name
2. List equipment furnished
3. Give reference to where detail information on representatives can be found in manual

I. **Manufacturer's Manuals**

1. May be bound separately
2. Manuals should give adequate operating and maintenance instructions
3. Manuals should be indexed/cross-referenced

J. **Sources for Service and Parts**

1. List service organizations for all equipment

2. List local repair services:
   a) Meter repair
   b) Motor rewinding
   c) Other

3. List local parts sources:
   a) Plumbing wholesalers
   b) Electrical wholesalers
   c) Mill Supply Houses
   d) Other

K. **As-Built Drawings**

1. Ensure drawings are complete and accurate
2. Cross-reference with shop drawings

L. **Approved Shop Drawings**

1. Index adequately
2. Cross-reference with engineering drawings and construction specifications

M. **Dimension Prints**

1. Provide when necessary to show units relation to other units, adjacent walls, etc.
2. Use to tie shop drawings to engineering drawings

N. **Construction Photos**

1. Label and date all photos
2. Outline photo indexing system

O. **Warranties and Bonds**

1. Provide copies
2. Index properly

P. **Copies of Provincial Reporting Forms - provide as required**

1. Monthly Operating Report
2. Bypass Report
3. Chlorine Failure Report
4. Other

Q. **Copies of Provincial Inspection Forms - provide as required**

R. **Infiltration Controls**

1. Provide copy of existing ordinance
2. Provide model ordinance if none exists

S. **Industrial Waste Controls**

1. Provide copy of existing ordinance
2. Provide model ordinance if none exists

T. **Piping Color Codes**

1. List color for each piping system
2. State if directional flow arrows and/or labelling required

U. Painting

1. Give type of coating required for each unit
2. Give painting frequency schedule
3. Provide a copy of Water Pollution Control Federation, MOP-17, "Paints and Protective Coatings", (1969)

V. References to be maintained at treatment facility

1. MOP #1
2. MOP #11
3. Suggested references for detailed study of process utilized
4. Other

4.2.3 Suggested Guide and Checklist for an Operation and Maintenance Manual for Municipal Wastewater Pumping Stations and/or Pipelines

Chapter I - Introduction

Manual User Guide

Table of Contents

A. Operation and Managerial responsibility

1. Operator responsibility:

   a) General - outline responsibilities:
      (1) Know proper operational procedures
      (2) Keep accurate records
      (3) Properly manage operating funds
      (4) Keep supervisors informed
      (5) Keep informed of current O & M practices

   b) List short courses and operator schools available

   c) Provide suggested list of journals/periodicals related to municipal wastewater treatment

2. Treatment system management responsibility -outline responsibilities:

   a) Maintain efficient plant operation and maintenance

   b) Maintain adequate records

   c) Establish staff requirements, prepare job descriptions and assign personnel

   d) Provide good working conditions

   e) Establish operator training program

f) Provide incentives for employees

g) Maintain good public relations

h) Prepare budgets and reports

i) Plan for future facility needs

j) Develop standard operating procedures

B. **Description of pumping stations and/or pipeline type**

1. Pumping station type - describe station type:

   a) Municipal wastewater
   b) Storm water runoff
   c) Industrial wastes
   d) Combined municipal and storm water
   e) Sludge
   f) Treated municipal wastewater

2. Pumping station classification - discuss how station is classified:
   a) Capacity (gpm, mgd)
   b) Energy source (Primary and Stand-by):
      (1) Electric
      (2) Diesel
      (3) Steam
      (4) Other
   c) Construction method

3. Discuss pumping station chlorination facilities

4. Pipeline types and sizes - describe pipeline:
   a) Asbestos-cement
   b) Brick masonry
   c) Clay
   d) Concrete
   e) Iron and Steel:
      (1) Cast iron
      (2) Ductile iron
      (3) Fabricated steel

5. Describe type of joint used

6. Discuss pipeline appurtenances and special structures:
   a) Manholes
   b) Check valves and relief overflows
   c) Siphons
   d) Flap gates
   e) Metering stations

f) Air relief valves
g) Other

Chapter II. Permits and Standards

Table of Contents

A. Permit and permit requirements

1. Give permit number
2. Give renewal date if applicable
3. List permit requirements
4. Include permit application guidelines
5. Copy of permit sections dealing with pumping station permits should be included

B. Reporting procedure for spills of raw or inadequately treated wastewater

1. Include copies of permit sections requiring reporting or bypass/spill condition:
   a) Discuss owner's responsibilities
   b) Discuss penalties
2. Outline reporting procedure to include telephone numbers and sample report format

C. Water Quality Standards for adjacent water courses

1. Include copy of Provincial Quality Standards for any water courses adjacent to pumping stations or pipelines, where there is a potential for a spill of raw wastewater
2. Include copy of Provincial receiving waters classification system

Chapter III. Description, Operation and Control of Pumping Stations and/or Pipelines

Table of Contents

A. General

1. Pumping station description - provide a brief general description of the pumping station:
   a) Typical
   b) Package
   c) Pneumatic-ejector
   d) Other

2. Pipeline description - provide a brief general description of the pipeline:
   a) Gravity
   b) Force Main

3. Pumping station major components - list major components:
   a) Pumps
   b) Suction and discharge piping
   c) Wet Well
   d) Automatic Controls
   e) Other

4. Pipeline major components - list major components:
   a) Pipe
   b) Manholes
   c) Siphons
   d) Metering Stations
   e) Other

5. Pumping Station and/or Pipelines - common operating/maintenance problems:

   a) state problems
   b) list probable causes
   c) give control/prevention techniques

6. Pumping Station and/or Pipelines start-up - give start-up techniques

B. **Specific Pumping Station and/or Pipeline Operation**

1. Normal Operation:
   a) Discuss the normal operation of each type of pumping station and/or pipeline
      (1) Pump settings
      (2) Valve positions
      (3) Flow meter settings
      (4) Chlorination system
      (5) Other

2. Alternate Operation:
   a) List alternative modes of operation
   b) Provide discussion and schematics to illustrate alternate operation

3. Emergency Operations and Failsafe Features:
   a) Discuss emergency operating procedures for potential emergency conditions
   b) List failsafe features
   c) Describe operation of failsafe features

Chapter IV. Personnel

Table of Contents

Chapter V. Records

Table of Contents

C. Annual Report

1. Designate individual responsible for preparing report
2. State whether calendar or fiscal year summary
3. Give sample report format:
   a) Annual summary of operating data
   b) Annual summary of management data

4. Provide coordinating instructions with financial arm of parent Governmental body

D. Maintenance - comprehensive discussion of maintenance records should be included under maintenance chapter of the manual

E. Operating Costs and Record Keeping - list and discuss each major cost group and record keeping procedures for each

1. Labour:
   a) Operation
   b) Adminstration
   c) Maintenance

2. Utilities:
   a) Electricity
   b) Fuel oil
   c) Potable water
   d) Telephone
   e) Other

3. Chemicals:
   a) Chlorine
   b) Lime
   c) Other

4. Supplies:
   a) Cleaning materials
   b) Maintenance materials
   c) Other expendables

F. Personnel Records

G. Emergency Conditions Record

1. Bypass Report
2. Other

Chapter VI. Maintenance

Table of Contents

3. Discuss purchase orders
4. Other

E. **Maintenance Personnel**

1. Outline maintenance staff
2. Review maintenance staff capabilities and limitations

F. **Cost and Budgets for Maintenance Operations**

1. Discuss importance of separation of maintenance costs:
    a) Preventive maintenance
    b) Corrective maintenance
    c) Major repairs or alterations
2. Suggest a cost accounting system for storeroom stock, special purchase items and man-hours
3. Other

G. **Miscellaneous Maintenance Records**

1. Provide sample preventive/corrective maintenance log
2. Give breakdown report format
3. Other

H. **Housekeeping - discuss housekeeping activities**

1. Yard work
2. Painting
3. General cleaning
4. Other

I. **Special Tools and Equipment**

1. Outline tool room procedures:
    a) Tool inventory
    b) Tool check control system
2. Discuss use of tool boards:
    a) Special/frequently used tools
    b) Location of boards
3. Give maintenance skills required for all special tools

J. **Lubrication**

1. Give lubrication specifications
2. Provide interchangeable lubricants chart
3. Discuss use of color coded lubrication tags for all equipment
4. Give sample consumption/inventory records
5. Outline sample lubrication route

K. **Major Equipment Information**

1. List all major equipment items
2. Outline basic maintenance considerations for all major electrical and mechanical equipment items

L. **Warranty Provisions**

1. List all guaranteed equipment
2. Give guarantee period for each piece of equipment
3. Discuss pertinent features of each guarantee

M. **Contract Maintenance**

1. Provide list of suggested contract jobs
2. Provide list of suggested contractors

Chapter VII. Emergency Operating and Response Program

Table of Contents

Chapter VIII. Safety

Table of Contents

A. **General**

1. Management's responsibility - discuss responsibilities:
   a) Communicate safety information to employees
   b) Eliminate hazardous working conditions
   c) Motivate employees to be safety minded
   d) Other

2. Emergency telephone numbers - provide a list of all numbers:
   a) Hospital
   b) Fire station
   c) Ambulance service

d) Chlorine supplier
e) Other

B. **Sewers - discuss safety aspects of sewer maintenance**

1. Work site protection
2. Gas testing equipment
3. Nonsparking tools
4. Other

C. **Electrical Hazards**

1. Discuss grounding of electric tools
2. Outline first aid for electric shock victim
3. Designate authorized personnel to perform electrical repairs
4. Other

D. **Mechanical Equipment Hazards**

1. Discuss equipment guards
2. Discuss noise level considerations
3. Designate authorized personnel to perform mechanical repairs
4. Other

E. **Explosion and Fire Hazards**

1. Discuss storage of flammable materials
2. Give type and location of fire extinguishers
3. Discuss use of flammable vapor detectors
4. Other

F. **Bacterial Infection (Health Hazards)**

1. State policy on tetanus shots
2. Outline personal hygiene considerations
3. State policy on care of cuts and other injuries
4. Other

G. **Chlorine Hazards**

1. Discuss cylinder handling
2. Outline procedure for testing for and responding to leaks
3. Describe self-contained breathing apparatus use
4. Other

H. **Oxygen Deficiency and Noxious Gases**

1. Outline noxious gas testing procedures
2. Discuss ventilating equipment

3. Provide tabulation of common gases encountered in wastewater treatment systems
4. Other

I. **Safety Equipment - list safety equipment required**

1. First aid kits
2. Fire extinguishers
3. Gas masks/air packs
4. Protective clothing and hard hats
5. Safety Harnesses
6. Other

J. **Process Chemical Handling - discuss procedures for all chemicals used**

K. **References - list pertinent safety references**

1. WPCF MOP #1 - Safety in Wastewater Works
2. WPCF MOP #7 - Sewer Maintenance
3. Chlorine Institute, Chlorine Manual
4. EPA Manual - Safety in the Design, Operation and Maintenance of Wastewater Treatment Works, Contract No. 68-01-0324
5. Other

Chapter IX. Utilities

A. **General**

1. Give name of utility company
2. List contact men within utility company
   a) Routine contact
   b) Emergency contact
3. Discuss reliability of service
4. Give any cost information available

B. **Electrical**

1. Give voltage of service adjacent to facility
2. Give reduced voltage entering facility
3. Discuss stand-by power from a second source

C. **Telephone**

1. Outline telephone communications system within treatment system
2. Discuss any alarm systems that utilize telephone wires

D. Natural Gas

1. Give cubic feet of gas per hour
2. Give normal operating pressure
3. Give size of gas line

E. Water

1. Give size of waterline
2. Give normal operating pressure
3. Discuss any backflow preventer prevention systems present

F. Fuel Oil

1. List capacities of storage tanks
2. Outline program to insure adequate supplies of fuel oil are always on hand
3. List potential suppliers

Chapter X. Electrical System - describe the Electrical System

Table of Contents

A. General

1. Schematic drawings
2. Tables
3. Manufacturer's literature
4. Shop drawings
5. Designer's notes

B. Power Source

1. Give name of electrical utility company
2. Give characteristics of primary distribution line
3. Describe main transformer and state ownership
4. Discuss protective devices
5. Give maximum available short-circuit current at point(s) of service from utility company

C. Power Distribution System

1. Describe service entrance equipment
2. Describe motor control centers and control panels
3. Provide tabulations indicating power wiring from and loads fed by major electrical components

D. Control and Monitoring System

1. Provide tabulations of type controls present and process equipment involved
2. Provide schematic diagrams

E. Alternate Power Source

1. Describe power source
2. Describe any duplicate equipment in the power distribution system

Appendices

Table of Contents

A. Schematics - provide as required

1. Basic flow diagrams
2. Bypass piping diagrams
3. Hydraulic profile
4. Other

B. Valve Indices - describe all major valves

1. Function
2. Type/Size
3. Location
4. Identification

C. Sample Forms - provide as required

1. Daily Operating Log
2. Equipment Data Cards
3. Maintenance Work Order
4. Purchase Order
5. Accident Report Form
6. Provincial Reports
7. Other

D. Chemicals Used in System

1. List all chemicals
2. Give safety precautions and outline storage considerations in Safety Chapter of Manual
3. List suppliers
4. Provide reorder schedule

E. **Emergency Operating and Response Program - provide as required**

1. Schematic diagrams
2. Sample forms

F. **Detailed Design Criteria - tabulate criteria**

1. Population served
2. Wastewater volume
3. Line size and capacities
4. Pump sizes and capacities
5. Pumping characteristics
6. Other

G. **Equipment Suppliers**

1. Give name
2. List equipment furnished
3. Give reference to where detail information on representatives can be found in manual

H. **Manufacturers' Manuals**

1. May be bound separately
2. Manuals should give adequate operating and maintenance instructions
3. Manuals should indexed/cross-referenced

I. **Sources for Service and Parts**

1. List service organizations for all equipment

2. List local repair services:
   a) Meter repair
   b) Motor rewinding
   c) Other

3. List local parts sources:
   a) Plumbing wholesalers
   b) Electrical wholesalers
   c) Mill supply houses
   d) Other

J. **As-Built Drawings**

1. Ensure drawings are complete and accurate
2. Cross-reference with shop drawings

K. **Approved Shop Drawings**

1. Index adequately
2. Cross-reference with engineering drawings and construction specifications

L. **Dimension Prints**

1. Provide when necessary to show units relation to other units, adjacent walls, etc.
2. Use to tie shop drawings to engineering drawings

M. **Construction Photos**

1. Label and date all photos
2. Outline photo indexing system

N. **Warranties and Bonds**

1. Provide copies
2. Index properly

O. **Copies of Provincial Reporting Forms - provide as required**

1. Monthly Operating Report
2. Bypass Report
3. Chlorine Failure Report
4. Other

P. **Copies of Provincial Inspection Forms - provide as required**

Q. **Infiltration Controls**

1. Provide copy of existing ordinance
2. Provide model ordinance if none exists

R. **Industrial Waste Controls**

1. Provide copy of existing ordinance
2. Provide model ordinance if none exists

S. **Piping Color Codes**

1. List color for each piping system
2. State if directional flow arrows and/or labelling required

T. Painting

1. Give type of coating required for each unit
2. Give painting frequency schedule
3. Provide a copy of Water Pollution Control Federation, MOP-17, "Paints and Protective Coatings", (1969)

4.3 PREPARATION OF O & M MANUALS

4.3.1 Persons Responsible for Manual Development

Individuals responsible for O & M Manual development should obtain input from persons experienced in treatment system operations. This input, combined with the design engineer's expertise, is essential to any good manual. If possible, operations input should be obtained from persons with experience in the same processes as those described in the manual.

4.3.2 Equipment Information

Persons involved in the preparation of the O & M Manual should take necessary action to insure they obtain timely and accurate operations and maintenance information on all equipment items. These actions might simply be enforcement of existing requirements or adding sections to project specifications calling for submittal of preliminary O & M information prior to paying for equipment.

O & M Manual preparation requires timely and accurate information from suppliers of wastewater treatment equipment for incorporation in O & M Manuals. The information should be tailored for the specific equipment item supplied.

4.3.3 Manual Flexibility

O & M Manuals should possess the necessary flexibility to remain viable tools to operating personnel, in the event of changing treatment system operating and maintenance needs.

4.3.4 Writing Style

The key to an O & M Manual's ultimate success is the language used and the writing style. Persons preparing an O & M Manual must ensure that they obtain information from people actually experienced in plant operations and maintenance and translate the design engineer's concepts into a language form acceptable to operating personnel. The Manual must also consider the comprehension level of the end users.

REFERENCES

1. Alberta Environment, "Standards and Guidelines for Municipal Water Supply, Wastewater, and Storm Drainage Facilities", March 1988.

2. Alberta Environment, "Water and Wastewater Operators' Certification Guidelines", 1983.

3. Antoine, R.L., "Fixed Biological Surfaces - Wastewater Treatment - The Rotating Biological Contactor", 1976.

4. Atlantic Canada Voluntary Certification Program.

5. British Columbia Ministry of the Environment, "Pollution Control Objectives for Municipal Type Waste Discharges in British Columbia", 1989.

6. Canadian Institute on Pollution Control, "Manual on Wastewater Sampling Practice", 1972.

7. Crites, R.W., "Design Criteria and Practice for Constructed Wetlands", Water Science and Technology, Vol. 29, No. 4, 1994.

8. Eckenfelder, W. Wesley, "Water Quality Engineering for Practicing Engineers", 1970.

9. Environment Canada, "Manual for Land Application of Treated Municipal Wastewater and Sludge", EPS 6-EP-84-1, March 1984.

10. Feurstein, Donald L., "Predesign Surveys and Monitoring of Waste Disposal Systems".

11. Ganczarczyk, Jerry J., "Activated Sludge Process - Theory and Practice", 1983.

12. Great Lakes - Upper Mississippi River Board of State Sanitary Engineers, "Recommended Standards for Sewage Works", 1978.

13. Great Lakes - Upper Mississippi River Board of State Public Health and Environmental Managers, "Recommended Standards for Wastewater Facilities", 1990.

14. Metcalf & Eddy Inc., "Wastewater Engineering : Treatment, Disposal, Reuse", 1991.

15. New Brunswick Department of Municipal Affairs and Environment, "Guidelines for the Collection and Treatment of Wastewater", September 1987.

16. New York State Department of Environmental Conservation, "Manual of Instructions for Wastewater Treatment Plant Operators - Volume One and Two", 1978.

17. Nova Scotia Department of the Environment, "Manual of Wastewater - Interim Guidelines - Collection and Treatment of Municipal Wastewater", 1976.

18. Nova Scotia Department of the Environment, "Interim Report - Guidelines for the Handling and Disposal of Sewage Sludge"

19. Ontario Ministry of the Environment (Ontario MOE), "Water Management - Goals, Policies, Objectives and Implementation Procedures of the Ministry of Environment", May 1984.

20. Ontario Ministry of Natural Resources, "Manual of Instruction - Aquatic Habitat Inventory Surveys", 1989.

21. Ontario MOE, "Guidelines for the Design of Sewage Treatment Works", July, 1984.

22. Ontario MOE, "Stream Water Quality Assessment Procedures Manual", March 1990.

23. Saskatchewan Environment and Public Safety, "Surface Water Quality Objectives", November 1988.

24. Saskatchewan Environment and Public Safety, "A Guide to Sewage Works Design", January 1989.

25. United States Environmental Protection Agency (USEPA), "Handbook for Stream Sampling for Waste Load Allocation Application", EPA/G25/6-86/013, 1988.

26. USEPA, "Considerations for Preparation of Operations and Maintenance Manuals", 1974.

27. USEPA, "Design Information on Rotating Biological Contactors", June 1984.

28. USEPA, "Aerobic Biological Wastewater Treatment Facilities", March 1977.

29. USEPA, "Process Design Manual for Sludge Treatment and Disposal".

30. USEPA, "Technical Guidance Manual for Providing Waste Load Allocations - Book IV Lakes and Impoundments - Chapter 1, 2, and 3".

31. USEPA, "Process Design Manual - Wastewater Treatment Facilities for Sewered Small Communities".

32. USEPA, "Technical Guidance Manual for Providing Waste Load Allocations - Book III Estuaries, Part 1 and 2", March 1990.

33. USEPA, "Technical Guidance Manual for Providing Waste Load Allocations - Book VI Design Conditions - Chapter 1 - Stream Flow Design for Steady State Modelling", September 1986.

34. USEPA, "Technical Guidance Manual for Providing Waste Load Allocations - Book II Streams and Rivers - Chapter 1, 2, and 3", 1983.

35. USEPA, "Technical Guidance Manual for Providing Waste Load Allocations - Simplified Analytical Method for Determining NPDES Effluent Limitations for POTW's Discharging into Low-Flow Streams", 1980.

36. USEPA, "Analysis of Operations and Maintenance Costs for Municipal Wastewater Treatment Systems", 1978.

37. USEPA, "Design Manual - Constructed Wetlands and Aquatic Plant Systems for Municipal Wastewater Treatment", September 1988.

38. USEPA, "Manual - Alternative Wastewater Collection Systems", October 1991.

39. USEPA, "Design Manual - Municipal Wastewater Disinfection", October 1986.

40. USEPA, "Design Manual - Phosphorus Removal", September 1987.

41. USEPA, "Process Design Manual for Phosphorus Removal", April 1976.

42. USEPA, "Process Design Manual for Nitrogen Control", October 1975.

43. USEPA, "Environmental Regulations and Technology - Autothermal Thermophilic Aerobic Digestion of Municipal Wastewater Sludge", September 1990.

44. Water Engineering and Management, "Rotating Biological Contactors", June 1984.

45. Water Environment Federation (WEF), "Manual of Practice No.8 - Design of Municipal Wastewater Treatment Plants - Volumes I and II", 1991.

46. WEF, "Manual of Practice FD-16, Natural Systems for Wastewater Treatment", 1990.

47. Water Pollution Control Federation (WPCF), "Wastewater Treatment Plant Design - Manual of Practice", 1975.

48. WPCF, "Manual of Practice 20 - Sludge Dewatering", 1983.

49. WPCF, "Manual of Practice OM-9 - Activated Sludge", 1987.

50. WPCF, "Manual of Practice FD-3 - Pretreatment of Industrial Wastes", 1981.

51. WPCF, "Manual of Practice FD-4 - Design of Wastewater and Stormwater Pumping Stations", 1981.

52. WPCF, "Manual of Practice FD-9 - Sludge Stabilization", 1985.

53. WPCF, "Manual of Practice FD-8 - Clarifier Design", 1985.

54. WPCF, "Manual of Practice FD-12 - Alternative Sewer Systems", 1986.

55. Yukon Territory Water Board, "Guidelines for Municipal Wastewater Discharges in the Yukon Territory", March 1983.

Environment Canada Environnement Canada

Appendix A

New Brunswick Legislation

New Nouveau Brunswick

REGULATION 82-126

under the

CLEAN ENVIRONMENT ACT

(O.C. 82-588)

Filed August 6, 1982

Under section 32 of the *Clean Environment Act*, the Lieutenant-Governor in Council makes the following Regulation:

1 This Regulation may be cited as the *Water Quality Regulation - Clean Environment Act.*

2(1) In this Regulation and in approvals issued pursuant to this Regulation

"Act" means the *Clean Environment Act;*

"collection system" means facilities used for collecting and conducting sewage to the point of treatment or disposal;

"contingency plan" means planned procedures for reporting, containing, removing and cleaning up after any unscheduled event which results or may result in the emitting, discharging, depositing, leaving or throwing of any contaminant into or upon the waters of the Province;

"distribution system" means a system of water pipes, storage reservoirs, valves and hydrants designed to convey water from the point where it is obtained to the consumers but does not include a system connected to a supply of water which serves only a single household;

"effluent" means any liquid discharging from a sewage works or source and includes industrial waste;

"person responsible for a source, sewage works or waterworks" includes

RÈGLEMENT 82-126

établi en vertu de la

LOI SUR L'ASSAINISSEMENT DE L'ENVIRONNEMENT

(D.C. 82-588)

Déposé le 6 août 1982

En vertu de l'article 32 de la *Loi sur l'assainissement de l'environnement*, le lieutenant-gouverneur en conseil établit le règlement suivant:

1 Le présent règlement peut être cité sous le titre: *Règlement sur la qualité de l'eau - Loi sur l'assainissement de l'environnement.*

2(1) Dans le présent règlement et dans les agréments octroyés sous son régime

«branchement» désigne un tuyau qui permet au consommateur d'obtenir de l'eau d'un réseau de distribution d'eau ou de déverser des eaux usées dans un collecteur;

«cautionnement de garantie ou de remise en état» désigne un cautionnement au profit de la province destiné à assurer l'exploitation, la modification, la réparation ou la remise en état de toute source, de tout ouvrage d'évacuation des eaux usées ou d'adduction d'eau ou de toute aire qu'ils peuvent affecter à tout moment, que ce soit avant ou après l'abandon de la source ou des ouvrages;

«collecteur» désigne les installations servant à recueillir et à transporter les eaux usées vers le lieu de traitement ou d'évacuation;

«eau potable» désigne l'eau qui peut être bue sans danger pour la santé;

«effluent» désigne tout liquide qui se déverse d'un ouvrage d'évacuation des eaux usées ou d'une source et comprend les matières usées industrielles;

(a) a person who owns or operates the source, sewage works or waterworks, or any part thereof,

(b) a person responsible or who at any time was responsible for the construction, modification or operation of the source, sewage works or waterworks, or any part thereof,

(c) a person having the charge, management and control of the source, sewage works or waterworks, or any part thereof, and

(d) a person to whom an approval has been issued with respect to the source, sewage works or waterworks;

"potable water" means water that is safe for human consumption;

"rehabilitation bond" means a bond payable to the Province for the purpose of ensuring the operation, modification, repair or rehabilitation of any source, sewage works or waterworks or areas affected thereby at any time, whether before or after abandonment of the source, sewage works or waterworks;

"service connection" means a pipe that enables a consumer to obtain water from a distribution system or to discharge sewage into a collection system;

"source" means "source of contaminant" as defined in the Act;

"storage reservoir" means an artificially created body of water, above, on or below the surface of the ground used as a potable water supply;

"water pollution" means

(a) any alteration of the physical, chemical, biological or aesthetic properties of the waters of the Province, including change of the temperature, colour, taste or odour of the waters, or

(b) the addition of any liquid, solid, radioactive, gaseous or other substance to the waters of

«installation de traitement de l'eau» désigne tout appareil ou procédé ou toute partie ou combinaison de ceux-ci servant ou devant servir au traitement chimique, mécanique ou autre de l'eau;

«loi» désigne la *Loi sur l'assainissement de l'environnement;*

«plan d'urgence» désigne les mesures prévues de rapport, de confinement, d'enlèvement et de nettoyage requises à la suite de tout incident imprévu causant ou pouvant causer l'émission, le déversement, le dépôt, l'abandon ou le rejet de tout polluant dans ou sur les eaux de la province;

«pollution de l'eau» désigne

a) toute modification des propriétés physiques, chimiques, biologiques ou esthétiques des eaux de la province et comprend leur changement de température, de couleur, de goût ou d'odeur, ou

b) l'addition ou le retrait de substances liquides, solides, radioactives, gazeuses ou autres

qui rendent ou qui sont susceptibles de rendre les eaux de la province nocives pour la santé, la sécurité ou le bien-être du public ou encore nocives ou d'une moindre utilité pour les usages ménagers, municipaux, industriels, agricoles, récréatifs ou autres usages légitimes ou pour les animaux, les oiseaux et les organismes qui vivent dans l'eau;

«réseau de distribution d'eau» désigne un ensemble de canalisations, de réservoirs, de robinets et de prises d'eau destinés à transiter l'eau du point d'eau au consommateur, mais ne comprend pas un réseau raccordé à un point d'approvisionnement en eau ne desservant qu'un seul logement;

«réservoir» désigne une eau réceptrice d'origine artificielle emmagasinée au-dessus, au niveau ou au-dessous de la surface du sol et servant d'approvisionnement en eau potable;

«responsable», pour ce qui a trait à une source, un ouvrage d'évacuation des eaux usées ou un ouvrage d'adduction d'eau, comprend the Province or the removal of such substance from the waters of the Province,

which renders or is likely to render the waters of the Province harmful to the public health, safety or welfare or harmful or less useful for domestic, municipal, industrial, agricultural, recreational or other lawful uses or harmful or less useful to animals, birds or aquatic life;

"water treatment unit" means any facility or process or any part or combination thereof used or intended to be used to treat water chemically, mechanically or otherwise.

a) le propriétaire ou l'exploitant d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau ou d'une partie de ceux-ci,

b) la personne qui est ou qui a été, à un moment donné, responsable de la construction, de la modification ou de l'exploitation de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau ou d'une partie ceux-ci,

c) la personne qui assume la responsabilité, la gestion et la direction de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau ou d'une partie de ceux-ci, et

d) le titulaire d'un agrément accordé à l'égard de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau;

«source» désigne une source de pollution telle que définie dans la loi.

2(2) For the purposes of this Regulation, sewage is a contaminant.

2(2) Pour les besoins du présent règlement, les eaux usées sont des polluants.

3(1) No person shall, without an approval, emit, discharge, deposit, leave or throw any contaminant into or upon the environment in any location such that it may, directly or indirectly, cause water pollution to any waters of the Province.

3(1) Nul ne peut, sans agrément, émettre, déverser, déposer, abandonner ou jeter un polluant dans l'environnement en un lieu où il risque de polluer, directement ou indirectement, des eaux de la province.

3(2) No person shall, without an approval, cause or permit a source to emit, discharge, deposit, leave or throw any contaminant into or upon the environment in any location such that it may, directly or indirectly, cause water pollution to any waters of the Province.

3(2) Nul ne peut, sans agrément, occasionner ou permettre l'émission, le déversement, le dépôt, l'abandon ou le rejet, par une source, d'un polluant dans l'environnement en un lieu où il risque de polluer, directement ou indirectement, des eaux de la province.

3(3) No person shall, without an approval, construct, modify or operate or permit the construction, modification or operation of a source.

3(3) Nul ne peut, sans agrément, effectuer ou permettre la construction, la modification ou l'exploitation d'une source.

3(4) No person shall, without an approval, which approval must include approval of the discharge point, construct, modify or operate or per-

3(4) Nul ne peut, sans un agrément comprenant l'approbation du point d'évacuation, effectuer ou permettre la construction, la modification ou l'exmit the construction, modification or operation of any sewage works.

ploitation d'un ouvrage d'évacuation des eaux usées.

3(5) No person shall, without an approval, which approval must include approval of the supply and quality of water, construct, modify or operate or permit the construction, modification or operation of any waterworks.

3(5) Nul ne peut, sans un agrément comprenant l'approbation du point d'approvisionnement et de la qualité de l'eau, effectuer ou permettre la construction, la modification ou l'exploitation d'un ouvrage d'adduction d'eau.

3(6) No person shall, without an approval, join or permit the joining of the pipes of a municipal distribution system to any other system for the distribution of water.

3(6) Nul ne peut, sans agrément, effectuer ou permettre le raccordement des tuyaux d'un réseau municipal de distribution d'eau à tout autre réseau de distribution d'eau.

3(7) No person shall construct, modify or operate or permit the construction, modification or operation of any source, sewage works or waterworks except in accordance with the terms and conditions of the approval issued for such source, sewage works or waterworks.

3(7) Nul ne peut effectuer ou permettre la construction, la modification ou l'exploitation d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau sauf en conformité avec les conditions de l'agrément accordé à leur égard.

3(8) No owner of land shall knowingly permit any construction, modification or operation of any source, sewage works or waterworks on his land which is in contravention of this Regulation.

3(8) Nul propriétaire foncier ne doit sciemment permettre la construction, la modification ou l'exploitation, sur ses terres, d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau qui contrevient au présent règlement.

3(8.1) In a protected area referred to in section 20, no person shall develop, construct, operate or maintain or permit the development, construction, operation or maintenance of an activity or thing which is regulated, controlled, prohibited, restricted or limited under this Regulation unless he has an approval issued under section 8 or an exemption granted under section 20.

3(8.1) Dans un périmètre de protection visé à l'article 20, nul ne peut développer, construire, exploiter ou entretenir ou permettre le développement, la construction, l'exploitation ou l'entretien d'une activité ou d'une chose réglementée, contrôlée, prohibée, restreinte ou limitée en vertu du présent règlement à moins qu'un agrément ne lui ait été octroyé en vertu de l'article 8 ou une exemption accordée en vertu de l'article 20.

3(8.2) In a protected area referred to in section 20, no person shall develop, construct, operate or maintain or permit the development, construction, operation or maintenance of an activity or thing which is regulated, controlled, prohibited, restricted or limited under this Regulation except in accordance with the terms and conditions of the approval or the exemption.

3(8.2) Dans un périmètre de protection visé à l'article 20, nul ne peut développer, construire, exploiter ou entretenir ou permettre le développement, la construction, l'exploitation ou l'entretien d'une activité ou d'une chose réglementée, contrôlée, prohibée, restreinte ou limitée en vertu du présent règlement sauf en conformité avec les conditions de l'agrément ou de l'exemption.

3(9) The Minister may revoke an approval at any time and an approval is automatically revoked by the issuing of a new approval applying to the same

(a) source,

(b) sewage works,

(c) waterworks,

(d) activity being developed, constructed, operated or maintained in a protected area, or

(e) thing being developed, constructed, operated or maintained in a protected area.

86-85

3(9) Le Ministre peut, en tout temps, révoquer un agrément et un agrément est automatiquement révoqué par l'octroi d'un nouvel agrément ayant trait à

a) une même source,

b) un même ouvrage d'évacuation des eaux usées,

c) un même ouvrage d'adduction d'eau,

d) une même activité en train d'être développée, construite, exploitée ou entretenue dans un périmètre de protection, ou

e) une même chose en train d'être développée, construite, exploitée ou entretenue dans un périmètre de protection.

86-85; 91-136

4(1) The Minister may designate a source which is or will be a danger of pollution as one which may not be used or operated without an approval permitting such use or operation.

4(1) Le Ministre peut désigner une source qui constitue ou constituera un risque de pollution comme une source qu'il est interdit d'utiliser ou d'exploiter sans l'obtention d'un agrément à cet effet.

4(2) When a source is designated pursuant to subsection (1), the Minister shall serve a notice upon a person responsible for the source stating that the source is so designated and setting the period of time in which an approval must be obtained for the use or operation of the source.

4(2) Lorsqu'une source est désignée en vertu du paragraphe (1), le Ministre doit le signifier au responsable au moyen d'un avis indiquant en outre le délai d'obtention de l'agrément autorisant son utilisation ou son exploitation.

4(3) The Minister may, by notice published in three successive issues of *The Royal Gazette*, designate all the sources in a class of sources which are or will be dangers of pollution as ones which may not be used or operated

4(3) Le Ministre peut, par avis publié dans trois numéros successifs de la *Gazette royale*, désigner toutes les sources d'une catégorie de sources qui constituent ou constitueront des risques de pollution comme des sources qu'il est interdit d'utiliser

without approvals permitting such use or operation.

4(4) When sources are designated pursuant to subsection (3), the notice shall set the period of time in which approvals must be obtained for the use and operation of such sources.

4(5) No person shall, without an approval, use or operate a source designated pursuant to this section after the expiration of the time allowed in the notice given pursuant to this section.

5(1) Notwithstanding section 3, no approval is required under this Regulation for the construction, modification or operation of a private system of sewage works which is regulated under the *Health Act* unless the system discharges industrial waste.

5(2) Notwithstanding subsection (1), the Minister, after consultation with the Minister of Health, may designate areas and restrict or prohibit therein the construction of private sewage works as regulated under the *Health Act* if in his opinion water pollution would otherwise result.

5(3) Notwithstanding section 3, no approval is required under this Regulation for the construction, modification or operation of

(a) domestic wells not connected to a distribution system, or

(b) waterworks using less than fifty cubic metres of water daily.

5(4) Notwithstanding section 3, no approval is required under this Regulation for

(a) the repair or replacement of a broken water or sewage pipe, or

(b) the construction of a private service connection including the tapping of a water or sewage main for that purpose.

ou d'exploiter sans l'obtention d'un agrément à cet effet.

4(4) Lorsqu'une source est désignée en vertu du paragraphe (3), l'avis doit fixer le délai d'obtention de l'agrément autorisant son utilisation et son exploitation.

4(5) Nul ne peut, sans agrément, utiliser ou exploiter une source désignée en vertu du présent article après l'expiration du délai imparti dans l'avis donné en vertu du présent article.

5(1) Nonobstant l'article 3, aucun agrément n'est requis en vertu du présent règlement pour la construction, la modification ou l'exploitation d'un réseau privé d'évacuation des eaux usées régi par la *Loi sur la santé*, à moins que le réseau ne déverse des matières usées industrielles.

5(2) Nonobstant le paragraphe (1), le Ministre peut, après consultation du ministre de la Santé, délimiter des périmètres et y restreindre ou interdire la construction d'ouvrages privés d'évacuation des eaux usées régis par la *Loi sur la santé* s'il estime qu'ils pourraient polluer l'eau.

5(3) Nonobstant l'article 3, aucun agrément n'est requis en vertu du présent règlement pour la construction, la modification ou l'exploitation des ouvrages suivants:

a) les puits domestiques qui ne sont pas raccordés à un réseau de distribution d'eau, ou

b) les ouvrages d'adduction d'eau utilisant moins de cinquante mètres cubes d'eau par jour.

5(4) Nonobstant l'article 3, aucun agrément n'est requis en vertu du présent règlement pour

a) la réparation ou le remplacement d'un tuyau d'eau ou d'égout brisé, ou

b) l'installation d'un branchement privé, y compris le taraudage d'une conduite principale d'eau ou d'égout.

6(1) An application for an approval shall be made to the Minister on a form supplied by the Minister.

6(2) Upon receipt of an application made pursuant to subsection (1) or of any information demanded by the Minister pursuant to this subsection, the Minister may demand any additional information he considers necessary or useful in enabling him to decide what disposition he will make of the application.

6(3) Without limiting the generality of subsections (1) and (2), the information demanded by the Minister may include location plans, site plans, process detail, flow plans, material balances, capacities, engineer's and other technical reports, design bases and assumptions, engineering plans and specifications, schedules of construction or production, final as-built drawings, test results and engineer's descriptions of contaminants or dangers of pollution, processes, facilities, the intended or actual efficiency and mode of operation of components and systems, points of discharge of effluent, contingency plans, pollution control equipment, personnel and procedures, costs of construction or modification of the source, sewage works or waterworks and internal arrangements related to the source, sewage works or waterworks.

6(4) The power of the Minister to demand information pursuant to subsection (2) continues after an approval has been issued.

6(5) If plans and specifications or an engineer's description or report are required to be included in an application for an approval, they shall be prepared or approved by a person who is a member of the Association of Professional Engineers of the Province of New Brunswick or is licensed to practise as a professional engineer pursuant to the *Engineering Profession Act*.

6(1) Les demandes d'agrément sont présentées au Ministre au moyen du formulaire qu'il fournit.

6(2) Le Ministre peut, sur réception d'une demande présentée sous le régime du paragraphe (1) ou de tout renseignement qu'il requiert en vertu du présent paragraphe, exiger les renseignements supplémentaires qu'il juge nécessaires ou utiles pour statuer sur la demande.

6(3) Sans limiter la portée générale des paragraphes (1) et (2), les renseignements exigés par le Ministre peuvent comprendre les plans d'emplacement ou d'aménagement, le détail des procédés, les schémas d'écoulement, les bilans de matériaux, les capacités, les rapports d'ingénieurs et autres rapports techniques, les bases et hypothèses de calcul, les plans et devis techniques, le calendrier de construction ou de production, le plan définitif (conforme à l'exécution), les résultats de contrôle et les descriptions qu'un ingénieur fait des polluants ou des risques de pollution, des procédés et des installations, l'efficacité prévue ou réelle et le mode de fonctionnement des éléments et des réseaux, les points de déversement des effluents, les plans d'urgence, l'équipement anti-pollution, les données relatives au personnel et aux procédures, les coûts de construction ou de modification des sources, ouvrages d'évacuation des eaux usées ou ouvrages d'adduction d'eau et l'arrangement interne afférent à la source, aux ouvrages d'évacuation des eaux usées ou aux ouvrages d'adduction d'eau.

6(4) Le Ministre conserve son pouvoir d'exiger des renseignements en vertu du paragraphe (2) même après l'octroi d'un agrément.

6(5) Les plans et devis ou les descriptions ou rapports d'ingénieur requis au moment de la demande d'agrément doivent être préparés ou approuvés par un membre de l'Association des ingénieurs professionnels du Nouveau-Brunswick ou par un ingénieur professionnel titulaire d'une licence l'autorisant à exercer la profession en vertu de la loi intitulée *Engineering Profession Act*.

6(6) An application for an approval shall be made at least ninety days prior to

(a) the construction, modification or operation of a source, sewage works or waterworks, or

(b) the development, construction, operation or maintenance of an activity or thing in a protected area.
86-85

6(6) Les demandes d'agrément doivent être présentées au moins quatre-vingt-dix jours avant

a) la construction, la modification ou l'exploitation d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau, ou

b) le développement, la construction, l'exploitation ou l'entretien d'une activité ou chose dans un périmètre de protection.
86-85

7(1) At any time after receiving an application for an approval under this Regulation, the Minister may require the applicant to do any or all of the following:

(a) publish notice of the application in *The Royal Gazette* or such newspaper as the Minister may require, including in the notice such details of the application as the Minister may require;

(b) serve a copy of the application upon such persons or unincorporated organizations and in such manner as the Minister may require;

(c) attend at any public meeting arranged by the Minister or make submissions with respect to the application; or

(d) enter a rehabilitation bond in such manner and amount and subject to such conditions as the Minister approves.

7(1) Le Ministre peut, en tout temps après réception d'une demande d'agrément, enjoindre le requérant de faire l'une ou l'autre ou l'ensemble des choses suivantes:

a) publier, dans la *Gazette royale* ou tout autre journal qu'il prescrit, un avis de demande comportant les détails pertinents qu'il peut prescrire;

b) signifier, en la forme qu'il prescrit, une copie de la demande aux personnes ou organismes non constitués en corporation qu'il désigne;

c) participer à toutes assemblées publiques qu'il organise ou présenter des mémoires à l'égard de la demande; ou

d) constituer un cautionnement de garantie ou de remise en état de la manière, au montant et aux conditions qu'il approuve.

7(2) When publication of a notice or service of the application is required by the Minister pursuant to subsection (1), any person or unincorporated organization may file with the Minister a written objection to the issuing of the approval sought at any time within thirty days of such publication or service and, in any other case, any person or unincorporated organization may file with the Minister a written objection to the issuing of the approval sought at any time within sixty days of the filing of the application for the approval.

7(2) Lorsque le Ministre prescrit la publication d'un avis ou la signification de la demande en vertu du paragraphe (1), toute personne ou tout organisme non constitué en corporation peut, dans les trente jours suivant la publication ou la signification, former opposition à l'agrément sollicité au moyen d'une objection écrite déposée auprès du Ministre; en l'absence de publication ou de signification, le délai imparti pour former opposition est de soixante jours.

7(3) A copy of an objection filed pursuant to subsection (2) shall be served by the Minister upon the applicant.

7(4) The decision of the Minister with respect to an objection filed pursuant to subsection (2) shall be served by the Minister upon the applicant and, subject to subsection (5), upon the person or unincorporated organization filing the objection.

7(5) The Minister shall not be obligated to serve a decision upon an unincorporated organization pursuant to subsection (4) unless the objection filed by the unincorporated organization states the name and address of the person who filed the objection on behalf of the unincorporated organization.

7(6) Where a decision of the Minister with respect to an objection filed pursuant to subsection (2) is to be served upon an unincorporated organization, the decision shall be sufficiently served upon that unincorporated organization if it is delivered personally or mailed prepaid registered post to the address stated in the objection as being the address of the person who filed the objection on behalf of the unincorporated organization.

8(1) Upon receipt of an application for an approval made pursuant to this Regulation together with any information demanded by the Minister pursuant to subsection 6(2) and after compliance with any requirements of the Minister pursuant to subsection 7(1), the Minister shall, within a reasonable time after considering any objections filed with him pursuant to subsection 7(2),

(a) issue an approval to the person making the application or to some other person, or

(b) notify the person making the application that he will not issue an approval and specify the reasons therefor.

8(2) An approval issued pursuant to subsection (1) may be issued subject to terms and conditions including, without limiting the generality of the foregoing,

7(3) Le Ministre doit signifier au requérant copie de l'objection déposée sous le régime du paragraphe (2).

7(4) Le Ministre doit signifier la décision qu'il rend à l'égard d'une objection déposée sous le régime du paragraphe (2) au requérant et, sous réserve du paragraphe (5), à la personne ou à l'organisme qui l'a déposée.

7(5) Par dérogation au paragraphe (4), le Ministre n'est pas tenu de signifier sa décision à un organisme non constitué en corporation si l'objection déposée ne comporte pas le nom et l'adresse de la personne qui l'a déposée au nom dudit organisme.

7(6) Lorsque la décision du Ministre à l'égard d'une objection déposée sous le régime du paragraphe (2) doit être signifiée à un organisme non constitué en corporation, il suffit de la lui remettre personnellement ou de l'expédier par courrier affranchi et recommandé à l'adresse figurant dans l'objection comme l'adresse de la personne qui l'a déposée au nom dudit organisme.

8(1) Sur réception d'une demande d'agrément présentée en vertu du présent règlement, accompagnée des renseignements qu'il prescrit en vertu du paragraphe 6(2), et une fois satisfaites toutes prescriptions prévues au paragraphe 7(1), le Ministre doit, dans un délai raisonnable et après étude des objections déposées sous le régime du paragraphe 7(2),

a) accorder un agrément au requérant ou à une autre personne, ou

b) indiquer au requérant qu'aucun agrément ne sera accordé et en préciser les raisons.

8(2) Sans restreindre la portée générale de ce qui précède, l'octroi d'un certificat d'agrément conformément au paragraphe (1) peut être assorti de certaines conditions, notamment *(a)* requiring any changes in any construction, modification, operation, development or maintenance for which the approval was sought,

(b) requiring the keeping in force of a rehabilitation bond in such manner and amount and subject to such conditions as the Minister approves,

(c) requiring the applicant to provide sewage works or modify existing sewage works,

(d) requiring the regular reporting of the names and addresses of all persons in charge of operating

a) l'apport de changements à la construction, à la modification, à l'exploitation, au développement ou à l'entretien à l'origine de la demande d'agrément,

b) le maintien d'un cautionnement de garantie ou de remise en état de la manière, au montant et aux conditions que le Ministre approuve;

c) l'obligation pour le requérant de fournir les ouvrages d'évacuation des eaux usées ou de modifier les ouvrages existants;

d) la communication périodique des noms et adresses de toutes les personnes chargées de l'exploitation

(i) the source, or any part thereof,

(ii) the sewage works, or any part thereof,

(iii) the waterworks, or any part thereof,

(iv) the activity in a protected area, or any part thereof, or

(v) the thing in a protected area, or any part thereof,

(e) requiring the regular submission of monitoring data to the Minister, and

(f) limiting the operating rate or effluent quantity and quality.

8(3) An approval permitting the construction or modification of a source, sewage works or waterworks shall be valid only for construction or modification completed within two years from the date of approval.

8(4) An approval shall be valid for a period of time, not to exceed five years, specified in the approval.

8(5) If no period of time is specified in an approval in accordance with subsection (4), the approval shall be valid for five years.

8(6) After an application for an approval has been received by the Minister, whether before or after an approval has been issued, if the name or address of the person making the application changes, that person shall notify the Minister of the full particulars of such change within thirty days of such change.
86-85

9(1) An approval is only valid for the person to whom it was issued and persons acting under his control.

(i) de la source ou d'une partie de celle-ci,

(ii) de l'ouvrage d'évacuation des eaux usées ou d'une partie de celui-ci,

(iii) de l'ouvrage d'adduction d'eau ou d'une partie de celui-ci,

(iv) de l'activité dans un périmètre de protection ou d'une partie de celle-ci, ou

(v) de la chose dans un périmètre de protection ou d'une partie de celle-ci;

e) la présentation périodique des données de surveillance au Ministre; et

f) la limitation du rythme d'exploitation ou du débit des effluents ou l'imposition de certaines réserves quant à leurs propriétés.

8(3) Un agrément permettant la construction ou la modification d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau n'est valide que pour les travaux de construction ou de modification qui se terminent dans les deux ans suivant la date de l'agrément.

8(4) L'agrément est valide pour la durée qui y est indiquée et qui ne peut excéder cinq ans.

8(5) Si aucune durée n'est indiquée conformément au paragraphe (4), l'agrément est valide pour cinq ans.

8(6) L'auteur d'une demande d'agrément reçue par le Ministre doit lui notifier le détail de tout changement dans son nom ou son adresse dans les trente jours de l'événement.
86-85

9(1) L'agrément ne vaut que pour son titulaire et pour les personnes qui agissent sous son contrôle.

9(2) Upon the expiry of the time for which a certificate of approval is valid or for which a certificate of approval has been renewed, the Minister may renew the certificate of approval for a further period not exceeding five years.

9(2) A l'expiration de la durée de l'agrément ou de son renouvellement, le Ministre peut renouveler le certificat d'agrément pour une période supplémentaire n'excédant pas cinq ans.

10(1) If a source, sewage works or waterworks is constructed, modified or operated without an approval contrary to or in violation of this Regulation, notwithstanding any other remedy which may be available, the Minister may direct that the construction, modification or operation of the source, sewage works or waterworks be investigated and may order a person responsible for the source, sewage works or waterworks to terminate the operation thereof, or to make such modifications thereto, or to the operation thereof, as the Minister considers necessary, which order shall be carried out by the person to whom the order was directed in such manner and within such period of time as the Minister may specify in the order.

10(1) Lorsqu'une source, un ouvrage d'évacuation des eaux usées ou un ouvrage d'adduction d'eau est construit, modifié ou exploité sans agrément, contrairement au présent règlement ou en contravention de celui-ci, le Ministre peut, nonobstant tout autre recours possible, prescrire la tenue d'une enquête sur leur construction, modification ou exploitation et ordonner au responsable d'en cesser l'exploitation ou d'y apporter les modifications qu'il juge nécessaires, cet arrêté devant être exécuté par la personne à qui il est destiné de la manière et dans les délais que le Ministre peut y fixer.

10(1.1) If an activity or thing is developed, constructed, operated or maintained in a protected area referred to in section 20 without an approval contrary to or in violation of this Regulation, notwithstanding any other remedy which may be available, the Minister may direct that the development, construction, operation or maintenance of the activity or thing be investigated and may order the person developing, constructing, operating or maintaining the activity or thing to terminate the development, construction, operation or maintenance thereof, or to make such modifications thereto, or to the development, construction, operation or maintenance thereof, as the Minister considers necessary, which order shall be carried out by the person to whom the order was directed in such manner and within such period of time as the Minister may specify in the order.

10(1.1) Lorsqu'une activité ou chose est développée, construite, exploitée ou entretenue dans un périmètre de protection visé à l'article 20 sans agrément, contrairement au présent règlement ou en contravention de celui-ci, le Ministre peut, nonobstant tout autre recours possible, prescrire la tenue d'une enquête sur leur développement, construction, exploitation ou entretien et ordonner au responsable d'en cesser leur développement, construction, exploitation ou entretien ou d'y apporter les modifications qu'il juge nécessaires, cet arrêté devant être exécuté par la personne à qui il est destiné de la manière et dans les délais que le Ministre peut y fixer.

10(2) If a source, sewage works or waterworks is constructed, modified or operated contrary to or in violation of the terms and conditions of an approval, notwithstanding any other remedy which may be available, the Minister may direct that the construction, modification or operation of the

10(2) Lorsqu'une source, un ouvrage d'évacuation des eaux usées ou un ouvrage d'adduction d'eau est construit, modifié ou exploité contrairement aux conditions de l'agrément ou en contravention de celles-ci, le Ministre peut, nonobstant tout autre recours possible, prescrire la tenue d'une source, sewage works or waterworks be investigated and may order a person responsible for the source, sewage works or waterworks to make such modifications thereto, or to the operation thereof, as the Minister considers necessary to effect compliance with the approval, which order shall be carried out by the person to whom the order was directed in such manner and within such period of time as the Minister may specify in the order.

enquête sur leur construction, modification ou exploitation et ordonner au responsable d'y apporter les modifications qu'il juge nécessaires pour qu'il soit satisfait aux conditions de l'agrément, cet arrêté devant être exécuté par la personne à qui il est destiné de la manière et dans les délais que le Ministre peut y fixer.

10(2.1) If an activity or thing is developed, constructed, operated or maintained in a protected area referred to in section 20 contrary to or in violation of the terms and conditions of an approval, notwithstanding any other remedy which may be available, the Minister may direct that the development, construction, operation or maintenance of the activity or thing be investigated and may order the person developing, constructing, operating or maintaining the activity or thing to make such modifications thereto, or to the development, construction, operation or maintenance thereof, as the Minister considers necessary to effect compliance with the approval, which order shall be carried out by the person to whom the order was directed in such manner and within such period of time as the Minister may specify in the order.

10(2.1) Lorsqu'une activité ou chose est développée, construite, exploitée ou entretenue dans un périmètre de protection visé à l'article 20 contrairement aux conditions de l'agrément ou en contravention de celles-ci, le Ministre peut, nonobstant tout autre recours possible, prescrire la tenue d'une enquête sur leur développement, construction, exploitation ou entretien et ordonner au responsable d'y apporter les modifications qu'il juge nécessaires pour qu'il soit satisfait aux conditions de l'agrément, cet arrêté devant être exécuté par la personne à qui il est destiné de la manière et dans les délais que le Ministre peut y fixer.

10(3) Notwithstanding the terms and conditions of any approval which may have been issued with respect to a source, sewage works or waterworks, the Minister may direct that the construction, modification or operation of the source, sewage works or waterworks be investigated and may order a person responsible for the source, sewage works or waterworks to make such modifications thereto, or to the operation thereof, as the Minister considers necessary, which order shall be carried out by the person to whom the order was directed in such manner and within such period of time as the Minister may specify in the order.

10(3) Nonobstant les conditions de tout agrément accordé à l'égard d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau, le Ministre peut prescrire la tenue d'une enquête sur leur construction, modification ou exploitation et ordonner au responsable d'y apporter les modifications qu'il juge nécessaires, cet arrêté devant être exécuté par la personne à qui il est destiné de la manière et dans les délais que le Ministre peut y fixer.

10(3.1) Notwithstanding the terms and conditions of an approval which may have been issued with respect to an activity or thing in a protected area referred to in section 20, the Minister may direct that the development, construction, operation or maintenance of the activity or thing be

10(3.1) Nonobstant les conditions de tout agrément accordé à l'égard d'une activité ou chose dans un périmètre de protection visé à l'article 20, le Ministre peut prescrire la tenue d'une enquête sur leur développement, construction, exploitation ou entretien et ordonner au responsable d'y apporter

investigated and may order the person developing, constructing, operating or maintaining the activity or thing to make such modifications thereto, or to the development, construction, operation or maintenance thereof, as the Minister considers necessary, which order shall be carried out by the person to whom the order was directed in such manner and within such period of time as the Minister may specify in the order.

les modifications qu'il juge nécessaires, cet arrêté devant être exécuté par la personne à qui il est destiné de la manière et dans les délais que le Ministre peut y fixer.

10(4) If any contaminant is emitted, discharged, deposited, left or thrown into or upon the environment in any location such that it may, directly or indirectly, result in water pollution or increased water pollution contrary to or in violation of this Regulation, notwithstanding any other remedy which may be available, the Minister may direct that the emission, discharging, depositing, leaving or throwing of the contaminant be investigated and may order the person who emits, discharges, deposits, leaves or throws such contaminant, or who has control of the source which emits, discharges, deposits, leaves or throws such contaminant, to take such action as the Minister considers necessary to minimize the water pollution, which order shall be carried out by the person to whom the order was directed in such manner and within such period of time as the Minister may specify in the order.
86-85

10(4) Lorsqu'un polluant est émis, déversé, déposé, abandonné ou jeté dans ou sur l'environnement en un endroit où il peut, directement ou indirectement, occasionner ou accroître la pollution de l'eau contrairement au présent règlement ou en contravention de celui-ci, le Ministre peut, nonobstant tout autre recours possible, prescrire la tenue d'une enquête à cet égard et ordonner à la personne qui émet, déverse, dépose, abandonne ou jette ce polluant ou à celle qui a la direction de la source qui en est la cause de prendre les mesures nécessaires pour minimiser la pollution de l'eau, cet arrêté devant être exécuté par la personne à qui il est destiné de la manière et dans les délais que le Ministre peut y fixer.
86-85

11(1) Where any term or condition of an approval is knowingly violated for any reason, the person to whom the approval was issued or any individual designated by him in writing as being in charge of the source, sewage works or waterworks which is subject to the approval, shall take adequate action to minimize the environmental effect of the violation and shall report such violation to the Minister immediately, which report shall contain

(a) a description of the source, sewage works or waterworks including the name of all persons responsible for the source, sewage works or waterworks,

(b) the nature of the violation, including its extent, duration and environmental impact,

11(1) Lorsqu'est enfreinte sciemment une condition quelconque d'un agrément pour quelque raison que ce soit, le titulaire de l'agrément ou la personne qu'il désigne par écrit comme étant chargée de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau visé par l'agrément doit prendre des mesures suffisantes pour minimiser les répercussions écologiques de l'infraction qu'il doit signaler au Ministre sur-le-champ et fournir les renseignements suivants:

a) une description de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau et le nom de tous leurs responsables,

b) la nature de l'infraction, y compris sa gravité, sa durée et son impact écologique, *(c)* the cause of the violation, and

(d) any remedial action taken or to be taken to minimize the environmental effect of the violation and to prevent a recurrence of the violation.

11(1.1) Where any term or condition of an approval issued with respect to an activity or thing in a protected area referred to in section 20 is knowingly violated for any reason, the person to whom the approval was issued, or any individual designated by him in writing as being in charge of the activity or thing which is subject to the approval, shall take adequate action to minimize the environmental effect of the violation and shall report such violation to the Minister immediately, which report shall contain

(a) a description of the protected area,

(b) a description of the activity or thing and the name of the person to whom the approval was issued and of any individual designated by him in writing as being in charge of the activity or thing,

(c) the nature of the violation, including its extent, duration and environmental impact,

(d) the cause of the violation, and

(e) any remedial action taken or to be taken to minimize the environmental effect of the violation and to prevent a recurrence of the violation.

11(2) Where any contaminant is emitted, discharged, deposited, left or thrown in any place such that it may, directly or indirectly, result in water pollution or increased water pollution in any waters of the Province, the person who emits, discharges, deposits, leaves or throws such contaminant, or who has control of the source which emits, discharges, deposits, leaves or throws such contaminant, shall take adequate action to minimize the water pollution and shall report such emission, discharging, depositing, leaving or throwing to the Minister immediately, which report shall contain

c) la cause de l'infraction, et

d) les mesures correctrices qui sont ou seront prises pour minimiser les répercussions écologiques de l'infraction et pour prévenir toute récidive.

11(1.1) Lorsqu'est enfreinte sciemment, pour quelque raison que ce soit, une condition quelconque d'un agrément émis par rapport à une activité ou chose dans un périmètre de protection visé à l'article 20, le titulaire de l'agrément, ou la personne qu'il désigne par écrit comme étant chargée de l'activité ou de la chose visée par l'agrément, doit prendre les mesures suffisantes pour minimiser les répercussions écologiques de l'infraction qu'il doit signaler au Ministre sur-le-champ et fournir les renseignements suivants:

a) une description du périmètre de protection,

b) une description de l'activité ou chose et le nom du titulaire de l'agrément et de la personne qu'il désigne par écrit comme étant chargée de l'activité ou de la chose,

c) la nature de l'infraction, y compris sa gravité, sa durée et son impact écologique,

d) la cause de l'infraction, et

e) les mesures correctrices qui sont ou seront prises pour minimiser les répercussions écologiques de l'infraction et pour prévenir toute récidive.

11(2) Lorsqu'un polluant est émis, déversé, déposé, abandonné ou jeté en un endroit où il peut, directement ou indirectement, polluer l'eau ou accroître la pollution de toute eau de la province, la personne qui émet, déverse, dépose, abandonne ou jette le polluant ou qui a la direction de la source qui en est à l'origine doit prendre des mesures suffisantes pour minimiser la pollution de l'eau, signaler l'émission, le déversement, le dépôt, l'abandon ou le rejet au Ministre sur-le-champ et fournir les renseignements suivants:

(a) a description of the contaminant, including its volume and the location of the place where it is emitted, discharged, deposited, left or thrown,

(b) a description of the water pollution which may result, including a description of the waters affected,

(c) the cause of the contamination, and

(d) any remedial action taken or to be taken to minimize the resulting water pollution and to prevent a recurrence.

11(3) In addition to the action required by subsection (1), (1.1) or (2), if the event described therein results or may result in a substantial increase in water pollution in any waters of the Province, the person required to report shall give immediate notice of the event to the Provincial Mobile Communications Centre by telephone at 1-506-453-7171.

11(4) If in his opinion the action taken pursuant to subsection (1), (1.1) or (2) to minimize the environmental effect of the event described therein is not adequate, the Minister may in writing order the taking of such remedial action as he deems necessary.

86-85; 95-59

12 Any person responsible for a sewage works shall ensure that the sewage works is maintained in a good state of repair and is under the control of a competent individual.

13(1) If the Minister is notified by the Minister of Health that, in the interest of the public health in a municipality, it is necessary that a waterworks should be constructed or modified, or that its operation should be commenced or modified, he may order the municipality to undertake such

a) une description du polluant, y compris son volume et l'endroit où il a été émis, déversé, déposé, abandonné ou jeté,

b) une description de la pollution de l'eau qui peut en résulter, y compris une description des eaux affectées,

c) la raison de l'abandon, du rejet ou du dépôt du polluant, et

d) les mesures correctrices qui sont ou seront prises pour minimiser la pollution de l'eau causée par l'incident et pour prévenir toute récidive.

11(3) Dans le cas où l'incident décrit occasionne ou risque d'occasionner un accroissement important de la pollution de toute eau de la province, la personne qui est tenue de le signaler doit, outre les mesures prescrites par le paragraphe (1), (1.1) ou (2), notifier l'incident sur-le-champ au Centre mobile de communication de la province au 1-506-453-7171.

11(4) S'il estime que les mesures prises conformément au paragraphe (1), (1.1) ou (2) pour minimiser les répercussions écologiques des incidents décrits ne suffisent pas, le Ministre peut ordonner par écrit que soient prises les mesures correctrices qu'il juge nécessaires.

86-85; 95-59

12 Le responsable d'un ouvrage d'évacuation des eaux usées doit veiller à ce que l'ouvrage soit maintenu en bon état de réparation et sous la direction d'une personne compétente.

13(1) Le Ministre peut, sur notification par le ministre de la Santé indiquant la nécessité de construire ou de modifier un ouvrage d'adduction d'eau ou encore d'en commencer ou d'en modifier l'exploitation dans l'intérêt de l'hygiène publique, ordonner à la municipalité d'entreprendre construction or modification or commence or modify such operation in accordance with any directions that the Minister may set out in the order.

13(2) When the Minister makes an order in accordance with subsection (1), the municipality shall immediately begin to comply with the Minister's directions and shall completely comply with them as soon as possible.

14 No person may cease to operate a sewage works or waterworks or any portion thereof without the written consent of the Minister.

15(1) No person shall erect or place any structure upon the ice of any body of water unless the name and address of the owner is clearly written upon the exterior of the structure in letters at least three inches high.

15(2) Any structure referred to in subsection (1) shall be mounted on runners or skids.

15(3) The Minister may remove and destroy or otherwise dispose of any structure located upon the ice of any body of water if there has not been compliance with the requirements of subsections (1) and (2).

15(4) The Minister may, by letter sent prepaid registered post to the name and address marked upon the structure pursuant to subsection (1), order that any structure placed upon the ice of any body of water be removed, either temporarily or permanently.

15(5) If a structure is not removed in accordance with directions given by the Minister pursuant to subsection (4) within ten days of the mailing of the letter prescribed by subsection (4), the Minister may remove and destroy or otherwise dispose of the structure.

ces opérations conformément aux directives contenues dans son arrêté.

13(2) La municipalité doit commencer sur-le-champ à se conformer à l'arrêté pris par le Ministre sous le régime du paragraphe (1) et y satisfaire pleinement le plus tôt possible.

14 Nul ne peut cesser l'exploitation d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau ou d'une partie de ceux-ci sans l'autorisation écrite du Ministre.

15(1) Nul ne peut ériger ou placer une construction sur la surface glacée d'une eau réceptrice à moins que le nom et l'adresse du propriétaire ne soient inscrits lisiblement sur l'extérieur de la construction en caractères de trois pouces de hauteur au moins.

15(2) Les constructions visées au paragraphe (1) doivent être montées sur des patins ou sur une plate-forme.

15(3) Le Ministre peut enlever et supprimer toute construction aménagée sur la surface glacée d'une eau réceptrice ou en disposer autrement s'il n'a pas été satisfait aux prescriptions des paragraphes (1) et (2).

15(4) Le Ministre peut, par lettre affranchie et recommandée expédiée au nom et à l'adresse inscrits sur la construction conformément au paragraphe (1), en ordonner l'enlèvement provisoire ou définitif.

15(5) S'il n'est pas satisfait aux prescriptions du paragraphe (4) dans les dix jours de la mise à la poste de la lettre que prévoit ce même paragraphe, le Ministre peut enlever et supprimer la construction ou en disposer autrement.

15(6) No person shall leave any structure upon the ice of any body of water at a time when melting of the ice may cause the structure to be deposited into or upon the water.

15(6) Il est interdit de laisser une construction sur la surface gelée d'une eau réceptrice au moment du dégel afin d'éviter qu'elle ne s'y enfonce.

15(7) When, in the opinion of the Minister, the melting of ice may cause structures erected or placed upon the ice of any body of water to be deposited into or upon the water, the Minister may, by notice published once in such newspaper or newspapers as the Minister may require, order that all such structures erected or placed upon the ice of such body of water be removed, either temporarily or permanently, by a date specified in the notice.

15(7) Lorsqu'il estime que le dégel peut entraîner l'enfoncement des constructions érigées ou placées sur la surface gelée d'une eau réceptrice, le Ministre peut, au moyen d'un avis publié une fois dans le journal ou les journaux qu'il peut prescrire, ordonner l'enlèvement provisoire ou définitif des constructions au plus tard à la date fixée dans l'avis.

15(8) If a structure placed upon the ice of any body of water referred to in a notice published pursuant to subsection (7) is not removed by the date specified in such notice, the Minister may remove and destroy or otherwise dispose of the structure.

15(8) Si les constructions placées sur la surface gelée d'une eau réceptrice et visées par l'avis publié en vertu du paragraphe (7) ne sont pas enlevées avant la date y fixée, le Ministre peut les enlever et les supprimer ou en disposer autrement.

16(1) The Minister may inspect

(a) a source,

(b) a sewage works,

(c) a waterworks,

(d) an activity being developed, constructed, operated or maintained in a protected area, or

16(1) Le Ministre peut inspecter

a) une source,

b) un ouvrage d'évacuation des eaux usées,

c) un ouvrage d'adduction d'eau,

d) une activité en train d'être développée, construite, exploitée ou entretenue dans un périmètre de protection, ou

(e) a thing being developed, constructed, operated or maintained in a protected area,

and during the inspection he may make such tests and measurements and take such samples as he may require.

16(2) An inspector who presents an identification card purporting to be signed by the Minister, bearing the photograph of the inspector, his name and a statement that he has been designated as an inspector pursuant to section 23 of the Act, shall be immediately admitted to any area or building not used primarily as a private dwelling in order to act on behalf of the Minister.

86-85

17(1) The Minister may require a person responsible for a source, sewage works or waterworks to monitor and maintain records of parameters of operation of the source, sewage works or waterworks and discharge therefrom.

17(2) The Minister may designate or approve the methods to be used in determining the parameters referred to in subsection (1), including, without limiting the generality of the foregoing, requiring the installation of recording devices approved by the Minister and the taking of such steps to ensure accuracy as may be required by the Minister.

17(3) The person responsible for a source, sewage works or waterworks who is required by the Minister pursuant to subsection (1) to monitor and maintain records of parameters of operation of the source, sewage works or waterworks or discharge therefrom shall, within such period of time as the Minister may specify, comply fully with such requirements and the methods designated or approved by the Minister pursuant to subsection (2).

e) une chose en train d'être développée, construite, exploitée ou entretenue dans un périmètre de protection,

et, en même temps, procéder aux contrôles et mesures et aux prélèvements d'échantillons dont il peut avoir besoin.

16(2) L'inspecteur qui présente une pièce d'identité réputée être revêtue de la signature du Ministre et sur laquelle se trouvent sa photographie, son nom et une déclaration attestant qu'il a été désigné à ce titre en vertu de l'article 23 de la loi doit être admis, sur-le-champ, dans tout lieu ou tout bâtiment qui ne sert pas principalement d'habitation privée, pour agir au nom du Ministre.

86-85

17(1) Le Ministre peut enjoindre le responsable d'assurer la surveillance de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau et de leurs débits et de dresser les relevés des paramètres d'exploitation.

17(2) Le Ministre peut arrêter ou approuver les méthodes de détermination des paramètres visés au paragraphe (1) et, sans limiter la portée générale de ce qui précède, prescrire l'installation d'appareils enregistreurs qu'il agrée et la prise des mesures qu'il détermine pour assurer la précision.

17(3) Lorsque le Ministre, en vertu du paragraphe (1), enjoint le responsable d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau de se conformer aux dispositions de ce paragraphe, celui-ci doit satisfaire à toutes ces prescriptions et se conformer aux méthodes arrêtées ou approuvées en vertu du paragraphe (2) dans les délais que le Ministre peut fixer.

17(4) Records maintained pursuant to subsection (1) shall be retained for such time as may be prescribed by the Minister and shall be made available to the Minister at his request.

18 Any person responsible for a waterworks shall ensure that the waterworks is maintained in a clean and sanitary condition, in a good state of repair and under the control of a competent person.

19(1) The Minister may by notice to a person responsible for a source, sewage works or waterworks prescribe a training program or programs for any person in control of or who is to be in control of the source, sewage works or waterworks, or any part thereof.

19(2) Notwithstanding sections 12 and 18, no person responsible for a source, sewage works or waterworks shall permit a person to be in control of a source, sewage works or waterworks, or any part thereof, who

(a) fails or refuses to take any training program prescribed by the Minister pursuant to subsection (1), or

(b) in taking any training program prescribed by the Minister pursuant to subsection (1), fails to successfully complete to the satisfaction of the Minister such training program and all tests and examinations which may be given in conjunction therewith.

20 Repealed: 92-77

86-85; 92-77

17(4) Les relevés dressés conformément au paragraphe (1) sont conservés durant la période que peut prescrire le Ministre et mis à sa disposition sur demande.

18 Le responsable d'un ouvrage d'adduction d'eau doit veiller à la propreté et à la salubrité de l'ouvrage ainsi qu'à son maintien en bon état de réparation et sous la direction d'une personne compétente.

19(1) Le Ministre peut, par voie d'avis adressé au responsable, prescrire un ou plusieurs programmes de formation à l'intention des personnes qui ont ou auront la direction de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau ou d'une partie de ceux-ci.

19(2) Nonobstant les articles 12 et 18, nul responsable ne peut confier la direction d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau ou d'une partie de ceux-ci à une personne qui

a) omet ou refuse de suivre le programme de formation que prescrit le Ministre en vertu du paragraphe (1), ou

b) ne termine pas avec succès, d'une façon que le Ministre estime satisfaisante, le programme de formation prescrit en vertu du paragraphe (1) et les épreuves et examens connexes, le cas échéant.

20 Abrogé: 92-77

86-85; 92-77

21 Unless the Minister consents otherwise in writing, no person shall add a chemical substance to a public water supply except at a water treatment unit.

21 A moins d'autorisation écrite du Ministre, nul ne peut ajouter une substance chimique à une source d'approvisionnement public en eau, sauf à une installation de traitement de l'eau.

22(1) If the person, to whom an order which was made by the Minister pursuant to subsection 10(1), 10(1.1), 10(2), 10(2.1), 10(3), 10(3.1), 10(4), 11(4) or 13(1) of this Regulation is directed, fails or refuses to comply with the order, the Minister or such agent as he may in writing appoint, together with such other persons, materials and equipment as he deems necessary, may enter upon any land or premises, using such force as may be necessary, and may do everything he considers necessary to effect compliance with the order.

22(1) Lorsque la personne visée par un arrêté pris en vertu du paragraphe 10(1), 10(1.1), 10(2), 10(2.1), 10(3), 10(3.1), 10(4), 11(4) ou 13(1) refuse ou omet d'y obtempérer, le Ministre ou le représentant qu'il peut désigner par écrit peut pénétrer, en utilisant la force dans la mesure et si nécessaire, sur tout bien-fonds ou dans tout lieu avec les autres personnes, les matériaux et le matériel qu'il estime nécessaires et y faire les interventions qu'il juge nécessaires pour qu'il soit satisfait à l'arrêté.

22(2) If a person ceases to operate a waterworks or sewage works contrary to section 14, the Minister or such agent as he may in writing appoint, together with such other persons, materials and equipment as he deems necessary, may enter upon any land or premises, using such force as may be necessary, and may do everything necessary to resume or continue the operation of the sewage works or waterworks.

22(2) En cas de cessation de l'exploitation d'un ouvrage d'adduction d'eau ou d'un ouvrage d'évacuation des eaux usées contrairement à l'article 14, le Ministre ou le représentant qu'il désigne par écrit peut pénétrer, en utilisant la force dans la mesure et si nécessaire, sur tout bien-fonds ou dans tout lieu avec les autres personnes, les matériaux et le matériel qu'il estime nécesaires et y faire les interventions qu'il juge nécessaires pour que reprenne ou continue l'exploitation de l'ouvrage en question.

22(3) The costs incurred by the Minister or his agent acting pursuant to subsections (1) or (2) or subsections 15(5) or 15(8) or in carrying out an investigation pursuant to subsection 10(1), 10(1.1), 10(2), 10(2.1), 10(3), 10(3.1) or 10(4), including the cost of all persons, materials and equipment employed and of repairing any damage done, shall be the responsibility of and paid by

(a) any person who failed to comply with section 14,

(b) any person who failed to comply with the order made pursuant to subsection 10(1), 10(1.1), 10(2), 10(2.1), 10(3), 10(3.1), 10(4), 11(4), 13(1), 15(4) or 15(7),

22(3) Si demande en est faite par le Ministre, les frais engagés par ce dernier ou par son représentant pour les interventions faites sous le régime des paragraphes (1) ou (2) ou 15(5) ou 15(8) ou encore pour toute enquête effectuée en vertu du paragraphe 10(1), 10(1.1), 10(2), 10(2.1), 10(3), 10(3.1) ou 10(4), y compris les frais pour les personnes, les matériaux et le matériel et pour la réparation des dommages causés, sont mis à la charge, selon le cas,

a) de la personne qui ne se conforme pas à l'article 14,

b) de la personne qui omet d'obtempérer à un arrêté pris en vertu du paragraphe 10(1), 10(1.1), 10(2), 10(2.1), 10(3), 10(3.1), 10(4), 11(4), 13(1), 15(4) ou 15(7), *(c)* any person responsible for a source, sewage works or waterworks investigated pursuant to subsections 10(1), 10(2) or 10(3), or

c) du responsable de la source, de l'ouvrage d'évacuation des eaux usées ou de l'ouvrage d'adduction d'eau qui a fait l'objet d'une enquête en vertu du paragraphe 10(1), 10(2) ou 10(3), ou

(d) any person who emitted, discharged, deposited, left or threw any contaminant into or upon the environment, or who had control of the source which emitted, discharged, deposited, left or threw any contaminant into or upon the environment, which was investigated pursuant to subsection 10(4),

d) de la personne qui a émis, déversé, déposé, abandonné ou jeté le polluant sur ou dans l'environnement ou de celle qui avait la direction de la source qui en a été à l'origine, cet incident ayant donné lieu à une enquête en vertu du paragraphe 10(4).

as the case may be, upon demand being made by the Minister.

22(4) The Minister may issue a certificate or certificates under his hand setting out the costs recoverable pursuant to subsection (3) and such a certificate may be filed with the clerk of The Court of Queen's Bench of New Brunswick for the judicial district where the source, sewage works or waterworks, or any part thereof, is situate or where the activity or thing, or any part thereof, is being developed, constructed, operated or maintained in a protected area and when so filed and sealed with the seal of the Court shall become an order of that Court upon which judgment may be entered against the person upon whom demand was made pursuant to subsection (3) for the amount mentioned in the certificate, together with the fees of the clerk allowable in the case of default judgment and such judgment may be enforced as any other judgment of the Court.

22(4) Le Ministre peut délivrer sous son seing un certificat établissant les coûts recouvrables en vertu du paragraphe (3), lequel certificat peut être déposé auprès du greffier de la Cour du Banc de la Reine du Nouveau-Brunswick dans la circonscription judiciaire où se trouve la source, l'ouvrage d'évacuation des eaux usées ou l'ouvrage d'adduction d'eau ou bien où se trouve l'activité ou la chose, ou une partie de celle-ci qui est en train d'être développée, construite, exploitée ou entretenue dans un périmètre de protection et, lorsqu'ainsi déposé et revêtu du sceau de la Cour, constitue une ordonnance de cette Cour sur laquelle un jugement peut être rendu contre la personne visée par la demande faite en vertu du paragraphe (3) pour le montant indiqué dans le certificat, majoré des émoluments du greffier pour les cas de jugement par défaut, ledit jugement pouvant être exécuté comme tout autre jugement de la Cour.

22(5) The Minister shall be liable for any unnecessary damage caused by any entry upon land or premises and action taken thereon pursuant to this section or sections 10, 15 or 16.
86-85

22(5) Le Ministre est tenu de tout dommage inutile causé par l'entrée sur un bien-fonds ou dans un lieu et par les interventions qui y sont faites en vertu du présent article ou des articles 10, 15 ou 16.
86-85

23 In this Regulation any time limited for the taking of any action or for the completion of any matter or thing by a person other than the Minister may be extended by the written consent of the Minister.

23 Dans le présent règlement, tout délai imparti pour la prise de quelque mesure que ce soit, la résolution finale de toute question ou l'achèvement de toute chose par une personne autre que le Ministre peut être prorogé avec l'autorisation écrite de ce dernier.

24(1) Any notice or other document which is to be given to, filed with or served upon the Minister shall be sufficiently given, filed or served if it is delivered personally or mailed prepaid registered post to The Director, Pollution Control Branch, New Brunswick Department of the Environment, P. O. Box 6000, Fredericton, New Brunswick, E3B 5H1.

24(2) Any notice or other document which is to be given to or served upon the owner of a source, sewage works or waterworks shall be sufficiently given or served if it is deposited upon or near the source, sewage works or waterworks.

25(1) The issuance of every approval under this Regulation is conditional upon

(a) the full disclosure of all material facts in the application for the approval, and

(b) the truth and accuracy of the facts, representations and other information contained in the application for the approval.

25(2) No person shall give false or misleading information in any report or statement made to the Minister pursuant to this Regulation.

26 Repealed: 95-60

95-60

27(1) An application for an approval and an approval shall be in the form prescribed by the Minister and one such form shall be completed for every application for an approval filed with the Minister and for each approval granted.

27(2) The Minister shall maintain one or more registers consisting of the forms referred to in subsection (1).

27(3) All forms in the registers maintained pursuant to subsection (2) shall be indexed under the name of the applicant for the approval.

24(1) Pour notifier ou signifier un avis ou autre document au Ministre ou pour le déposer auprès de lui, il suffit de le lui remettre personnellement ou de l'expédier par courrier affranchi et recommandé au directeur de la Direction de contrôle de la pollution, ministère de l'Environnement, case postale 6 000, Fredericton, Nouveau-Brunswick, E3B 5H1.

24(2) Pour notifier ou signifier un avis ou autre document au propriétaire d'une source, d'un ouvrage d'évacuation des eaux usées ou d'un ouvrage d'adduction d'eau, il suffit de le déposer sur l'installation en question ou à proximité.

25(1) La délivrance d'un agrément en vertu du présent règlement est soumise aux conditions suivantes:

a) la divulgation entière de tous les faits pertinents dans la demande d'agrément, et

b) la véracité et l'exactitude des faits, indications et autres renseignements figurant dans la demande d'agrément.

25(2) Les rapports ou déclarations présentés au Ministre conformément au présent règlement ne doivent comporter aucun renseignement faux ou trompeur.

26 Abrogé: 95-60

95-60

27(1) Le Ministre arrête le modèle du formulaire de demande d'agrément et de l'agrément proprement dit et chaque demande d'agrément et chaque agrément est établi au moyen de ces formulaires.

27(2) Le Ministre consigne dans un ou plusieurs registres les formulaires visés au paragraphe (1).

27(3) Les formulaires sont répertoriés sous le nom du requérant dans les registres prescrits par le paragraphe (1).

27(4) The register or registers shall be available for inspection at the offices of the Department of the Environment, Fredericton, during normal office hours upon payment of a fee of one dollar.

86-85

28 No person obtaining an approval under this Regulation shall be thereby exempted from obtaining any approval required by other authorities.

29 *Regulation 76-154 under the Clean Environment Act is repealed.*

N.B. This Regulation is consolidated to June 30, 1995.

27(4) Le ou les registres peuvent être examinés aux bureaux du ministère de l'Environnement à Fredericton, Nouveau-Brunswick, durant les heures normales de bureau, moyennant paiement d'un droit d'un dollar.

86-85

28 Nul n'est exempté de l'obtention de toute approbation prescrite par d'autres autorités du seul fait de l'obtention d'un agrément sous le régime du présent règlement.

29 *Est abrogé le règlement 76-154 établi en vertu de la Loi sur l'assainissement de l'environnement.*

N.B. Le présent règlement est refondu au 30 juin 1995.

QUEEN'S PRINTER FOR NEW BRUNSWICK © IMPRIMEUR DE LA REINE POUR LE NOUVEAU-BRUNSWICK

Environment Canada Environnement Canada

Appendix B

Newfoundland Legislation

New Nouveau Brunswick

CHAPTER E - 13.1

AN ACT RESPECTING THE PROTECTION OF THE ENVIRONMENT

(Assented to December 21, 1995)

Analysis

Be it enacted by the Lieutenant-Governor and House of Assembly in Legislative Session convened, as follows:

Short title — **1.** This Act may be cited as the *Environment Act.*

Definitions — **2.** In this Act

(a) "beneficial use" means a use of water, including the method of diversion, storage, transportation and application, that is reasonable and consistent with the public interest in the proper utilization of water resources, including but not limited to domestic, agricultural, industrial, power, municipal, navigational, fish and wild life and recreational uses;

(b) "body of water" means a surface or subterranean source of fresh or salt water within the jurisdiction of the province, whether that source usually contains water or not, and includes water above the bed of the sea that is within the jurisdiction of the province, a river, stream, brook, creek, watercourse, lake, pond, spring, lagoon, ravine, gully, canal and other flowing or standing water and the land usually or at a time occupied by that body of water;

(c) "land" means all land within the province and includes land covered by water;

(d) "licence" means a licence issued under this Act;

(e) "minister" means the minister responsible for the administration of this Act;

(f) "municipal authority" includes

(i) the City of St. John's,

(ii) the City of Corner Brook,

(iii) the City of Mount Pearl, and

(iv) a local service district committee or the council of a community, town or region constituted or continued under the *Municipalities Act;*

(g) "person" includes a body of persons whether incorporated or not;

(h) "pollution" means an alteration of the physical, chemical, biological or aesthetic properties of air, soil or waters of the province, including a change of temperature, taste or odour, or the addition of a liquid, solid, radio-active, gaseous or other substance to the air, soil or waters, or the removal of those substances from the air, soil or waters, which will render or is likely to render the air, soil or waters of the province harmful to the public health, safety or welfare, or harmful or less useful for domestic, agricultural, industrial, power, municipal, navigational, recrea-

tional or other lawful uses, or for animals, birds, or aquatic life;

(i) "sewage" includes residential, municipal, commercial or industrial waterborne or solid wastes, which would, if left untreated, cause pollution, but does not include drainage and storm water collected from natural run-off;

(j) "sewage works" means works for or incidental to the collection, transmission, treatment and disposal of sewage, or a part of those sewage works;

(k) "water resources" means all bodies of water in the province;

(l) "waterworks" means a public, commercial or industrial works for the collection, production, treatment, storage, supply and distribution of water, or a part of those waterworks; and

(m) "works" includes all property, buildings, erections, plant, machinery, installations, materials, dams, canals, devices, fittings, apparatus, appliances and equipment.

Property in water

3. (1) The property in and the right to the use and flow of all water at a time in a body of water in the province are for all purposes vested in the Crown, and no right to divert or use water or a body of water may be acquired by prescription.

(2) Notwithstanding subsection (1), the property in and the right to the use and flow of all water vested in the Crown by virtue of subsection (1) shall be subject to rights of property, use and flow conferred on a municipal authority or person by or under an Act of the province or a valid grant, lease, licence or other instrument.

(3) Nothing in this section or an Act of the province or a valid grant, lease, licence or other instrument shall confer or be construed to confer the right or privilege of water pollution to the degree beyond that which is prescribed by the regulations as constituting a polluted or unwholesome condition, or tending to that condition or a right or privilege which would have the effect of excluding or limiting the right of control conferred by this Act or the regulations on the minister in respect of the pollution of water, and those rights or privileges held immediately before December 18, 1989 whether

those rights or privileges are held by an Act or by a valid grant, lease or licence or by the operation of law or otherwise are forever extinguished and barred.

Water conservation studies

4. (1) The minister may order studies to be made of bodies of water within the province for the purpose of assembling the fullest possible information on the quantity, quality, character, location and use or possible use of those bodies of water, and respecting matters which the minister considers advisable in the interests of the present or future conservation, development, control, improvement or proper utilization of those bodies of water or in the interests of the compilation of information of value to the province in or for that conservation, development, control, improvement or proper utilization.

(2) The minister shall make a written report to the Lieutenant-Governor in Council on the results of studies carried out under subsection (1), and copies of the report shall be laid before the House of Assembly at the next session after the report is made to the Lieutenant-Governor in Council.

(3) The minister shall, in the report referred to in subsection (2), make recommendations for carrying out the purpose and intent of this Act, including recommendations respecting reforestation or other ancillary water conservation, development or improvement measures.

Minister's power re water

5. Subject to the *Municipal Affairs Act*, the minister shall have control of

(a) the use of all surface, ground and shore waters;

(b) the allocation of the use of waters;

(c) pollution of air, soil and water originating within the jurisdiction of the province; and

(d) alteration of the natural features of a body of water and the natural movement of water in a body of water.

Approval of waterworks

6. (1) Where a municipal authority or person contemplates the establishment of waterworks, or the extension of or change in existing waterworks, the plans, specifications and an engineer's report of the

water supply and the works to be undertaken, together with other information that the minister may require, shall be submitted to the minister, and no work shall be undertaken or proceeded with until the source of water supply and the proposed works have been approved, in writing by the minister.

(2) Where a municipal authority or person undertakes or proceeds with the establishment of waterworks or the extension of or change in an existing waterworks, without first obtaining the approval referred to in subsection (1), the minister may order an investigation of the works and the source of water supply and may order those changes to be made in the works or in the source of water supply, that the minister considers necessary, and the investigation and changes shall be made at the expense of the municipal authority or person.

(3) Where, in the opinion of the minister, it is in the public interest to do so, the minister may refuse to grant his or her approval or may grant his or her approval on those terms and conditions that the minister considers necessary.

(4) Where, in the opinion of the minister, the quality or property of water in an existing waterworks is in a polluted or unwholesome condition or an existing waterworks requires alteration, the minister may order the alteration or additions, that may be considered necessary, to be made by and at the expense of the municipal authority or person operating the waterworks and in a manner and within a time that the minister directs.

Maintenance of waterworks

7. Waterworks referred to in section 6 shall at all times be maintained, kept in repair and operated in a manner and with those facilities that the minister directs.

Approval of sewage works

8. (1) A person or municipal authority shall, before

(a) the construction of sewage works or the extension of or change in sewage works; or

(b) the construction of an industrial or processing works which will, when established and in operation, emit smoke, vapour or gas into the open air, or the extension or change in an existing industrial or processing works which will,

when the extension or change is completed and in operation, emit smoke, vapour or gas into the open air,

submit to the minister the plans, specifications and an engineer's report of the works to be undertaken and the location of the discharge of the effluent or emission, together with other information that the minister may require, and the works shall not be undertaken or proceeded with until the proposed works have been approved in writing by the minister.

(2) Where a person or municipal authority undertakes or proceeds with the construction, extension or change of the works referred to in subsection (1), without first obtaining the approval referred to in that subsection, the minister may order an investigation of the works and the location of the discharge of effluent or emission and may order changes to be made in the works or in the location of the discharge of effluent or emission that the minister considers necessary, the investigation and changes to be made at the expense of the person or municipal authority.

(3) The minister may, after considering the plans, specifications, report and other information that may be required by the minister under subsection (1), and after considering also the regulations relating to qualities, properties and treatment of sewage or standards of emission for gaseous or particulate substances, grant approval to the construction of the proposed works, which approval may be given subject to those terms and conditions that may be warranted by the preceding considerations.

(4) Where, upon receiving information that

(a) sewage requires sewage works;

(b) existing sewage works require alteration; or

(c) smoke, vapour or gas that is emitted from industrial or processing works is likely to pollute the air,

the minister may order alterations or additions, that may be necessary, to be made by and at the expense of the municipal authority or person operating the facility and in a manner and within a time that the minister directs.

Pollution prohibited

Public water supplies

Approval of commercial use

(5) The works referred to in subsection (1) shall at all times be maintained, kept in repair and operated in a manner and with those facilities that may be directed by the minister.

Pollution prohibited

9. Subject to the regulations, a municipal authority or person shall not discharge or deposit material of any kind into a body of water or on a shore or bank of a body of water or in a place that may cause pollution or impair the quality of water for a beneficial use.

Public water supplies

10. (1) The minister may define and prescribe an area surrounding a source of public water supply, and the municipal authority or person operating a waterworks and using water from that source shall

(a) give notice of the area so defined and prescribed by publication or otherwise; and

(b) protect that source of public water supply.

(2) In a defined and prescribed area, a person shall not

(a) place, deposit, discharge or allow to remain in the prescribed area material of a kind that might impair the quality of the water; or

(b) fish, bathe, swim or wash in or otherwise impair the quality of the water.

(3) Notwithstanding subsection (2), where the minister is satisfied upon the advice of his or her officials that the nature and size of a public water supply area is sufficiently large to preclude pollution by a person, the minister may define and prescribe a section of the public water supply area to be used by persons for fishing, boating, swimming, washing or other activity prescribed by the regulations.

Approval of commercial use

11. (1) Where a municipal authority or person contemplates a hydro-electric power project, a control dam, a river diversion, a drainage diversion or an alteration of a body of water or of water flow in it, the plans and other information that the minister may require shall be submitted to the minister, and no proposed work shall be undertaken or proceeded with until approved in writing by the minister.

(2) Subsection 8(3) shall apply to an approval by the minister under this section in so far as it affects a body of water to which subsection 3(2) applies.

Stopping orders

12. (1) The minister may, on receiving a report from his or her officials or from the commission or a local advisory commission that a condition exists which is causing or is likely to cause pollution of the air, soil or a body of water, make an order to protect the environment from that condition and to prevent, restrict or prohibit an activity which in the minister's opinion is giving rise to or is likely to give rise to that condition and may make an order stopping works or operations, in this and the next succeeding section referred to as a "stopping order", either permanently or for a period that is specified in the order.

(2) The minister shall serve on the owner or person in charge of the works or the operations affected by the stopping order a copy of the order and a statement showing the reasons for the making of the order, and upon receipt of that copy and statement, the owner or person in charge of the works or operations shall ensure that the works or operations are stopped.

Appeal

13. (1) The owner or other person aggrieved by a stopping order may

(a) in the case of a stopping order directing a permanent stoppage, within 60 days from the date of the order; or

(b) in the case of a stopping order directing stoppage for a period that is not permanent, at a time during that period,

appeal against the order to a judge of the Trial Division by filing a notice of the appeal in the office of the Registrar of the Supreme Court and by serving a copy of the notice of appeal on the minister or deputy minister.

(2) Notwithstanding a rule or practice to the contrary, the notice of appeal shall

(a) set out in detail the allegations of the appellant and the grounds upon which the order is appealed against; and

(b) be signed by the appellant or the appellant's solicitor.

(3) The appellant shall, within 14 days after service of the notice of appeal under this section, apply to the judge for the appointment of a day for the hearing of the appeal and shall, not less than 14 days before the hearing, serve upon the deputy minister a written notice of the day appointed for the hearing.

(4) The minister shall produce before the judge hearing the appeal all papers and documents in his or her possession affecting the matter of the appeal.

(5) The judge shall hear the appeal and the evidence brought forward by the appellant and the Crown in a summary manner and shall decide the matter of the appeal by

(a) upholding, amending or revoking the stopping order after considering, upon all matters submitted to him or her, whether the works or operations did constitute a condition which did pollute or was likely to pollute the air, soil or a body of water; or

(b) making another decision which the judge considers to be proper in the circumstances,

and with power also to make orders as to costs for or against the appellant or the Crown and to fix the amount of the costs.

(6) An appeal may be taken from the decision of the judge of the Trial Division to the Court of Appeal upon a point of law raised upon the hearing of the appeal, and the rules governing appeals to that court from a decision of a judge of the Trial Division shall apply to appeals under this subsection.

(7) The filing of a notice of appeal under this section, or the appeal itself, shall not affect the stopping order, which shall remain in force pending the outcome of the appeal.

Regulations

14. (1) The Lieutenant-Governor in Council may make regulations

(a) providing for the inspection and testing of air, soil or bodies of water;

(b) prohibiting, restricting and regulating the use of water from a specified body of water generally for household, industrial, commercial or irrigation purposes;

(c) prescribing what qualities and properties of air, soil or water shall constitute a polluted condition or an unwholesome condition;

(d) preventing or restricting the pollution, discolouration or rendering unwholesome of bodies of water;

(e) prescribing standards of quality of water supplies intended for household, industrial or irrigation purposes, with power to adopt, with or without modification, published codes, rules or standards relating to water quality;

(f) subject to the terms and conditions of a permit issued under the regulations made under paragraph (h), regulating the qualities and properties of and prohibiting or restricting the discharge of sewage and waste effluents that may be discharged into sewage works, public sewage systems, bodies of water, sea waters from a source within the province, or on or into the soil;

(g) prescribing methods of treatment of sewage and waste effluents that may be discharged into sewage works, public sewage systems, bodies of water, sea waters from a source within the province, or on or into the soil;

(h) providing for the issuance of permits on terms and conditions that may be described in the permit to persons or groups of persons for the discharge of sewage and waste effluents, and in a permit provision may be made exempting those persons or groups from compliance in whole or in part with regulations made under paragraph (f);

(i) providing for the investigation of complaints of

(i) the pollution or rendering unwholesome of bodies of water,

(ii) acts tending to pollution or unwholesomeness, and

(iii) acts detrimental to the conservation, development, control, improvement or proper utilization of the water resources of the province;

(j) regulating the use for pleasure or recreation of bodies of water;

(k) requiring a person who has caused a body of water, or part of a body of water, or soil on an area of land to become polluted or unwholesome to cleanse, disinfect or purify it at his or her own cost and expense, and prescribing how and when that cleansing, disinfection or purification is to be carried out;

(l) regulating the use for pleasure or recreation of public water supplies under section 10;

(m) prescribing the type and manner of protection of water supplies under subsection 10(1);

(n) prescribing the types of activities for the purpose of subsection 10(3);

(o) regulating the method of the carrying on of businesses, trades or industries which in the opinion of the minister, if not so regulated, would or might cause pollution or the rendering unwholesome of a body of water or would or might be detrimental to the proper conservation, development, control, improvement or utilization of the water resources of the province;

(p) preventing or restricting the pollution of the air;

(q) providing for the investigation of complaints of air pollution;

(r) prescribing standards of emission for gaseous or particulate substances emitted to the air from a public, industrial or commercial works;

(s) preventing or restricting pollution of the soil;

(t) providing for the licensing of persons with respect to the use of water from a specified body of water or bodies of water generally for a specified household, industrial, commercial or irrigation purpose and fixing the licence fees payable by those persons at different amounts;

(u) providing for the form of licences and the terms and conditions upon which licences may be issued, refused, renewed, suspended or revoked;

(v) prohibiting persons from using water from a specified body of water or bodies of water generally for specified household, industrial, commercial or irrigation purpose, except under authority of a licence;

(w) requiring and prescribing returns, accounts, records and statements to be made by persons holding licences and other persons, the information to be given in those returns, accounts, records and statements, and by whom and in what manner and at what time they shall be made;

(x) providing for the holding of inquiries into a complaint referred to in paragraph (i) or into the operation of this Act or into a charge or complaint that a person has contravened this Act or the regulations, or has made a false statement in a form, return, account or statement required to be made under this Act or the regulations, or into another matter arising in the administration of this Act, and providing that the person holding the inquiry shall have all of the powers that are or may be conferred upon a commissioner by or under the *Public Inquiries Act*, including the power to take evidence under oath or affirmation;

(y) providing for the issuance by the minister of orders designed to prevent or remedy the pollution or rendering unwholesome of the air, soil or a body of water;

(z) providing for the appointment of inspectors and other officers to carry out and enforce this Act and the regulations and prescribing their powers, duties and functions;

(aa) adopting by reference in whole or in part with or without modification and a supplement or amendment

(i) regulations of the Government of Canada, and

(ii) a code, rule or standard adopted by a recognized engineering association in Canada, Great Britain or the United States of America,

relating or capable of application to matters set out in this section;

(bb) exempting from the regulations or a portion of the regulations a person or class of persons; and

(cc) generally, to give effect to the purpose of this Act.

(2) Regulations may be made under subsection (1) to apply to the whole of the province or may be restricted in their application to specified areas of the province and may be limited as to time or otherwise.

(3) A copy of regulations, codes, rules or standards and amendments or supplements made to them, as adopted by reference under paragraph (1)(aa) signed by the minister, shall be kept on record in the department and shall be available for inspection by members of the general public.

(4) The copy of regulations, codes, rules or standards referred to in subsection (3) as signed by the minister is the copy of the regulations, codes, rules or standards adopted or varied by the Lieutenant-Governor in Council under subsection (1), notwithstanding that a revised set of regulations, codes, rules or standards has been made.

(5) An alleged infringement of the regulations made under paragraph (1)(aa) is to be governed by the copy of the regulations, codes, rules or standards signed under subsection (3).

(6) A certificate of the minister that a document is a copy of regulations, codes, rules or standards or a supplement or amendment to them, or an extract of them, is, in the absence of evidence to the contrary, proof that the document is a true copy of the original.

(7) Every person who contravenes the regulations made under subsection (1) or an order made under the regulations is guilty of an

offence and is liable on summary conviction to the penalty prescribed under subsection (8).

(8) The minister may, in regulations made under subsection (1), prescribe penalties for offences under subsection (7).

(9) The conviction of a person for contravening the regulations or an order made under the regulations shall not operate as a bar to further prosecution for the continued contravention of the regulation or order.

Powers of inspectors

15. An inspector or other officer appointed under this Act or the regulations may at all reasonable times, so long as it is reasonably necessary to determine compliance with this Act, enter on to land or a body of water for the purpose of carrying out his or her duties, powers and functions, including inspecting and testing air, soil or a body of water.

Access to records

16. The minister, or a person appointed by the minister for the purpose, shall have authority to inspect the works, books, accounts, papers and records of a person licensed to use water under the regulations made under paragraph 14(1)(t) as may be relevant to that use.

Entry on land

17. (1) The minister, after giving

(a) to the owner of land, where the owner is known and available and can easily be contacted; or

(b) to the occupier of occupied land, whether or not the occupier is the owner of the land, where the owner lives on a part of the land or is known and available and can easily be contacted,

reasonable notice, may authorize an engineer, agent, servant or worker employed by the minister to enter into and upon the land and survey the land and make those borings or sink those trial-pits and cut those trees that the minister considers necessary relative to the work under his or her control and where agreement cannot be reached between the minister and the party having ownership of the land as to compensation to be paid, the amount of compensation shall be ascertained in the manner provided by law for assessing the compensation payable where land is expropriated.

(2) The minister shall, by his or her engineers, agents, servants, and workers,

(a) in doing anything authorized by subsection (1), exercise reasonable precautions to prevent fires; and

(b) fill in, as soon as practicable, the borings and trial-pits referred to in subsection (1), as nearly as reasonably possible to the condition existing before the borings were made and the trial-pits were sunk.

Prohibition

18. A person shall not

(a) obstruct or interfere with an engineer, agent, servant or worker of the minister engaged in exercising, on behalf of the minister, a power under this Act; or

(b) interfere with an erection placed upon or work done on land under this Act.

Offences

19. (1) A municipal authority or person who contravenes this Act or the regulations or an order made under this Act or the regulations, or makes a false statement in an application, form, return, account, record, statement, or other document completed or made under this Act or the regulations, is guilty of an offence and is, where no penalty is specifically provided in this Act or the regulations, liable on summary conviction,

(a) in the case of a corporation, including a municipal authority, to a fine of not more than $25,000; and

(b) in the case of a person not being a municipal authority or corporation to a fine of not more than $1,000 and, in default of payment to imprisonment for a term not exceeding 6 months, or to both a fine and imprisonment.

(2) Every continuance for a day or a part of a day of the contravention referred to in subsection (1) constitutes a separate offence.

Consent to prosecution

20. A prosecution under this Act or the regulations shall not be taken except with the written consent of the minister.

Action to recover costs

21. Where pollution occurs and the person or municipal authority that the minister considers responsible for the occurrence of the pollution fails to do the things that the minister considers are appropriate to prevent, control, eliminate or ameliorate the pollution, the minister may take appropriate action to prevent, control, eliminate or ameliorate the pollution and the costs incurred by the minister in taking that action are a debt due the Crown and are recoverable from the person or municipal authority that the minister considers responsible for the occurrence of the pollution.

Earl G. Tucker, Queen's Printer

1. These regulations may be cited as *The Environmental Control (Water And Sewage) Regulations, 1980.*
2. In these regulations,
   (a) "Act" means *The Department Of Consumer Affairs And Environment Act 1973*;
   (b) "Composite sample" means a quantity of undiluted effluent collected continually at an equal rate or at a rate proportionate to flow over a designated sampling period; and
   (c) "Grab sample" means a quantity of undiluted effluent collected at any given time.
3. Every person discharging sewage and other materials into a body of water or a public sewer or sewer leading to a public sewer shall comply with the standards, conditions and provisions prescribed in these regulations for the constituents, contents or description of the sewage or other materials so discharged.
4. Subject to Section 7, no person shall discharge sewage or other effluent into a public sewer or a sewer leading to a public sewer containing materials which would obstruct or impede the flow of sewage within the public sewer or any sewage works pertaining thereto, which materials include without prejudice to the generality of the foregoing oil or by-products of oil, flammable, explosive, toxic, poisonous or corrosive liquids, solids or gases, fats, congealing materials and other substances in quantity which interfere with the free flow within the public sewer.
5. Subject to Section 7 and 9, no person shall discharge into a public sewer, sewage or effluent
   (a) containing a constituent specified in Column 1 of Schedule B having a content in milligrams per litre (parts per million) in excess of the maximum specified in Column 2 of that Schedule,
   (b) having a temperature in excess of 65C, or,
   (c) having a pH value less than 5.5 or greater than 9.0.
6. Subject to Sections 7 and 9, no person shall discharge into a body of water any sewage or effluent
   (a) containing a constituent specified in Column 1 of Schedule A having a content in milligrams per litre in excess of the maximum specified in Column 2 of that Schedule,
   (b) having a temperature in excess of 32C,
   (c) having a pH less than 5.5 or greater than 9.0, or,
   (d) any radio-active substance having a gross beta activity before discharge of more than 37 Bq per litre with the exception of
      (i) radium 226 which shall not in any event exceed 0.37 Bq per litre, and
      (ii) strontium 90 which shall not in any event exceed 0.37 Bq per litre.
7. Nothing in these regulations shall be construed to permit the discharge of a pollutant into a body of water.
8. All analytical work in relation to effluent samples and receiving water samples is to be carried out using analytical procedures acceptable to the Assistant Deputy Minister of Environmental Management and Control Division of the Department of Consumer Affairs and Environment of the Government of Newfoundland.

Column 1 CONSTITUENTS	Column 2 MAXIMUM CONTENT (milligrams per litre unless noted)
B.O.D.	20
Coliform - faecal	1000/100 mL
Coliform - total	5000/100 mL
Solids, dissolved	1000
Solids, suspended	30
Oils (Ether extract)	15
Floating debris, oils and grease	None to be visible
Arsenic	0.5
Barium	5.0
Boron	5.0
Cadmium	0.05
Chlorine	1.0
Chromium (hexavalent)	0.05
Chromium (trivalent)	1.0
Copper	0.3
Cyanide	0.025
Iron (total)	10
Lead	0.2
Mercury	0.005
Nickel	0.5
Nitrates	10
Nitrogen (ammoniacal)	2.0
Phenol	0.1
Phosphates (total as P2O5)	1.0
Phosphorous (elemental)	0.0005
Selenium	0.01
Sulfides	0.5
Silver	0.05
Zinc	0.5

Schedule A

9.

(1) A person taking effluent samples or receiving water samples shall take them as composite samples or as grab samples.

(2) In the case of composite sampling, all levels are required to be within the appropriate values as established in Sections 5 and 6 and Schedules A and B.

(3) In the case of grab sampling, 90% of all levels taken in one month shall be within the appropriate values as established in Sections 5 and 6 and Schedules A and B.

10. The Minister may, for specific purposes and time periods, as he may by order prescribe, require that a water user or discharger of sewage monitor its effluent for any or all of the constituents in Sections 4 and 5 and Schedules A and B report the effluent quality.

11. *The Environmental Control (Water and Sewage) Regulations, 1974*, are hereby revoked.

Column 1 CONSTITUENTS	Column 2 MAXIMUM CONTENT (milligrams per litre unless noted)
B.O.D.	300
Chlorine Demand	30
Fats, Oils and Grease (Ether extract)	100
Solids, suspended	350
Boron	5.0
Cadmium	0.05
Chromium (hexavalent)	0.05
Chromium (trivalent)	1.0
Copper	0.3
Cyanide	2.0
Iron (total)	15.0
Lead	0.2
Mercury	0.005
Nickel	0.5
Phenols	0.5
Phosphates (total as P2O5)	10.0
Phosphorous (elemental)	0.0005
Zinc	0.5

Schedule B

Appendix C

Nova Scotia Legislation

Environment Act

CHAPTER 1 OF THE ACTS OF 1994-95

Printed and Published by the Queen's Printer
Halifax

Table of Contents

Section

PART I
Introduction

PART II
Administration

PART III
Environmental Education and Research

PART IV
Environmental-assessment Process

PART V
Approvals and Certificates

Approvals

Certificate of Qualification

PART XX
Miscellaneous

CHAPTER 1 OF THE ACTS OF 1994-95

An Act to Reform the Environmental Laws of the Province and to Encourage and Promote the Protection, Enhancement and Prudent Use of the Environment

Short title

1 This Act may be cited as the *Environment Act*. 1994-95, c. 1, s. 1.

PART I

INTRODUCTION

Purpose

2 The purpose of this Act is to support and promote the protection, enhancement and prudent use of the environment while recognizing the following goals:

(a) maintaining environmental protection as essential to the integrity of ecosystems, human health and the socio-economic well-being of society;

(b) maintaining the principles of sustainable development, including

(i) the principle of ecological value, ensuring the maintenance and restoration of essential ecological processes and the preservation and prevention of loss of biological diversity,

(ii) the precautionary principle will be used in decision-making so that where there are threats of serious or irreversible damage, the lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation,

(iii) the principle of pollution prevention and waste reduction as the foundation for long-term environmental protection, including

(A) the conservation and efficient use of resources,

(B) the promotion of the development and use of sustainable, scientific and technological innovations and management systems, and

(C) the importance of reducing, reusing, recycling and recovering the products of our society,

(iv) the principle of shared responsibility of all Nova Scotians to sustain the environment and the economy, both locally and globally, through individual and government actions,

(v) the stewardship principle, which recognizes the responsibility of a producer for a product from the point of manufacturing to the point of final disposal,

(vi) the linkage between economic and environmental issues, recognizing that long-term economic prosperity depends upon sound environmental management and that effective environmental protection depends on a strong economy, and

(vii) the comprehensive integration of sustainable development principles in public policy making in the Province;

(c) the polluter-pay principle confirming the responsibility of anyone who creates an adverse effect on the environment to take remedial action and pay for the costs of that action;

(d) taking remedial action and providing for rehabilitation to restore an adversely affected area to a beneficial use;

(e) Government having a catalyst role in the areas of environmental education, environmental emergencies, environmental research and the development of policies, standards, objectives and guidelines and other measures to protect the environment;

(f) encouraging the development and use of environmental technologies, innovations and industries;

(g) the Province being responsible for working co-operatively and building partnerships with other provinces, the Government of Canada, other governments and other persons respecting transboundary matters and the co-ordination of legislative and regulatory initiatives;

(h) providing access to information and facilitating effective public participation in the formulation of decisions affecting the environment, including opportunities to participate in the review of legislation, regulations and policies and the provision of access to information affecting the environment;

(i) providing a responsive, effective, fair, timely and efficient administrative and regulatory system, recognizing that wherever practical, it is essential to promote the purpose of this Act primarily through non-regulatory means such as co-operation, communication, education, incentives and partnerships, instead of punitive measures. 1994-95, c. 1, s. 2.

Interpretation

3 In this Act,

(a) "activity" means an activity or part of an activity prescribed by the regulations;

(b) "administrator" means a person appointed by the Minister for the purpose of this Act, and includes an acting administrator;

(c) "adverse effect" means an effect that impairs or damages the environment, including an adverse effect respecting the health of humans or the reasonable enjoyment of life or property;

(d) "air" means open air not enclosed in a building, structure, machine, chimney, stack, flue, tank or pipe;

(e) "analyst" means a person appointed as an analyst by the Minister pursuant to this Act;

(f) "approval" means an approval issued pursuant to this Act with respect to an activity, and includes the renewal of an approval;

(g) "Board" means the Nova Scotia Environmental Assessment Board established by Part IV;

(h) "certificate of qualification" means a certificate of qualification issued pursuant to this Act and includes the renewal of a certificate of qualification;

(i) "certificate of variance" means a certificate of variance issued pursuant to this Act;

(j) "class environmental assessment" means a planning process used for types of undertakings that occur frequently and have a generally predictable range of environmental effects;

(k) "contaminant" means, unless otherwise defined in the regulations, a substance that causes or may cause an adverse effect;

(l) "contaminated site" means a site designated as a contaminated site by the Minister pursuant to this Act;

(m) "Corps" means the Nova Scotia Youth Conservation Corps;

(n) "dangerous goods" means a substance designated as such in the regulations or conforming with criteria set out in the regulations;

(o) "Department" means the Department of the Environment;

(p) "designated material" includes a material prescribed as such in the regulations or conforming with criteria set out in the regulations;

(q) "document" includes a book, sound recording, videotape, film, photograph, chart, graph, map, plan, survey, book of account, electronic device or any other device that stores or contains information;

(r) "environment" means the components of the earth and includes

(i) air, land and water,

(ii) the layers of the atmosphere,

(iii) organic and inorganic matter and living organisms,

(iv) the interacting natural systems that include components referred to in subclauses (i) to (iii), and

(v) for the purpose of Part IV, the socio-economic, environmental health, cultural and other items referred to in the definition of environmental effect;

(s) "environmental assessment" means a process by which the environmental effects of an undertaking are predicted and evaluated and a subsequent decision is made on the acceptability of the undertaking;

(t) "environmental-assessment report" means a report that presents the results of an environmental assessment;

(u) "environmental audit" means a process of independently obtaining and evaluating evidence about an environmental matter to determine the relationship between the environmental matter and the established standards and criteria;

(v) "environmental effect" means, in respect of an undertaking,

(i) any change, whether negative or positive, that the undertaking may cause in the environment, including any effect on socio-economic conditions, on environmental health, physical and cultural heritage or on any structure, site or thing including those of historical, archaeological, paleontological or architectural significance, and

(ii) any change to the undertaking that may be caused by the environment,

whether the change occurs inside or outside the Province;

(w) "environmental-site assessment" means the process by which an assessor seeks to determine whether a particular property is or may be subject to contamination;

(x) "focus report" means a report that presents the results of an environmental assessment of a limited range of adverse effects that may be caused by the undertaking;

(y) "Fund" means the Resource Recovery Fund;

(z) "Government" means Her Majesty in right of the Province;

(aa) "Government agency" means

(i) a person who is an agent of the Government, or

(ii) an agency, commission, board or other body, some or all of whose members are appointed by an Act of the Legislature, the Governor in

Council or a member of the Executive Council, or any combination thereof;

(ab) "groundwater" means all water naturally occurring under the surface of the Province;

(ac) "handle" includes use, store, distribute, treat, manufacture, transport, generate, process, package, re-process, recycle, sell, offer for sale, dispose of and import into the Province;

(ad) "inspector" means any person who is appointed as an inspector by the Minister, and includes any municipal or town police officer and any member of the Royal Canadian Mounted Police;

(ae) "land" means surface land, land covered by water, subsoil, matter beneath the subsoil or any combination or part thereof;

(af) "loss or damage" includes personal injury, loss of life, loss of use or enjoyment of property and pecuniary loss, including loss of income;

(ag) "Minister" means the Minister of the Environment;

(ah) "municipality" means a city, an incorporated town, a municipality of a county or district or village commissioners;

(ai) "peace officer" means a peace officer within the meaning of the *Criminal Code* (Canada);

(aj) "person" includes an individual and a partnership and, for greater certainty, a corporation, municipality and any other entity, and, without restricting the generality of the foregoing, the Government, a Government agency, and Her Majesty in right of Canada and a person acting on behalf of Her Majesty;

(ak) "person responsible" means

(i) the owner of the substance or thing,

(ii) the owner or occupier of land on which an adverse effect has occurred or may occur,

(iii) a previous owner of the substance or thing,

(iv) a person who has or has had care, management or control, including care, management and control during the generation, manufacture, treatment, sale, handling, distribution, use, storage, disposal, transportation, display or method of application of the substance or thing,

(v) a successor, assignee, executor, administrator, receiver, receiver manager or trustee of a person referred to in subclauses (i) to (iv), or

(vi) a person who acts as the principal or agent of a person referred to in subclauses (i) to (v);

(al) "person responsible for the contaminated site" means

(i) a person responsible for a substance that is over, in, on or under the contaminated site,

(ii) any other person whom the Minister considers to be responsible for causing or contributing to the release of a substance into the environment,

(iii) the owner or occupier of, or an operator on, the contaminated site,

(iv) any previous owner, occupier or operator of the contaminated site who was the owner, occupier or operator at any time when the substance was released over, in, on or under the contaminated site,

(v) a successor, assignee, executor, administrator, receiver, receiver manager or trustee of a person referred to in subclauses (i) to (iv), or

(vi) a person who acts as the principal or agent of a person referred to in subclauses (i) to (v);

(am) "pesticide" or "pest control product" means

(i) any substance that is intended, sold or represented for use in preventing, destroying, repelling or mitigating, directly or indirectly, any pest,

(ii) any substance that is a pest control product within the meaning of the *Pest Control Products Act* (Canada) or is intended for use as a pest control product,

(iii) any substance that is a plant growth regulator, a defoliant or a plant desiccant,

(iv) a fertilizer within the meaning of the *Fertilizers Act* (Canada) that contains a substance referred to in subclause (i), (ii) or (iii), or

(v) any other substance designated as a pesticide in the regulations,

but does not include a substance that is intended, sold or represented for use in potable water to prevent or destroy bacteria, parasites or viruses if the substance is not a pest control product within the meaning of the *Pest Control Products Act* (Canada);

(an) "place" includes any land, building, structure, machine, aircraft, vehicle or vessel;

(ao) "proponent" means a person who

(i) carries out or proposes to carry out an undertaking or activity, or

(ii) is the owner or person having care, management or control of an undertaking or activity;

(ap) "registered owner" with respect to real property, means an owner of real property whose interest is defined and whose name is specified in an instrument recorded in a registry of deeds office, and includes a person shown as tenant of real property on the last revised assessment roll;

(aq) "rehabilitation" includes

(i) the removal of equipment or a building or other structure or appurtenance,

(ii) the conducting of an investigation to determine the presence of a substance,

(iii) the removal of a contaminant from land or water,

(iv) the stabilization, contouring, maintenance, conditioning or reconstruction of the surface of land,

(v) any other procedure, operation or requirement in accordance with this Act;

(ar) "release" means to spill, discharge, dispose of, spray, inject, inoculate, abandon, deposit, leak, seep, pour, emit, empty, throw, dump, place, drain, pump or exhaust;

(as) "Round Table" means the Nova Scotia Round Table on Environment and Economy;

(at) "storage" means the holding of a substance for a temporary period at the end of which it is intended to be processed, used, transported, treated or disposed of;

(au) "substance" means

(i) matter that is capable of becoming dispersed in the environment,

(ii) matter that is capable of becoming transformed in the environment into matter referred to in subclause (i),

(iii) sound, vibration, heat, radiation or another form of energy, or

(iv) any combination of things referred to in subclauses (i) to (iii);

(av) "Supreme Court" means the Supreme Court of Nova Scotia;

(aw) "sustainable development" means development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs;

(ax) "treat" means to apply any method, technique or process, including neutralization and stabilization that is designed to change the physical, chemical or biological concentration, character or composition of a substance;

(ay) "Trust" means the Nova Scotia Environmental Trust;

(az) "undertaking" means an enterprise, activity, project, structure, work or proposal and may include, in the opinion of the Minister, a policy, plan or program that has an adverse effect or an environmental effect and may include, in the opinion of the Minister, a modification, extension, abandonment, demolition or rehabilitation, as the case may be, of an undertaking;

(ba) "waste" means a substance that would cause or tend to cause an adverse effect if added to the environment, and includes rubbish, slimes, tailings, fumes, smoke from mines or factories, other air emissions, or other industrial wastes, effluent, sludge, sewage, garbage, refuse, scrap, litter or other waste products of any kind;

(bb) "waste dangerous goods" means a substance designated as such in the regulations or conforming with criteria set out in the regulations;

(bc) "water resource" means all fresh and marine waters comprising all surface water, groundwater and coastal water;

(bd) "water works" means any public, commercial or industrial works for the collection, production, treatment, storage, supply or distribution of water;

(be) "watercourse" means

(i) the bed and shore of every river, stream, lake, creek, pond, spring, lagoon or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and

(ii) all ground water;

(bf) "watershed" means the area drained by, or contributing to a stream, lake or other body of water. 1994-95, c. 1, s. 3.

Act binds Provincial Crown

4 (1) This Act binds Her Majesty in right of the Province, Her Majesty's corporations, agents, administrators, servants and employees and Government agencies.

Act binds federal Crown

(2) This Act binds Her Majesty in right of Canada and Her Majesty's corporations, boards, commissions, agents, administrators, servants and employees.

Prosecution

(3) For greater certainty, the persons referred to in subsections (1) and (2) are subject to prosecution, a ministerial order and other remedies under this Act. 1994-95, c. 1, s. 4.

Approvals authorized under other Acts

5 A licence, permit, approval or other authorization issued pursuant to any other enactment does not constitute an approval under this Act, unless otherwise stated in the regulations. 1994-95, c. 1, s. 5.

Conflict

6 (1) Where there is a conflict between this Act and any other enactment, this Act prevails.

Greater restriction in other enactment

(2) A provision of any other enactment is not in conflict with this Act by reason only that it imposes a restriction or requires a condition for the protection of the environment in excess of those required by this Act.

By-laws not affected

(3) Subject to subsections (4) and (5), nothing in this Act affects or impairs the validity of a by-law of a municipality relating to matters dealt with in this Act except in so far as the by-law is in conflict or inconsistent with this Act.

By-law suspended

(4) A by-law or regulation of a municipality, or an authorization issued by a municipality is, to the extent that it is in conflict or inconsistent with this Act, suspended and of no effect.

Greater restriction in by-law or regulation

(5) A by-law, regulation or authorization of a municipality is not in conflict or inconsistent with this Act by reason only that it imposes a restriction or requires a condition for the protection of the environment in excess of those required by this Act. 1994-95, c. 1, s. 6.

PART II

ADMINISTRATION

Appointment of personnel

7 Such administrators and employees as are necessary for the administration of this Act shall be

appointed in accordance with the *Civil Service Act.* 1994-95, c. 1, s. 7.

Supervision of Act

8 (1) The Minister is responsible for the general supervision and management of this Act.

Duties of Minister

(2) The Minister, for the purposes of the administration and enforcement of this Act, and after engaging in such public review as the Minister considers appropriate, shall

(a) promote sustainable development, including pollution prevention;

(b) establish and administer policies, programs, standards, guidelines, objectives, codes of practice, directives and approval processes pertaining to the protection and stewardship of the environment;

(c) consult with and co-ordinate activities with other departments, Government agencies, municipalities, governments and other persons;

(d) develop policies and plans for the management of wastes;

(e) control the handling of substances that may have an adverse effect;

(f) promote the rehabilitation and restoration of degraded areas of the environment;

(g) establish and assist demonstration programs that are consistent with the intent of this Act;

(h) conduct economic analyses to determine the costs and benefits of proposed alterations of the environment and assess methods of offsetting the environmental costs associated with those alterations;

(i) establish criteria to be applied by an administrator or a person to whom responsibility is delegated pursuant to this Act in making any decision under this Act;

(j) implement policies and programs respecting environmental technologies, innovations and industries;

(k) establish fees for the provision, registration or filing of any information, documents, returns and reports, any application for, processing and issuance of an approval or a certificate, any inspection or investigation and any services or material provided in the course of the administration of this Act;

(l) prescribe forms for the purpose of this Act. 1994-95, c. 1, s. 8.

Advisory committees and experts

9 The Minister may

(a) establish advisory and *ad hoc* committees and retain experts to

(i) report to the Minister with respect to

(A) the content and administration of this Act,

(B) any policies, programs, standards, guidelines, objectives, codes of practice, directives, approval processes or other matters under the administration of the Minister,

(ii) review any refusals to issue, suspensions or cancellations of approvals or certificates of qualification under Part V;

(b) specify the functions that the committees and experts are to perform, including the seeking of input from the public and the manner and time period in which those functions are to be performed;

(c) provide for the remuneration of and payment of expenses to experts, witnesses and members of committees;

(d) provide for the issue of summonses requiring the attendance of witnesses, the production of documents and things and the payment of fees to witnesses. 1994-95, c. 1, s. 9.

Environmental registry

10 (1) The Minister shall establish an environmental registry containing

(a) approvals;

(b) certificates of qualification;

(c) certificates of variance;

(d) orders, appeals, decisions and hearings made under this Act;

(e) notices of designation given pursuant to this Act;

(f) notices of a charge or lien given pursuant to Section 132;

(g) policies, programs, standards, codes of practice, guidelines, objectives, directives and approval processes established under this Act;

(h) convictions, penalties and other enforcement actions brought under this Act;

(i) information or documents required by the regulations to be included in the registry;

(j) annual reports; and

(k) any other information or document considered appropriate by the Minister.

Access to information

(2) All information under the control of the Department is accessible to the public, subject only to the *Freedom of Information and Protection of Privacy Act* and, in particular, Section 21 of that Act.

Duty of Minister

(3) The Minister shall ensure public access to the information and documents contained in the environmental registry during business hours of the Department.

Written reasons for decision

(4) Where the Minister, administrator or delegated agent makes a decision under Section 34, 35, 40, 52, 54 or 56, any person who asks for a reason for the decision shall, within thirty days, and subject to the *Freedom of Information and Protection of Privacy Act*, be furnished with a written statement of the decision, setting out the findings of fact upon which it is based and the reasons for the decision. 1994-95, c. 1, s. 10.

Round Table on Environment and Economy

11 (1) There is hereby established the Nova Scotia Round Table on Environment and Economy consisting of two Co-chairs and other members as are appointed in accordance with the regulations.

Co-chairs of Round Table

(2) The Co-chairs of the Round Table are the President of the Executive Council and the Minister.

Agent of Government

(3) The Round Table is an agent of the Government. 1994-95, c. 1, s. 11.

Functions of Round Table

12 The Round Table shall identify, explain, promote and encourage, in all sectors of society and in all regions of the Province, principles and practices of sustainable development by

(a) undertaking research and conducting analyses on issues of sustainable development;

(b) advising and reporting to governments, including the Government, on ways of incorporating environmental and economic considerations into their decision-making processes and on local, regional and global issues of sustainable development;

(c) advising on ways of incorporating principles and practices of sustainable development into activities and undertakings;

(d) increasing public awareness of the cultural, social, economic and policy changes required to attain sustainable development;

(e) communicating with other provincial and national round tables and the public;

(f) facilitating and assisting efforts in the Province and with other governments to overcome barriers to the attainment of sustainable development. 1994-95, c. 1, s. 12.

Duties of Round Table

13 (1) The Round Table shall

(a) support and recommend initiatives to incorporate principles and practices of sustainable development into all aspects of Government and society throughout the Province;

(b) expend any money provided by the Legislature or any other sources or received by the Round Table through the conduct of its operations for the activities of the Round Table, subject to any terms on which it is provided or received;

(c) administer the Trust in accordance with the regulations.

Powers of Round Table

(2) The Round Table may

(a) initiate, sponsor and support seminars, workshops, conferences and other meetings;

(b) undertake and support studies and inquiries;

(c) publish and disseminate studies, reports and other materials;

(d) appoint, organize and assist committees and other groups;

(e) acquire any money, securities or other property by gift, bequest or otherwise and hold, expend, invest, administer or dispose of that property, subject to any terms on which it is received, given or otherwise made available to the Round Table; and

(f) do other things that are conducive to the fulfilment of its purpose. 1994-95, c. 1, s. 13.

Alternate dispute resolution

14 (1) For the purpose of resolving a dispute, the Minister may refer a matter to a form of alternate dispute resolution, including but not limited to, conciliation, negotiation, mediation or arbitration.

Form of dispute resolution

(2) Where the Minister decides to use a form of alternate dispute resolution to resolve a dispute, the Minister, in consultation with the affected parties and using criteria prescribed or adopted by the Department, shall determine which form of dispute resolution is most appropriate to use to resolve the dispute.

Consensus

(3) Any form of alternate dispute resolution used shall strive to achieve consensus to resolve procedural and substantive issues throughout the process.

Report

(4) Where a form of alternate dispute resolution is being used to resolve a dispute, and where an independent

party or neutral third party has been chosen to facilitate, mediate or arbitrate, at the conclusion of the process that person shall file a report with the Minister and with the parties whether or not the dispute was resolved.

Uses of alternate dispute resolution

(5) Without limiting the generality of subsections (1) to (4), a form of alternate dispute resolution may be used

(a) in case of a dispute over a certificate of qualification or a certificate of variance;

(b) in case of a dispute over an approval;

(c) in case of a dispute under Part VIII respecting responsibility for rehabilitation of a contaminated site; or

(d) generally, for conflict resolution. 1994-95, c. 1, s. 14.

Economic instruments

15 The Minister may, in accordance with the regulations, establish programs for the research, development and use of economic instruments and market-based approaches for the management of the environment and for the purpose of achieving environmental quality objectives in a cost-effective manner, including, without limiting the generality of the foregoing,

(a) tradable emission and effluent permits;

(b) offsetting environmental costs and benefits;

(c) user charges;

(d) resource pricing and physical resource accounts;

(e) deposit refund systems;

(f) emission, effluent and waste-disposal fees;

(g) product charges;

(h) charges on inputs or materials;

(i) tax incentives and tax differentiation;

(j) subsidies, loans and grants. 1994-95, c. 1, s. 15.

Reporting on state of the environment

16 The Minister shall report periodically to the people of the Province on the state of the environment in the Province. 1994-95, c. 1, s. 16.

Delegation

17 (1) The Minister may, in writing, delegate to

(a) any employee of the Government or a Government agency;

(b) any employee of the Government of Canada or an agency of that government;

(c) any employee of a municipality; or

(d) any person,

who has the qualifications and experience, any power or duty conferred or imposed on the Minister pursuant to this Act.

Consultation

(2) Before making a delegation to a person pursuant to subsection (1), the Minister shall consult with and obtain the consent of the person or, where applicable, the employer of the person.

Subsection (1) does not apply

(3) Subsection (1) does not apply to the power or duty of the Minister under clause 8(2)(b) or Section 40.

Revocation

(4) The Minister may revoke a delegation made pursuant to this Section. 1994-95, c. 1, s. 17.

Transfer of administration and control

18 (1) The Minister may, with the approval of the Governor in Council, transfer the administration and control of a provision of this Act, after appropriate consultation, to

(a) another minister of the Government or a Government agency;

(b) a municipality; or

(c) any other person,

and may specify the terms and conditions under which and subject to which the transfer is made.

Revocation

(2) The Minister may, with the approval of the Governor in Council, revoke a transfer of administration and control made pursuant to this Section. 1994-95, c. 1, s. 18.

Agreements

19 (1) Subject to subsection (2), the Minister may enter into agreements with any person relating to any matter pertaining to the environment.

Agreements with Government of Canada

(2) The Minister, with the approval of the Governor in Council, may enter into agreements with the Government of Canada with respect to the administration of this Act, the *Canadian Environmental Assessment Act*, the *Canadian Environmental Protection Act*, the *Fisheries Act* (Canada) or any other federal enactment for the purpose of protection of the environment. 1994-95, c. 1, s. 19.

Purchase and disposition of real property

20 The Minister may, with the approval of the Governor in Council, purchase and dispose of any estate or interest in real property for the purpose of this Act. 1994-95, c. 1, s. 20.

Appointment of administrator

21 (1) The Minister may appoint as an administrator a person who has the qualifications and experience to be an administrator for the purpose of all or part of this Act.

Appointment of inspector

(2) The Minister may appoint as an inspector a person who has the qualifications and experience to be so appointed.

Consultation

(3) Where a person appointed pursuant to subsection (2) is not an employee of the Department, the Minister, before making the appointment, shall consult with and obtain the consent of the person or, where applicable, the employer of the person.

Appointment subject to conditions

(4) An appointment under subsection (2) may direct that the authority of the inspector be exercised subject to any terms and conditions that the Minister prescribes in the appointment, including limitations on the scope of the appointment. 1994-95, c. 1, s. 21.

Identification card

22 On entering any place, an inspector shall, on request, produce an identification card provided by the Department and provide reasons for the entry. 1994-95, c. 1, s. 22.

Proof of certification of laboratory

23 (1) Before accepting results from any laboratory, the Minister may require proof of acceptable certification of the laboratory.

Methods of sampling

(2) The Minister may prescribe methods and procedures for sampling and analysis of the environment and any substance, discharge or emission into the environment. 1994-95, c. 1, s. 23.

Service of documents

24 (1) Where any notice, request, order, direction or other document is required to be given in writing or served pursuant to this Act, it is deemed to be sufficiently given or served

(a) upon a copy being personally given to or served on the person to whom it is directed;

(b) upon a copy being sent by facsimile or by other electronic means to the person to whom it is directed and an acknowledgement of receipt being received;

(c) five days after a copy is sent by mail addressed to the person to whom it is directed at the last known address for that person; or

(d) in the case of a registered owner of real property, five days after a copy is sent by mail to the address for the registered owner shown on the last revised assessment roll.

Service on corporation

(2) Where the person to be served is a corporation, service on a director, officer or recognized agent of the corporation in accordance with subsection (1), or service in accordance with the *Corporations Registration Act*, is deemed to be service on the corporation for the purpose of this Act.

Substituted service

(3) Where it is impractical for any reason to serve a document in the manner prescribed in subsection (1), an *ex parte* application may be made to a judge of the Supreme Court who may make an order for substituted service providing for such steps to be taken to bring the matter to the attention of the person to be served. 1994-95, c. 1, s. 24.

Regulations

25 (1) The Governor in Council may make regulations

(a) respecting information or documentation to be filed in the environmental registry established pursuant to this Part;

(b) respecting the manner in which reports of advisory or *ad hoc* committees and experts are made public;

(c) regarding research, development and use of economic instruments and market-based approaches;

(d) respecting alternate dispute-resolution mechanisms;

(e) respecting the management, administration and membership of the Round Table, and any other matter related to its functioning;

(f) respecting state of environment reporting;

(g) defining terms not otherwise defined in this Act, or further clarifying defined terms;

(h) for the effective administration and enforcement of this Act, and, without restricting the generality of the foregoing, exempting a person or a class of persons, activities, matters or things from this Act;

(i) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Act.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection(1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 25.

Public review of regulations

26 Any new regulations or any substantive amendment to the regulations becomes law only after the regulations or amendments, as the case may be, have been sub-

jected to such public review as the Minister considers appropriate. 1994-95, c. 1, s. 26.

PART III

ENVIRONMENTAL EDUCATION AND RESEARCH

Education

27 (1) For the purpose of fostering an understanding of, and responsibility for, the environment, the Minister may

(a) compile information and undertake research related to the environment, environmental education and sustainable development;

(b) subject to the *Freedom of Information and Protection of Privacy Act*, provide any person with access to environmental information in the control of the Department;

(c) convene conferences and conduct seminars and educational and training programs relating to the environment and sustainable development;

(d) maintain a library consisting of publications and other information relating to environmental matters;

(e) develop, publish and distribute educational material with respect to the environment and sustainable development;

(f) assist and support other ministers of the Government or other persons in designing, producing and delivering throughout the Province educational programs pertaining to sustainable development and other information.

Research

(2) The Minister may contribute to, sponsor or undertake research that the Minister considers necessary to achieve the purpose of this Act. 1994-95, c. 1, s. 27.

Nova Scotia Environmental Trust

28 (1) There is hereby established the Nova Scotia Environmental Trust for the purpose of funding programs for environmental research and management and conservation of the environment.

Acquisition of property

(2) The Minister may acquire, on behalf of the Trust, by agreement, gift, donation, bequest or devise or through any Governmental or private program any real or personal property for the purpose of the Trust.

Disposition of real property

(3) With the approval of the Governor in Council, the Minister, on the recommendation of the Round Table, may dispose of real property acquired by the Trust.

Administration of Trust

(4) The Round Table shall administer the Trust.

Composition

(5) The Trust consists of

(a) property acquired pursuant to subsection (2) or money from the disposition of such property; and

(b) income accruing to the Trust. 1994-95, c. 1, s. 28.

Nova Scotia Youth Conservation Corps

29 (1) There is hereby established, in accordance with the regulations, the Nova Scotia Youth Conservation Corps.

Purpose of Corps

(2) The purpose of the Corps is to

(a) promote youth involvement in and commitment to the preservation and enhancement of the environment;

(b) assist in carrying out Government policies for environmental management by providing a corps of young persons to undertake projects for environmental enhancement and clean-up, thereby providing participants with leadership skills and training and providing communities with environmental enhancement and clean-up services;

(c) provide summer and longer term employment, including relevant training and education, for youth; and

(d) facilitate and encourage movement of participants in the Corps program to private sector employment by linking the program with the private sector through co-operative work programs. 1994-95, c. 1, s. 29.

Regulations

30 (1) The Governor in Council may make regulations

(a) respecting any matter necessary or advisable for the administration of the Trust;

(b) respecting any matter necessary or advisable for the administration of the Corps.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 30.

PART IV

ENVIRONMENTAL-ASSESSMENT PROCESS

Application of Part

31 The environmental-assessment process under this Part applies with respect to an undertaking as determined by the Minister or as prescribed in the regulations. 1994-95, c. 1, s. 31.

No work without approval

32 (1) Until the Minister has notified the proponent in writing that an undertaking is approved, no person shall commence work on the undertaking.

Approval subject to conditions

(2) The Minister may impose conditions upon the approval of an undertaking and the proponent shall comply with the conditions if the undertaking proceeds. 1994-95, c. 1, s. 32.

Registration of undertaking

33 Every proponent of an undertaking shall

(a) register the undertaking with the Minister in the time and manner prescribed by the regulations; and

(b) publish a notice of the undertaking containing the information prescribed by the regulations. 1994-95, c. 1, s. 33.

Examination of information

34 (1) After an undertaking is registered pursuant to Section 33, the Minister shall examine or cause to be examined the information that is provided respecting an undertaking and shall determine that

(a) additional information is required;

(b) a focus report is required;

(c) an environmental-assessment report is required;

(d) all or part of the undertaking may be referred to alternate dispute resolution;

(e) a focus report or an environmental-assessment report is not required, and the undertaking may proceed; or

(f) the undertaking is rejected because of the likelihood that it will cause adverse effects or environmental effects that cannot be mitigated.

Notice of decision

(2) The Minister shall notify the proponent, in writing, of the decision pursuant to subsection (1), together with reasons for the decision, within the time period prescribed by the regulations.

Deemed withdrawal

(3) In case of a determination pursuant to clause (1)(a), (b), (c), (d) or (e), the registration of an undertaking is deemed to have been withdrawn if

(a) the Minister is not aware of any action taken by the proponent on the environmental assessment of the undertaking within the time period prescribed in the regulations;

(b) the Minister has notified the proponent when no action has been taken within the time period prescribed by the regulations; and

(c) the proponent has not given any reasonable explanation for the delay within the time period prescribed by the regulations. 1994-95, c. 1, s. 34.

Focus report

35 (1) Where the Minister decides that a focus report is necessary pursuant to Section 34, an administrator shall provide the proponent with terms of reference for the preparation of the focus report.

Report submitted to Minister

(2) The proponent shall undertake the necessary study for the preparation of the focus report and submit the report to the Minister.

Examination of report

(3) Upon receiving the focus report, the Minister shall examine the report or cause it to be examined and shall determine that

(a) an environmental-assessment report is required;

(b) all or part of the undertaking may be referred to alternate dispute resolution;

(c) an environmental-assessment report is not required and the undertaking may proceed; or

(d) the undertaking is rejected because of the likelihood that it will cause adverse effects or environmental effects that cannot be mitigated.

Notification of decision

(4) The Minister shall notify the proponent, in writing, of the decision pursuant to subsection (3), together with reasons for the decision, within the time period prescribed by the regulations. 1994-95, c. 1, s. 35.

Terms of reference

36 Where the Minister decides that an environmental-assessment report is required, an administrator shall

(a) prepare proposed terms of reference for the environmental assessment;

(b) give the public and the proponent an opportunity to comment on the proposed terms of reference in the prescribed manner;

(c) modify the terms of reference as the administrator considers appropriate; and

(d) provide the proponent with the terms of reference. 1994-95, c. 1, s. 36.

Examination of report

37 (1) Upon receiving the environmental-assessment report, an administrator shall examine it or cause it to be examined to determine whether it adheres to the terms of reference.

Deficient report

(2) Where the environmental-assessment report is deficient in any respect, an administrator shall notify the proponent, in writing, and may require the proponent to conduct such further work or provide such further information as may be necessary to complete the report.

Notification of decision

(3) Where the environmental-assessment report is acceptable, an administrator shall so notify the proponent, in writing. 1994-95, c. 1, s. 37.

Duties and powers of Minister

38 (1) Upon receiving an environmental-assessment report, and before approving or rejecting an undertaking pursuant to Section 40, the Minister

(a) shall release the environmental-assessment report to interested persons and the public generally;

(b) shall refer the environmental-assessment report to the Board on Class II undertakings as defined in the regulations;

(c) may refer the environmental-assessment report to the Board on Class I undertakings as defined in the regulations;

(d) may refer all or part of an undertaking to alternate dispute resolution;

(e) may give directions regarding the scope of a review to be conducted by the Board or by alternate dispute resolution.

Powers of Minister

(2) On Class I undertakings not referred to the Board or to alternate dispute resolution, the Minister may approve the undertaking, reject the undertaking or approve the undertaking with conditions.

Notification of decision

(3) The Minister shall notify the proponent, in writing, of the decision pursuant to subsection (2), together with reasons for the decision, within the time period prescribed by the regulations. 1994-95, c. 1, s. 38.

Hearing and recommendation by Board

39 (1) Upon receiving a referral from the Minister pursuant to Section 38, the Board shall conduct a public hearing or review and submit a report and make a recommendation to the Minister to approve the undertaking, reject the undertaking or approve the undertaking with conditions.

Powers of Minister

(2) Upon receiving a recommendation from the Board, the Minister shall approve the undertaking, reject the undertaking or approve the undertaking with conditions.

Notification of decision

(3) The Minister shall notify the proponent, in writing, of the decision pursuant to subsection (2), together with reasons for the decision, within the time period prescribed by the regulations. 1994-95, c. 1, s. 39.

Powers of Minister

40 (1) Upon receiving information under Section 34, a focus report under Section 35, an environmental-assessment report under Section 38, a recommendation from the Board under Section 39 or from a referral to alternate dispute resolution, the Minister may

(a) approve the undertaking;

(b) approve the undertaking, subject to any conditions the Minister deems appropriate; or

(c) reject the undertaking.

Notification of decision

(2) The Minister shall notify the proponent, in writing, of the decision pursuant to subsection (1), together with reasons for the decision, within the time period prescribed by the regulations. 1994-95, c. 1, s. 40.

Requirements after approval

41 Where approval for an undertaking has been given to a proponent pursuant to this Part, the Minister shall require the proponent to

(a) carry out environmental monitoring and rehabilitation studies and programs in order to determine the effect of mitigation measures;

(b) remediate the affected environment to a level acceptable to the Minister. 1994-95, c. 1, s. 41.

Environmental Assessment Board

42 (1) There is hereby established the Nova Scotia Environmental Assessment Board.

Duties of Board

(2) The Board shall conduct public hearings or reviews and carry out the other functions assigned to the Board by this Act or as may be prescribed by the regulations.

Composition

(3) The Board consists of a Chair and such other members, not exceeding five, as are appointed by the Governor in Council in accordance with the regulations.

Non-Board members on panel

(4) Upon the recommendation of the Chair, the Minister may appoint persons who are not members of the

Board to sit on a panel to conduct a public hearing or review pursuant to this Part.

Board members on panel

(5) Any public hearing or review conducted pursuant to this Part shall be conducted by a panel at least one member of which shall be a member of the Board who shall act as the panel chair or co-chair. 1994-95, c. 1, s. 42.

Duties of Board

43 The Board shall

(a) review an environmental-assessment report with respect to an undertaking referred to the Board by the Minister in accordance with the directions of the Minister;

(b) consult with the public in accordance with this Act;

(c) recommend to the Minister the approval or rejection of an undertaking, or conditions that ought to be imposed upon an undertaking if it proceeds; and

(d) perform such other functions and exercise such powers as may be assigned to or conferred upon the Board by the Governor in Council or the Minister. 1994-95, c. 1, s. 43.

Public consultation

44 (1) In reviewing an environmental-assessment report pursuant to Section 43, the Board shall consult with the public by inviting written submissions from the public, by conducting a public hearing or review or in such other manner as determined by the Board.

Hearing conducted in accordance with regulations

(2) A public hearing or review conducted pursuant to subsection (1) shall be conducted in accordance with the regulations.

Powers of Board

(3) For the purpose of any public hearing or review conducted pursuant to subsection (1), the Board may

(a) administer oaths to witnesses and require the witnesses to give evidence under oath;

(b) issue summonses requiring the attendance of witnesses and the production of documents and things;

(c) pay witnesses summonsed to give evidence before the Board. 1994-95, c. 1, s. 44.

Municipal approvals

45 The Minister may require a proponent to obtain any municipal approval, permit or other authorization required at the time of registration pursuant to this Part before the Minister approves or rejects the undertaking. 1994-95, c. 1, s. 45.

Other enactments

46 This Part does not exempt the proponent of any undertaking, whether or not the proponent has submitted an environmental-assessment report, from the requirements of any other enactment or other provision of this Act. 1994-95, c. 1, s. 46.

Joint assessments

47 (1) Where an undertaking is also subject to the environmental assessment or other review requirements of a municipality, Her Majesty in right of Canada, another province of Canada or another review process of the Government, the Minister may enter into an agreement with the other government, Government agency or municipality in order to

(a) determine what aspects of the undertaking are governed by the laws of the respective governments;

(b) provide for the carrying out of

(i) the environmental assessment in whole or in part for the purpose of this Part, or

(ii) the review of the undertaking under any enactment;

(c) adopt for the purposes of the review

(i) all or part of the procedures for environmental assessment or other review,

(ii) reports and similar documents prepared by or under the authority of any enactment as part of the environmental assessment or other review;

(d) determine what issues shall be addressed in the assessment or review; and

(e) delegate the Minister's administrative responsibilities under this Part to the other government, Government agency or municipality, or accept the delegation of these responsibilities.

Variation of requirements

(2) Subject to subsection (3), the Minister, when negotiating an agreement pursuant to subsection (1), may vary the environmental-assessment administrative requirements of this Part.

Time limitations

(3) An agreement entered into pursuant to this Section shall stipulate time limitations for various stages of the assessment consistent with any regulations under this Act. 1994-95, c. 1, s. 47.

Single hearing process

48 Notwithstanding any other enactment, where an undertaking is subject to a municipal hearing, or a hearing under another review process of the Government, the Minister may enter into an agreement with the other party to provide for a single hearing process for the undertaking and

the issues to be addressed at the single hearing. 1994-95, c. 1, s. 48.

Regulations

49 (1) The Governor in Council may make regulations

(a) designating an undertaking or any class of undertakings to which this Part applies;

(b) prescribing when an undertaking shall be registered and the information to be provided in a registration document;

(c) prescribing terms of reference to be contained in a notice respecting an undertaking;

(d) prescribing terms of reference for the preparation of a focus report or an environmental-assessment report;

(e) respecting public consultation during a public hearing or review;

(f) respecting the format of any report;

(g) establishing criteria for the examination of proposed undertakings in order to determine whether an environmental-assessment report is required;

(h) respecting the reference of any matter related to an environmental assessment of an undertaking or aspects of an undertaking to alternate dispute resolution;

(i) respecting procedures for alternate dispute resolution;

(j) prescribing periods of time within which the Minister or other persons must perform certain duties pursuant to this Part;

(k) prescribing duties and procedures to be followed by the Board;

(l) respecting public hearings and reviews by the Board;

(m) respecting remuneration for members of the Board and experts retained by the Board;

(n) exempting any person, class of persons, undertaking or class of undertakings from this Part;

(o) respecting a time period during which a proponent can act upon the approval of an undertaking;

(p) respecting the requirements, design and implementation of environmental monitoring and rehabilitation programs;

(q) respecting class environmental assessments;

(r) respecting assessments under other enactments carried out jointly with an environmental assessment under this Act;

(s) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 49.

PART V

APPROVALS AND CERTIFICATES

Approvals

Prohibition

50 (1) No person shall knowingly commence or continue any activity designated by the regulations as requiring an approval unless that person holds the appropriate approval.

Prohibition

(2) No person shall commence or continue any activity designated by the regulations as requiring an approval, unless that person holds the appropriate approval. 1994-95, c. 1, s. 50.

Exception

51 Nothing in Section 50 prohibits the commencement of work that, in the opinion of the Minister or according to the regulations, is work that is permitted to enable a proponent to comply with Part IV. 1994-95, c. 1, s. 51.

Decision not to approve proposed activity

52 (1) Where the Minister is of the opinion that a proposed activity should not proceed because it is not in the public interest having regard to the purpose of this Act, the Minister may, at any time, decide that no approval be issued in respect of the proposed activity if notice is given to the proponent, together with reasons.

Factors to be considered

(2) When deciding, pursuant to subsection (1), whether a proposed activity should proceed, the Minister shall take into consideration such matters as whether the proposed activity contravenes a policy of the Government or the Department, whether the location of the proposed activity is unacceptable or whether adverse effects from the proposed activity are unacceptable. 1994-95, c. 1, s. 52.

Application for approval

53 (1) An application for an approval shall be made in a form prescribed by the Minister and accompanied by the information stipulated by the Minister.

Additional information

(2) The Minister may require an applicant for an approval to submit any additional information the Minister considers necessary.

Incomplete application

(3) Where the Minister considers an application to be incomplete, the application shall not be processed until the information required is submitted.

Municipal approval

(4) The Minister may require, as part of an application for an approval, that an applicant obtain any municipal approval, permit or other authorization that is required at the time of the application made pursuant to this Part. 1994-95, c. 1, s. 53.

Receipt of application acknowledged

54 (1) On receipt of a completed application, the Minister shall acknowledge receipt of the application.

Deadline for decision

(2) A decision on the application shall be made within sixty days of the receipt of the completed application unless the Minister notifies the applicant otherwise in writing within ten days of receipt of the completed application. 1994-95, c. 1, s. 54.

Change of activity

55 (1) No person shall, in any manner, change an activity that is the subject of an approval in a manner that will result, or may result, in an adverse effect unless an approval or an amendment to an approval authorizing the change is issued by the Minister.

Application to Minister

(2) A person who wishes to changean activity under subsection (1) shall apply to the Minister.

Subsection (1) does not apply

(3) Subsection (1) does not apply to adjustments, repairs, replacements or maintenance made in the normal course of operations. 1994-95, c. 1, s. 55.

Approval

56 (1) The Minister may issue or refuse to issue an approval.

Approval subject to conditions

(2) The Minister may issue an approval subject to any terms and conditions the Minister considers appropriate to prevent an adverse effect.

Additional requirements

(3) Without restricting the generality of subsection (2), the Minister may require rehabilitation plans, implementation schedules and security from the approval holder.

Environmentally sensitive areas

(4) In environmentally sensitive areas, the terms and conditions of an approval may be more stringent, but may not be less stringent, than applicable terms and conditions provided in the regulations, policies, guidelines or standards prescribed or adopted by the Department. 1994-95, c. 1, s. 56.

Security

57 (1) Any person who seeks an approval, a certificate of qualification or certificate of variance under this Act to carry out any activity or undertaking shall provide financial or other security in respect of the activity or undertaking as required by the Minister or by the regulations.

Forfeiture or return of security

(2) The Minister may determine the manner in which, and the conditions under which, any security that is deposited by an approval holder, the holder of a certificate of qualification or a certificate of variance may be forfeited or returned, in whole or in part. 1994-95, c. 1, s. 57.

Amendment of approval

58 (1) On application by an approval holder, the Minister may amend a term or condition of, add a term or condition to, or delete a term or condition from an approval, if the Minister considers it appropriate to do so.

Powers of Minister

(2) The Minister may

(a) amend a term or condition of, add a term or condition to, or delete a term or condition from an approval

(i) if in the opinion of the Minister an adverse effect that was not reasonably foreseeable at the time the approval was issued has occurred or may occur,

(ii) if the term or condition relates to a monitoring or reporting requirement, or

(iii) if the purpose of the amendment, addition or deletion is to address matters related to a temporary suspension of the activity by the approval holder;

(b) cancel or suspend an approval for breach or default of the approval, or if new or corrected information respecting an adverse effect has been brought to the attention of the Minister; or

(c) correct a typographical error in an approval.

Notice to approval holder

(3) The Minister shall give notice in writing, together with reasons, to the approval holder at least thirty days in advance of making an amendment, addition or deletion pursuant to clause (2)(a).

Notice to approval holder

(4) The Minister shall forthwith on cancellation or suspension of an approval pursuant to clause (2)(b) give

notice, in writing, together with reasons, of the cancellation or suspension to the approval holder. 1994-95, c. 1, s. 58.

Transfer of approval

59 (1) No person shall transfer, sell, lease, assign or otherwise dispose of an approval without the written consent of the Minister.

Deadline for consent

(2) A consent pursuant to subsection (1) shall be given within sixty days of the receipt of an application or request, unless the Minister notifies the applicant otherwise, in writing, within ten days of receipt of the application or request.

Amendment of approval

(3) The Minister may, after consultation with the applicant, amend a term or condition of, add a term or condition to, or delete a term or condition from an approval. 1994-95, c. 1, s. 59.

New information

60 An approval holder shall forthwith submit to the Minister any new and relevant information respecting any adverse effect that actually results or may potentially result from the activity to which the approval relates that comes to the attention of the approval holder after the issuance of the approval. 1994-95, c. 1, s. 60.

Application for certificate of variance

61 (1) An approval holder and any person acting on behalf of the approval holder may apply to the Minister for a certificate of variance to vary a term or condition of the approval or a requirement of the regulations.

Issuance of certificate

(2) The Minister may issue a certificate of variance if the Minister considers that the proposed variance is not likely to cause a significant adverse effect and shall advise the approval holder of the decision.

Powers of Minister

(3) The Minister may

(a) impose any term or condition that the Minister considers appropriate with respect to any certificate of variance;

(b) specify requirements as to the manner in which the activity to which the certificate of variance relates is to be carried out or operated; or

(c) amend a term or condition of, add a term or condition to, or delete a term or condition from a certificate of variance.

Certificate in effect during prescribed period

(4) A certificate of variance is in effect only during the period prescribed and, notwithstanding anything contained in this Act, during that period the terms and conditions of the approval or the requirements of the regulations that are not varied by the certificate apply to the activity to which the certificate relates.. 1994-95, c. 1, s. 61.

Certificate of Qualification

Certificate of qualification

62 No person shall commence or continue any activity or the use of any thing that is designated by the regulations as an activity or thing in respect of which a certificate of qualification is required unless that person holds the appropriate certificate of qualification. 1994-95, c. 1, s. 62.

Application for certificate

63 (1) Application for a certificate of qualification shall be made to the Minister in accordance with the regulations.

Additional information

(2) The Minister may require an applicant for a certificate of qualification to submit any additional information the Minister considers necessary. 1994-95, c. 1, s. 63.

Issuance of certificate

64 (1) The Minister may issue or refuse to issue a certificate of qualification in accordance with the regulations.

Certificate may be subject to conditions

(2) The Minister may issue a certificate of qualification subject to any terms and conditions considered appropriate.

Validity

(3) A certificate of qualification is valid for the term prescribed in the regulations. 1994-95, c. 1, s. 64.

Amendment and cancellation of certificate

65 (1) The Minister may

(a) amend a term or condition of, add a term or condition to, or delete a term or condition from a certificate of qualification if the Minister considers it appropriate to do so;

(b) cancel or suspend a certificate of qualification if the Minister considers that it is appropriate to do so;

(c) correct a typographical error in a certificate of qualification; or

(d) cancel a certificate of qualification on application by the holder of the certificate of qualification.

Advance notice

(2) The Minister shall give notice in writing, together with reasons, to the holder of a certificate of qualification at least thirty days in advance of making an amendment, addition or deletion pursuant to clause (1)(a).

Notification of decision

(3) The Minister shall forthwith on cancellation or suspension of a certificate of qualification pursuant to clause (1)(b) give notice, in writing, together with reasons, of

the cancellation or suspension to the holder of the certificate of qualification. 1994-95, c. 1, s. 65.

Regulations

66 (1) The Governor in Council may make regulations

(a) designating activities or any class of activities for which an approval or certificate of qualification is required, and specifying the kind of approval or certification of qualification required;

(b) prescribing the length of time for which approvals and certificates of qualification may be issued and permitting an approval or certificate of qualification to be issued for a shorter period of time than prescribed in the regulations;

(c) governing and prohibiting any activity or the use of any thing for the purpose of the protection of the environment, including regulations governing the design, construction, maintenance or use of the activity or thing;

(d) governing and prohibiting the manufacture, sale or use of any equipment, device or service designed or provided for any purpose related to the protection of the environment;

(e) respecting security under Section 57;

(f) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 66.

PART VI

RELEASE OF SUBSTANCES

Prohibition

67 (1) No person shall knowingly release or permit the release into the environment of a substance in an amount, concentration or level or at a rate of release that causes or may cause a significant adverse effect, unless authorized by an approval or the regulations.

Prohibition

(2) No person shall release or permit the release into the environment of a substance in an amount, concentration or level or at a rate of release that causes or may cause a significant adverse effect, unless authorized by an approval or the regulations. 1994-95, c. 1, s. 67.

Prohibition

68 (1) No person shall knowingly release or permit the release of a substance into the environment in an amount, concentration or level or at a rate of release that is in excess of that expressly authorized by an approval or the regulations.

Prohibition

(2) No person shall release or permit the release of a substance into the environment in an amount, concentration or level or at a rate of release that is in excess of that expressly authorized by an approval or the regulations. 1994-95, c. 1, s. 68.

Duty to report release

69 (1) Any person responsible for the release of a substance into the environment that has caused, is causing or may cause an adverse effect, shall forthwith, as soon as that person knows or ought to know of the release, report it to

(a) the Department at its emergency telephone number;

(b) the owner of the substance, where applicable, if the person reporting knows or is readily able to ascertain the identity of the owner;

(c) the person having care, management or control of the substance, where applicable, if the person reporting knows or is readily able to ascertain the identity of that person; and

(d) any other person who the person reporting knows or ought to know may be directly affected by the release.

Duty to report release

(2) Any person responsible for the release of a substance into the environment that is in excess of an amount, concentration, level or rate of release expressly authorized by an approval or regulations, shall forthwith, as soon as that person knows or ought to know of the release, report it in the manner prescribed in the approval or the regulations, as the case may be, to the persons identified in clauses (1)(a) to (d). 1994-95, c. 1, s. 69.

Voluntary submission of information

70 (1) Any person responsible who voluntarily provides the Department with detailed information obtained through an environmental audit or environmental-site assessment about non-compliance with the requirements of this Act by that person, shall not be prosecuted for the non-compliance, if the person complies with

(a) the terms of any agreement negotiated by the Minister and the person; or

(b) any order issued under Part XIII to address the non-compliance by the person.

Subsection (1) does not apply

(2) Subsection (1) does not apply if the Department is independently aware of the non-compliance prior to receiving the information from the person. 1994-95, c. 1, s. 70.

Duty to take remedial measures

71 Any person responsible for the release of a substance under this Part shall, at that person's own cost, and as soon as that person knows or ought to have known of the release of a substance into the environment that has caused, is causing or may cause an adverse effect,

(a) take all reasonable measures to

(i) prevent, reduce and remedy the adverse effects of the substance, and

(ii) remove or otherwise dispose of the substance in such a manner as to minimize adverse effects;

(b) take any other measures required by an inspector or an administrator; and

(c) rehabilitate the environment to a standard prescribed or adopted by the Department. 1994-95, c. 1, s. 71.

Emergency measures

72 (1) Where an inspector or an administrator is of the opinion that

(a) a release of a substance into the environment may occur, is occurring or has occurred; and

(b) the release may cause, is causing or has caused an environmental emergency,

the inspector or administrator may take such emergency measures prescribed in the regulations that the inspector or administrator considers necessary to prevent, reduce and remedy the adverse effects.

Application of subsection (1)

(2) Subsection (1) applies whether or not the release of the substance into the environment is or was expressly authorized by, and is or was in compliance with, an approval or the regulations. 1994-95, c. 1, s. 72.

Powers of Minister

73 The Minister may

(a) classify releases for the purpose of this Part and exempt any release or any class of release from the application of this Part and attach terms and conditions to any such exemption;

(b) prescribe the concentration, amount, level and rate, including the maximum concentration, amount, level and rate of a substance that may be released into the environment;

(c) determine the manner in which a report of a release of a substance is to be made and the contents of the report. 1994-95, c. 1, s. 73.

Regulations

74 (1) The Governor in Council may make regulations

(a) respecting spill reporting under Section 69;

(b) respecting environmental-site assessments and environmental audits provided pursuant to Section 70;

(c) respecting remediation measures under Section 71;

(d) respecting emergency measures taken under Section 72, including the levels of training for responding to environmental emergencies;

(e) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 74.

PART VII

DANGEROUS GOODS AND PESTICIDES

Storing and handling

75 Unless authorized under this Part or regulations made pursuant to this Part, a person who handles dangerous goods, waste dangerous goods or pesticides shall do so in a manner that ensures that the dangerous goods, waste dangerous goods or pesticides do not cause an adverse effect to the environment. 1994-95, c. 1, s. 75.

Prohibition

76 Subject to the regulations, no person shall sell or distribute any crop, food, feed, animal, plant, water, produce, product or other matter that

(a) contains dangerous goods, waste dangerous goods or a pesticide in excess of the permissible concentrations as established by this Act, the *Food and Drug Act* (Canada) or the *Pest Control Products Act* (Canada); or

(b) the person knows or ought reasonably to know has been contaminated by dangerous goods, waste dangerous goods or pesticides in excess of permissible concentrations as established by this Act, the *Food and Drug Act* (Canada) or the *Pest Control Products Act* (Canada). 1994-95, c. 1, s. 76.

Research

77 The Minister shall undertake research and adopt policies, programs and strategies to find alternatives to the use of dangerous goods and pesticides and to reduce the production of waste dangerous goods and pesticides. 1994-95, c. 1, s. 77.

Dangerous Goods and Waste Dangerous Goods

Powers of Minister

78 (1) The Minister may

(a) stipulate the quantity or concentration of dangerous goods or waste dangerous goods that may be released into the environment, either alone or in combination with any other substance from any source;

(b) stipulate the manner and conditions under which dangerous goods or waste dangerous goods may be released into the environment, either alone or in combination with any other substance;

(c) establish procedures respecting the conducting of sampling, analyses, tests, measurements or monitoring of dangerous goods or waste dangerous goods and the submission of the results to the Minister;

(d) establish procedures requiring and respecting the submission of samples of dangerous goods or waste dangerous goods to the Minister.

Powers of Minister

(2) The Minister may direct a person responsible for dangerous goods or waste dangerous goods to

(a) take specified precautions regarding the handling of dangerous goods or waste dangerous goods;

(b) handle dangerous goods or waste dangerous goods in accordance with specified terms and conditions;

(c) remove dangerous goods or waste dangerous goods from a specified location;

(d) take dangerous goods or waste dangerous goods to a specified location;

(e) take specified precautions with respect to the treatment or decontamination of a place affected by dangerous goods or waste dangerous goods;

(f) take specified precautions with respect to the future use of a place affected by dangerous goods or waste dangerous goods;

(g) undertake, in respect of dangerous goods or waste dangerous goods, investigations, tests, surveys or other action and report the results to the Minister;

(h) prepare and submit to the Minister a written contingency plan respecting the handling of dangerous goods or waste dangerous goods. 1994-95, c. 1, s. 78.

Pesticides

Prohibition

79 (1) Subject to subsection (2), no person shall

(a) sell, distribute, use, apply, handle, store or transport a pesticide;

(b) operate or clean any machinery, equipment, vehicle, aircraft or vessel used in connection with the sale, distribution, use, application, handling, storage or transportation of a pesticide; or

(c) use or clean a pesticide container,

except in accordance with the regulations and the label filed with the certificate of registration for that pesticide.

Conflict

(2) Where there is a conflict between any applicable provision of a regulation and the provision on the label referred to in subsection (1), the most stringent provision prevails.

Prohibition

(3) No person shall dispose of a pesticide, a mixture containing a pesticide, a thing that is treated or contaminated with a pesticide or a container that has been

used to hold a pesticide in a manner other than the manner prescribed in the regulations. 1994-95, c. 1, s. 79.

"Federal Regulatory Authority" defined

80 (1) In this Section, Federal Regulatory Authority includes, but is not limited to, the Minister of Agriculture for Canada, and includes Acts and regulations within the jurisdiction of that Minister.

Destruction of crops

(2) Crops used for pesticide research shall be destroyed or otherwise prevented from direct or indirect entry into food-marketing channels, unless otherwise approved by Health Canada.

Pesticide research

(3) Pesticide research is subject to all requirements of the Federal Regulatory Authority.

Notification before conducting research

(4) A person conducting pesticide research in the Province shall notify the Department before commencing the pesticide research and shall provide the Department with such information as the Minister considers necessary.

Minister may give directions

(5) The Minister may give additional directions to a person to whom a pesticide research permit is issued by the Federal Regulatory Authority. 1994-95, c. 1, s. 80.

Powers and duties of Minister

81 The Minister

(a) shall develop, co-ordinate and enforce policies, planning and programs respecting integrated pest management and alternatives to the use of pesticides;

(b) may make grants and loans for research related to pesticides and integrated pest management and the control of pests in such amounts and on such terms and conditions as the regulations prescribe. 1994-95, c. 1, s. 81.

Petroleum Products

"motive fuel" defined

82 In Sections 83 and 84, "motive fuel" means any petroleum product used to power a vehicle, aircraft or vessel and includes gasoline and diesel oil but does not include kerosene or fuel oil. 1994-95, c. 1, s. 82.

Prohibition

83 (1) No person shall store or sell as a retailer, wholesaler or wholesaler-retailer any motive fuel or fuel oil from

(a) a terminal, bulk plant, bulk station or other facility operated in the Province by a wholesaler of motive fuel or fuel oil;

(b) a motive fuel or fuel oil outlet operated by that person; or

(c) any other facility,

unless that person holds a valid approval.

Prohibition

(2) No retailer shall sell or store motive fuel or fuel oil unless

(a) the motive fuel or fuel oil is purchased from a wholesaler who holds a valid approval; or

(b) that person is a wholesaler-retailer who holds a valid approval. 1994-95, c. 1, s. 83.

Regulations

84 (1) The Governor in Council may make regulations

(a) designating dangerous goods and waste dangerous goods, and classifying dangerous goods and waste dangerous goods;

(b) respecting the places where dangerous goods, waste dangerous goods or pesticides may be released into the environment;

(c) respecting the quantity or concentration of dangerous goods, waste dangerous goods or pesticides that may be handled;

(d) respecting the purposes for which dangerous goods, waste dangerous goods or pesticides or a product containing dangerous goods, waste dangerous goods or pesticides may be handled;

(e) regulating or prohibiting the handling of dangerous goods, waste dangerous goods or pesticides, and containers holding dangerous goods, waste dangerous goods or pesticides;

(f) respecting the sale or distribution of items referred to in Section 76;

(g) requiring and respecting the submission of information including manifests relating to dangerous goods, waste dangerous goods or pesticides to the Minister;

(h) requiring manufacturers, distributors or sellers to recall products or materials containing dangerous goods, waste dangerous goods or pesticides;

(i) governing signs, markings or other identification to be used for public notification;

(j) respecting the use, operation and cleaning of vehicles, aircraft, vessels, machinery, equipment and containers used in connection with the handling of dangerous goods, waste dangerous goods or pesticides;

(k) determining, in the case of any fluid or substance, whether or not that fluid or substance is motive fuel or fuel oil;

(l) prescribing the conditions under which an approval holder may purchase, receive, sell or deliver motive fuel or fuel oil;

(m) prescribing the safety requirements which may apply to this Part;

(n) designating organizations to test equipment and train persons who handle motive fuel or fuel oil according to standards or specifications established or approved by the Minister;

(o) approving equipment or any type of equipment used by an approval holder;

(p) prescribing grades of motive fuel and associated products and providing for the identification thereof;

(q) specifying the books and records required to be maintained;

(r) prohibiting or restricting giving away merchandise to promote the sale of motive fuel or fuel oil;

(s) regarding the rights of approval holders to discharge security documents and leasing arrangements for wholesale and retail motive fuel and fuel oil outlets;

(t) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act.* 1994-95, c. 1, s. 84.

PART VIII

CONTAMINATED SITES

Application of Part

85 This Part applies regardless of when a substance became present over, in, on or under a contaminated site. 1994-95, c. 1, s. 85.

Orphan contaminated sites

86 The Minister may enter into agreements and establish programs and other measures the Minister considers necessary to pay for the costs of restoring and securing contaminated sites and the environment affected by contaminated sites where a person responsible for the contaminated site cannot be identified or is unable to pay for the costs. 1994-95, c. 1, s. 86.

Designation of contaminated site

87 (1) Where the Minister is of the opinion that a substance that may cause, is causing or has caused an adverse effect is present in an area of the environment, the Minister may designate that area of the environment as a contaminated site.

Guidelines for designation

(2) The Minister shall follow standards, criteria or guidelines established or adopted by the Department before making a designation pursuant to subsection (1).

Application of subsection (1)

(3) Subsection (1) applies notwithstanding that

(a) an administrative or enforcement remedy has been pursued under this Act or under any other law in respect of the contaminated site;

(b) the substance was released in accordance with this Act or any other law;

(c) the release of the substance was not prohibited under this Act; or

(d) the substance originated from a source other than the contaminated site.

Cancellation

(4) The Minister may cancel the designation of a contaminated site made pursuant to this Section. 1994-95, c. 1, s. 87.

Notice of designation

88 The Minister shall

(a) give notice, in writing, of a preliminary determination of a designation of an area of the environment, provide an opportunity for comment on the determination, make a final determination on whether or not the site is contaminated and give notice, in writing, together with reasons, of the final determination to

(i) any person responsible for the contaminated site that the Minister considers appropriate,

(ii) any registered owner of real property directly affected by the designation,

(iii) a municipality where the contaminated site is located;

(b) give notice to the persons referred to in clause (a) respecting the cancellation of a designation;

(c) file the designation or cancellation of the designation in the environmental registry. 1994-95, c. 1, s. 88.

Remedial action plans and agreements

89 (1) A person responsible for a contaminated site may

(a) prepare for the approval of the Minister a remedial action plan in respect of the contaminated site; and

(b) enter into a written agreement with the Minister or with other persons responsible for the contaminated site or with both the Minister and other persons responsible, providing for the remedial action to be taken in respect of the contaminated site and providing for the apportionment of the costs of taking that action.

Approval by Minister

(2) An agreement pursuant to clause (1)(b) to which the Minister is not a party is not binding on the Minister unless it is approved by the Minister.

Alternate dispute resolution

(3) Where the persons responsible for a contaminated site cannot reach an agreement or where the Minister rejects an agreement entered into pursuant to clause (1)(b), the Minister may refer the matter to alternate dispute resolution under Part II.

Ministerial order

(4) Where alternate dispute resolution is unsuccessful or considered inappropriate by the Minister, the Minister may make an order under Part XIII.

Offence

(5) A person responsible for the contaminated site who violates a term of an agreement reached under clause (1)(b) is guilty of an offence.

Ministerial order

(6) Where a person responsible for a contaminated site does not, within a reasonable period of time, comply with subsection (1), the Minister may make an order under Part XIII. 1994-95, c. 1, s. 89.

Powers of Minister

90 The Minister may

(a) determine the criteria respecting the designation and classification of a contaminated site;

(b) determine the manner and time frame in which the contaminated site must be rehabilitated or managed;

(c) issue guidelines and certificates of compliance respecting the establishment of standards or criteria to be used in determining whether rehabilitation or management have been completed in a satisfactory manner;

(d) subject to Section 165, enter into written agreements pursuant to Section 89 respecting the liability of secured creditors, receivers, receiver managers, trustees in bankruptcy, executors, administrators and other persons;

(e) compile a list of persons or classes of persons who are not responsible for rehabilitation at a contaminated site;

(f) establish programs and enter into agreements to rehabilitate or manage a contaminated site or prevent the creation of a contaminated site. 1994-95, c. 1, s. 90.

Regulations

91 (1) The Governor in Council may make regulations

(a) respecting assessment and rehabilitation criteria, including guidelines and standards to be used for the purpose of designating a contaminated site, and for the cleanup of such sites;

(b) designating persons or classes of persons who are not responsible persons for contaminated sites;

(c) respecting the duties and rights of vendors, purchasers or other persons of property that may be contaminated;

(d) respecting procedures to cover the allocation of liability or agreements negotiated under this Part;

(e) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act.* 1994-95, c. 1, s. 91.

PART IX

WASTE-RESOURCE MANAGEMENT

Solid-waste-resource strategy

92 The Minister shall establish a solid-waste-resource management strategy for the Province. 1994-95, c. 1, s. 92.

Waste diversion goal

93 (1) There is hereby adopted the Canadian target of a fifty per cent solid-waste diversion goal for the year 2000.

Specific waste reduction goals

(2) The Minister shall, after public consultation, prescribe specific waste diversion goals applicable to a prescribed class of works, undertakings, substances or events.

Waste-reduction agreement

(3) The Minister may enter into waste-reduction agreements with any person having an interest in waste reduction or solid-waste-resource management.

Goals may vary

(4) A waste-reduction goal prescribed pursuant to subsection (2) may apply to all of the Province or part of the Province as specified by the Minister, and the goal may vary in different areas of the Province.

Amendment of approvals to meet goals

(5) In setting a waste-reduction goal pursuant to subsection (2), the Minister may specify how and when approvals held by persons affected by the target shall be amended in order to implement a waste-reduction goal. 1994-95, c. 1, s. 93.

Waste-resource management studies

94 (1) The Minister shall conduct, support or promote research on waste-resource management including, but not limited to,

(a) the composition and distribution of waste in the Province;

(b) source reduction, reuse, composting and recycling;

(c) the use of packaging;

(d) litter prevention;

(e) market information and business opportunities for specific waste-resource management practices;

(f) waste-disposal practices and facilities including composting, landfills and incineration;

(g) the social and economic feasibility of household and other solid waste-separation schemes, including studies of the type and amount of recyclable materials in solid wastes from all sources in the Province.

Financial assistance

(2) The Minister may provide financial assistance for waste-resource management studies undertaken pursuant to subsection (1). 1994-95, c. 1, s. 94.

Agreements

95 The Minister may enter into agreements or co-operate with a municipality or other persons to

(a) establish cost sharing arrangements or provide other financial incentives to encourage source reduction, reuse, recycling and composting;

(b) implement policies to recycle waste materials, to promote energy conservation and to purchase products made from recyclable materials;

(c) prepare model by-laws and promote the enactment of municipal legislation respecting waste-resource management, including littering, recycling and composting;

(d) undertake and encourage litter clean-up and composting programs, and encourage industry to support such programs;

(e) encourage industry stewardship;

(f) generally, promote integrated waste-resource management. 1994-95, c. 1, s. 95.

Recyclable materials

96 The Minister may

(a) establish restrictions and prohibitions on the storage and disposal of types of waste or recyclable materials in specified types of waste treatment, storage or disposal facilities;

(b) develop codes and guidelines for the use and content of recyclable materials in the manufacture of new substances or products;

(c) prescribe minimum content requirements for recyclable materials in specific substances or products, or establish restrictions on the production or sale of products that cannot be reused or recycled. 1994-95, c. 1, s. 96.

Composting

97 The Minister shall promote composting as an option for waste-resource management. 1994-95, c. 1, s. 97.

Resource Recovery Fund

98 There is hereby established in accordance with the regulations the Resource Recovery Fund. 1994-95, c. 1, s. 98.

Litter prevention

99 (1) The Minister shall encourage litter prevention or reduction by

(a) regulating waste-disposal practices at construction sites, at commercial and service outlets and at other places where litter is or may be accumulated;

(b) requiring organizers of public and private events to have available and maintain an adequate number of receptacles for recyclable materials and litter or waste disposal;

(c) regulating or prohibiting activities that result or may result in the unlawful disposal of litter or waste including the placement of flyers on vehicles, utility poles, structures or other things;

(d) regulating the disposal of waste or litter on real property or on, into or under water or ice;

(e) generally, providing for any matter that will prevent or reduce litter.

Prohibition

(2) No person shall release or permit the release of litter into the environment, except as authorized by this Act or the regulations. 1994-95, c. 1, s. 99.

Designated materials

100 (1) The Minister may designate materials the use of which is to be banned, reduced, composted or recycled.

Surcharge

(2) A person who manufactures or distributes a designated material for sale in the Province and a retailer of a designated material shall, in accordance with the regulations,

(a) collect the surcharge prescribed for the designated material in accordance with the regulations;

(b) where the regulations require, deposit the surcharge in the Resource Recovery Fund.

Depots for collection of material

(3) A person who manufactures or distributes a designated material for sale in the Province and a retailer shall, in accordance with the regulations, provide in the Province depots and other methods for the collection and recovery of the designated material.

Prohibition

(4) No person shall sell or use, for a purpose beyond the purpose designated under subsection (1), a designated material the use of which has been banned, reduced or requires recycling under subsection (1). 1994-95, c. 1, s. 100.

Packaging

101 (1) The Minister may establish or adopt programs or policies respecting the use of packaging and labelling of materials including, but not limited to,

(a) imposing requirements or standards with respect to the type, size, labelling, composition and disposal of packaging, including standards for material degradability and recyclability;

(b) reducing or mitigating the adverse effects created by packaging;

(c) establishing measures to encourage source reduction, reuse and recycling of packaging;

(d) providing information on packaging to enable consumers to identify products or packaging that have the least impact on the environment;

(e) requiring any person who produces or sells a product or substance to

(i) accept the product or substance, or packaging associated with the product or substance, from any person, except for a person engaged in commercial waste management, including recycling, who no longer wants the product, substance or packaging, and

(ii) manage the product, substance or packaging in such a manner that there are no adverse effects upon the environment.

Approval of packaging and labelling

(2) The Minister may approve the packaging and labelling of materials.

Prohibition

(3) No person shall use, offer for sale or sell packaging, product containers or disposable products, or any material used in packaging, product containers or disposable products, contrary to this Act or the regulations. 1994-95, c. 1, s. 101.

Regulations

102 (1) The Governor in Council may make regulations

(a) respecting designated materials including, but not limited to,

(i) prescribing designated material for the purposes of this Part and creating different classes of designated material for different purposes,

(ii) prohibiting or restricting the manufacture, sale or distribution of designated material,

(iii) requiring that designated material or any other product be recycled, including the prohibition of a material or product in landfills or other disposal areas,

(iv) requiring the development and implementation of a waste minimization, recycling or recovery plan for designated material by manufacturers, distributors, retailers or any other person, specifying the manner in which designated material is to be handled and recycled,

(v) respecting surcharges on designated material including, without restricting the generality of the foregoing, regulations establishing or providing for the manner of establishing the classes of designated material for which surcharges are payable, prescribing the amount of a surcharge or the method of determining it, providing for the manner in which and the times at which surcharges are to be collected and paid and respecting the advertising of surcharges,

(vi) providing for the payment by manufacturers, distributors and retailers of designated material and any other persons of surcharges to fund litter control programs and respecting the collection and spending of these surcharges,

(vii) respecting the establishment, classification, licensing and operation of depots, including the qualifications of persons who may operate such depots,

(viii) respecting the amount and kind of designated material a retailer is required to accept at depots,

(ix) specifying designated material or other material for which payment must be made by a retailer or depot operator on its return, and specifying the amount of such payment and commissions or fees which the retailer or the depot operator may retain,

(x) requiring manufacturers or distributors to pay depot operators and retailers in respect of the collection of designated material or other material and prescribing the amount of the payments, the manner in which payments are to be calculated and commissions or fees which the manufacturer or distributor may retain,

(xi) requiring the compilation, maintenance and provision of recycle dockets or records and information in respect of designated materials;

(b) respecting the establishment and operation of the Resource Recovery Fund and respecting the manner and the purposes for which money in the Fund may be used;

(c) establishing standards for waste-separation programs, and waste-disposal programs, facilities and sites;

(d) respecting recycling, including the recycling of dangerous goods and how recyclable dangerous goods are to be dealt with when they are no longer recyclable and must be treated as waste dangerous goods;

(e) regarding the use and disposal of beverage containers;

(f) regarding the use of packaging and the labelling of materials;

(g) regarding the use or disposal of litter;

(h) establishing guidelines or standards restricting or prohibiting the use or sale of composting products;

(i) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 102.

PART X

WATER-RESOURCE MANAGEMENT

Vesting of watercourses

103 Notwithstanding any enactment, or any grant, deed or transfer made on or before May 16, 1919, whether by Her Majesty or otherwise, or any possession, occupation, use or obstruction of any watercourse, or any use of any water by any person for any time whatever, but subject to subsection 3(2) of the *Water Act*, every watercourse and the sole and exclusive right to use, divert and appropriate any and all water at any time in any watercourse is vested forever in Her Majesty in right of the Province and is deemed conclusively to have been so vested since May 16, 1919, and is fully freed, discharged and released of and from every fishery, right to take fish, easement, *profit à prendre* and of and from every estate, interest, claim, right and privilege, whether or not of the kind hereinbefore enumerated, and is deemed conclusively to have been so fully freed, discharged and released since May 16, 1919. 1994-95, c. 1, s. 103.

Lead agency

104 The Department is designated as the lead agency of Government to

(a) ensure that water is managed appropriately and used efficiently;

(b) allocate water resources among competing users in a manner that will further sustainable development;

(c) take such measures as are reasonable to provide access to safe, adequate and reliable water supplies for individual, municipal, industrial and agricultural uses;

(d) ensure the health and integrity of aquatic ecosystems, to protect habitats for animals and plants and to provide for continued recreational benefits;

(e) ensure informed decision making in water-resource management through public education and participation. 1994-95, c. 1, s. 104.

Minister has supervision of water resources

105 (1) The Minister has supervision of the uses of all water resources and watercourses and the allocation of water in the Province.

Water-resource management strategy

(2) The Minister shall establish a water-resource management strategy for the Province.

Powers of Minister

(3) To assist in the development of a water-resource management strategy, the Minister may

(a) authorize, restrict or prohibit the alteration of watercourses;

(b) establish or adopt water-management goals;

(c) establish or adopt water-quality guidelines, objectives and standards;

(d) establish or adopt indicators of aquatic-ecosystem health and integrity;

(e) develop sensitivity indices for the water resources of the Province;

(f) establish or adopt goals for effluent reduction;

(g) establish total allowable wasteloads for water bodies;

(h) provide funding for water related research, investigation and monitoring;

(i) approve water works and sewage works and funding for water works and sewage works;

(j) approve watershed-protection strategies;

(k) adopt strategies to protect watersheds for specific uses;

(l) classify water resources according to their sensitivity or uses;

(m) promote water-resource management with any person who may have an interest, and co-ordinate the activities of the Government or any Government agency with interests and mandates related to water-resource management;

(n) co-operate with other agencies respecting areas naturally prone to flooding;

(o) operate a water utility for the Province.

Public participation and advice

(4) The Minister may identify any qualified persons, including water or watershed advisory boards, committees or authorities, and request those persons to promote informed public participation, provide advice to the Minister respecting watershed management and undertake such aspects of watershed management as may be assigned to those persons by the Minister. 1994-95, c. 1, s. 105.

Designation of protected water area

106 (1) The Minister, when requested by an operator of a water works or proposed water works, may designate an area surrounding any source or future source of water supply for a water works as a protected water area.

Notice of designation

(2) The operator of a water works or proposed water works named in a designation made pursuant to subsection (1) shall

(a) give notice of the designation of the area as a protected water area by publishing the notice in a newspaper having circulation in the county or counties in which the area is located and in the Royal Gazette;

(b) have the notice of designation recorded at the registry of deeds in the county or counties in which the area is located; and

(c) post signs in the area indicating that it has been designated a protected water area.

Responsibility of operator

(3) The operator of a water works or proposed water works is responsible for taking all measures to protect the area designated, and the enforcement of any regulations made pursuant to subsection (6).

Cancellation

(4) When requested by an operator of a water works or proposed water works, the Minister may cancel a designation made pursuant to this Section, in whole or in part.

Designation continues

(5) Any protected water area designated pursuant to the *Water Act*, prior to the coming into force of this Act remains so designated.

Regulations

(6) At the request of the operator of the water works or proposed water works, the Minister may make regulations to prohibit, regulate or require the doing of any

act or acts in a protected water area that may impair or prevent the impairment, as the case may be, of the quality of the water in the protected water area.

Public consultation

(7) Before designating a protected water area, the Minister shall ensure that the operator of the water works or proposed water works has provided opportunities for public consultation.

Claim for injurious affection prohibited

(8) No claim for injurious affection lies against any person as the result of a designation of a protected water area.

Regulations Act

(9) The exercise by the Minister of the authority contained in subsection (6) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 106.

No grant of fishing rights

107 Nothing in this Act authorizes the granting of any fishing right or privilege. 1994-95, c. 1, s. 107.

No rights by prescription

108 Possession, occupation, use or obstruction of any watercourse, or any use of any water resource by any person for any time whatever on or after May 17, 1919, shall not be deemed to give an estate, right, title or interest therein or thereto or in respect thereof to any person. 1994-95, c. 1, s. 108.

Well drillers

109 No person, who is not the holder of a certificate of qualification, shall

(a) for gain or reward, contract to drill a well or dig a well for another person, or install a pump in a well;

(b) hold himself out as a well contractor or pump installer; or

(c) carry on the business of well drilling, well digging or pump installing. 1994-95, c. 1, s. 109.

Regulations

110 (1) The Governor in Council may make regulations

(a) respecting the uses to which specified watercourses may be put;

(b) defining contaminants for the purpose of this Part and prescribing permissible limits for such contaminants present in or being discharged into water or a watercourse;

(c) respecting the construction, operation, classification and maintenance of water-treatment facilities and sewage-treatment facilities and the operators of such facilities;

(d) respecting the infilling or alteration of wetlands, swamps, marshes, ravines or gulches;

(e) respecting the qualifications for well contractors and well pump installers;

(f) providing for the issuing of tags, decals, plates, devices, documents or other things to a holder of a certificate of qualification to serve as evidence that a drilling machine is being operated under a certificate;

(g) requiring and governing the taking of samples, tests, analyses, surveys and logs and other well data and the submission of them to the Minister;

(h) governing the reclamation of wells and the methods and requirements to be observed in reclamation operations;

(i) respecting remedial action to be taken with respect to problem wells;

(j) respecting the control of flowing wells;

(k) respecting the methods of drilling and digging wells, and of determining sources of ground water;

(l) respecting the precautions and measures to be taken prior to and during the drilling, digging and development of a well;

(m) respecting the casing, anchorage, equipment, materials and installations to be used in the drilling, completion, operation, reconditioning and production of wells;

(n) respecting the maintenance of inactive wells;

(o) respecting the ongoing maintenance and operation of active wells;

(p) respecting the drilling and reclamation of wells;

(q) respecting well log books;

(r) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 110.

PART XI

AIR-QUALITY MANAGEMENT

Duties of Minister

111 (1) The Minister shall

(a) establish Provincial ambient air-quality standards or objectives necessary for the protection of the environment;

(b) establish performances specifications and standards for air-quality testing and monitoring; and

(c) maintain inventories and establish reporting requirements for emissions of air contaminants.

Powers of Minister

(2) The Minister may

(a) establish air-emission standards to toxic, common and nuisance air contaminants and odour;

(b) adopt overall Provincial emission caps and production goals and product manufacturing, sale and use restrictions to address air-quality issues of regional or global significance;

(c) conduct or require air-quality and meteorological studies and compliance-monitoring programs;

(d) establish regional air-quality-management programs to address the combined effects of multiple sources of air contaminants;

(e) enter into agreements respecting air-management issues;

(f) prepare model by-laws and otherwise co-operate with municipalities to promote improved air quality;

(g) establish requirements respecting the operation or maintenance of any equipment, device or service that may emit contaminants into the air. 1994-95, c. 1, s. 111.

Regulations

112 (1) The Governor in Council may make regulations

(a) restricting the manufacture, sale or use of a substance having the potential to release environmentally damaging substances into the atmosphere;

(b) limiting the concentration or quantity of emissions into the atmosphere, either alone or in combination with any other substance;

(c) requiring the submission of information related to the release of substances into the atmosphere;

(d) establishing standards or objectives for ambient air quality;

(e) governing or prohibiting practices or activities that may emit contaminants into the atmosphere;

(f) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 112.

PART XII

INSPECTIONS AND INVESTIGATIONS

Inspector deemed peace officer

113 An inspector, in carrying out duties pursuant to this Act, has and may exercise in any part of the Province all the powers, authorities and immunities of a peace officer as defined in the *Criminal Code* (Canada). 1994-95, c. 1, s. 113.

Programs to promote reporting

114 The Minister shall establish programs to promote the reporting of

(a) acts or omissions that cause adverse effects; and

(b) acts or omissions that may constitute offences under this Act. 1994-95, c. 1, s. 114.

Application for investigation

115 (1) Any person who is of the opinion that an offence has been committed under this Act may apply to the Department to have an investigation of the alleged offence conducted.

Solemn declaration

(2) An application pursuant to subsection (1), if the Department so requests, shall be accompanied by a solemn declaration

(a) stating the name and address of the applicants;

(b) stating the nature of the alleged offence and the name of each person alleged to be involved in its commission; and

(c) containing a concise statement of the evidence supporting the allegations of the applicants.

Offence

(3) Any person who wilfully or intentionally provides false information in an application pursuant to subsection (1) is guilty of an offence. 1994-95, c. 1, s. 115.

Investigation

116 (1) On receipt of an application pursuant to Section 115, an administrator shall acknowledge receipt of the application and shall investigate all matters that the administrator considers necessary for a determination of the facts about the alleged offence.

Report to applicant

(2) Within ninety days after receiving the application, the administrator shall report to the applicant on the progress of the investigation and the action, if any, proposed to be taken in respect of the alleged offence, but information shall not be disclosed to the applicant, if such disclosure would be contrary to the *Freedom of Information and Protection of Privacy Act.*

Investigation may be discontinued

(3) An administrator may discontinue an investigation if the administrator is of the opinion that the alleged offence does not require further investigation.

Report to applicant

(4) Where an investigation is discontinued, the administrator shall

(a) prepare a statement in writing stating the reasons for its discontinuance; and

(b) send a copy of the statement to the applicant and to any person whose conduct was investigated. 1994-95, c. 1, s. 116.

Inspections must be permitted

117 It is a condition of every approval, certificate of qualification or certificate of variance that the holder must forthwith on request permit inspectors to carry out inspections authorized pursuant to this Part of any place, other than a dwelling place, to which the approval, certificate of qualification or certificate of variance relates. 1994-95, c. 1, s. 117.

Assistance to inspectors

118 The owner or occupier of any place in respect of which an inspector is exercising powers or carrying out duties pursuant to this Part shall

(a) give the inspector all reasonable assistance to enable the inspector to exercise those powers and carry out those duties; and

(b) furnish all information relative to the exercising of those powers and the carrying out of those duties that the inspector may reasonably require. 1994-95, c. 1, s. 118.

Right of entry and inspection

119 (1) For the purpose of the administration of this Act, an inspector, subject to Sections 22 and 120, may, at any reasonable time,

(a) enter and inspect any place to which an approval issued pursuant to this Act relates to determine

(i) the extent, if any, to which a substance may cause, is causing or has caused an adverse effect,

(ii) the cause of any adverse effect that may occur, is occurring or has occurred,

(iii) how an adverse effect may be prevented, eliminated, reduced or ameliorated and how the environment may be rehabilitated;

(b) enter and inspect any place if the inspector has reasonable grounds to believe waste can be found in that place;

(c) enter and inspect any place in or from which the inspector has reasonable grounds to believe a substance is being, has been or may be released into the environment;

(d) enter and inspect any place that the inspector has reasonable grounds to believe is likely to contain documents related to

(i) an activity or thing that is or is required to be the subject of an approval, certificate of qualification, certificate of variance or order, or

(ii) the release of a substance into the environment;

(e) enter and inspect any place that the inspector has reasonable grounds to believe is, or is required to be, the subject of or referred to in an approval, certificate of qualification, certificate of variance or order;

(f) stop and inspect any vehicle, aircraft or vessel to ascertain whether it or the manner in which it is being operated complies with this Act;

(g) where the inspector has reasonable grounds to believe that any thing may release, is releasing or has released into the environment a substance that may cause, is causing or has caused an adverse effect,

(i) require the person having care, management or control of the thing to detain the thing at the place where it is found, or

(ii) remove the thing or cause it to be removed from the place where it is found and give a receipt for it;

(h) require the production of any documents that are required to be kept pursuant to this Act or any other documents that are related to the purpose for which the inspector is exercising any power under clauses (a) to (g).

Restriction on detention or removal

(2) An inspector may not detain or remove a thing pursuant to clause (1)(g) for more than five days, excluding holidays, without the consent of the person having care, management or control of it or the owner of it, except pursuant to an order issued pursuant to subsection (3).

Exception

(3) Where a justice is satisfied on evidence under oath by an inspector that there is reasonable ground to believe that a thing detained or removed pursuant to

clause (1)(g) should be detained or removed for longer than five days, excluding holidays, to protect or conserve the environment, the justice may issue or renew an order authorizing an inspector to detain or remove the thing for the period of time set out in the order.

Notice of application

(4) An inspector who applies for an order pursuant to subsection (3) shall give reasonable notice of the application to the person having care, management or control of the thing to be detained or removed or to the owner of it.

Return of documents

(5) An inspector may remove documents that the inspector is entitled to examine or copy or otherwise reproduce but shall give a receipt to the person from whom they were taken and shall promptly return them on completion of the examination or reproduction. 1994-95, c. 1, s. 119.

Private dwelling place

120 Notwithstanding anything contained in this Act, an inspector may not enter a private dwelling place or any part of a place that is designed to be used and is being used as a permanent or temporary private dwelling place except

(a) with the consent of the occupant of the place; or

(b) pursuant to an order under Section 121 to enter and inspect, or under the authority of a search warrant. 1994-95, c. 1, s. 120.

Order to enter and inspect

121 (1) Notwithstanding anything contained in this Act, where a justice is satisfied on evidence under oath by an inspector that

(a) there are reasonable grounds to believe that it is appropriate for the administration of this Act for the inspector to do anything set out in Section 119; and

(b) the inspector may not be able to carry out duties under this Act effectively without an order under this Section because

(i) no person is present to grant access to a place that is locked or is otherwise inaccessible,

(ii) a person has denied the inspector access to a place or there is reasonable ground for believing that a person may deny the inspector access to a place,

(iii) a person has prevented the inspector from doing anything set out in Section 119 or denied the inspector access to any thing as a result of which the inspector is unable to do anything set out in Section 119,

(iv) there is reasonable ground to believe that a person may prevent an inspector from doing anything set out in Section 119, or may deny the inspector access to any thing as a result of which the inspector may be unable to do anything set out in Section 119,

(v) it is inpractical, because of the remoteness of the place to be inspected or because of any other reason, for the inspector to obtain an order under this Section without delay if access is denied, or

(vi) there are reasonable grounds to believe that an attempt by the inspector to do anything set out in Section 119 without the order might defeat the purpose of that Section or cause an adverse effect,

the justice may issue an order authorizing the inspector to do anything set out in Section 119 that is specified in the order for the period of time set out in the order.

Time period of order

(2) The period of time referred to in subsection (1) may not extend beyond thirty days after the date on which the order is made, but the order may be renewed for any reason set out in subsection (1) for one or more periods each of which is not more than thirty days.

Application

(3) An application pursuant to subsection (2) may be made before or after the expiry of the period.

No notice required

(4) An order under this Section may be issued or renewed on application without notice. 1994-95, c. 1, s. 121.

Seizure without order or search warrant

122 (1) An inspector may, without a court order or a search warrant, seize any thing that is produced to the inspector, or that is in plain view during an inspection under Sections 119 and 121 if the inspector has reasonable grounds to believe that there has been an offence committed under this Act and that the thing will afford evidence as to the commission of the offence.

Removal and detention

(2) The inspector may remove the thing seized or may detain it in the place where it is seized.

Notice

(3) The inspector shall inform the person from whom the thing was seized of the reason for the seizure and shall give the person a receipt for it.

Duty of inspector

(4) An inspector who seizes any thing under this Section shall deal with it in the same way as if it were seized pursuant to the authority of a search warrant. 1994-95, c. 1, s. 122.

Use of assistants

123 An inspector or administrator, in carrying out any duties or exercising any powers under this Act, may be accompanied by one or more persons considered by the

inspector or administrator to be necessary to enable the inspector or administrator to carry out those duties and exercise those powers. 1994-95, c. 1, s. 123.

Employee protection

124 (1) No employer shall

(a) dismiss or threaten to dismiss an employee;

(b) discipline or suspend an employee;

(c) impose a penalty on an employee; or

(d) intimidate or coerce an employee,

because the employee has reported or proposes to report to any person an act or omission that contravenes or that the employee has reasonable grounds to believe may contravene this Act.

Offence

(2) Any person who wilfully or intentionally provides false or misleading information pursuant to subsection (1) is guilty of an offence. 1994-95, c. 1, s. 124.

PART XIII

ORDERS

Ministerial control order

125 (1) Where the Minister believes on reasonable and probable grounds that a person has contravened or will contravene this Act, the Minister may, whether or not the person has been charged or convicted in respect of the contravention, issue an order requiring a person, at that person's own expense, to

(a) cease the specified activity;

(b) stop, limit, alter or control the release of any substance into the environment or part thereof in accordance with the directions set out in the order, either permanently or for a specified period;

(c) alter the procedures to be followed in the control, reduction or elimination of the release of any substance into the environment or part thereof;

(d) install, replace or alter any equipment or thing designed to control, reduce or eliminate the release of any substance into the environment or part thereof;

(e) take interim measures to control, eliminate or manage the adverse effect, including the provision of potable water to affected parties;

(f) undertake remedial action to control, reduce, eliminate or mitigate an adverse effect;

(g) install, replace or alter a facility in order to control, reduce, eliminate or mitigate the release of any substance into or on the environment or part thereof;

(h) carry out clean-up, site rehabilitation or management, site security and protection or other remedial actions in accordance with directions set out in the order;

(i) comply with directions set out in the order respecting the withdrawal of water from a watercourse, including directions to stop the withdrawal;

(j) refrain from altering a watercourse or comply with directions set out in the order respecting altering a watercourse;

(k) where a person has altered a watercourse, or has unlawfully released a contaminant into a watercourse, or where a contaminant may reach a watercourse, take immediate action to remedy the damage that person has caused;

(l) where a person is handling, storing or transporting dangerous goods, waste dangerous goods or pest-control products, take such action as is deemed necessary to avoid contamination by the good or product;

(m) cause a crop, feed, food, animal, plant, water, produce, product or other matter contaminated by a pest-control product to be destroyed or rendered harmless;

(n) restrict the sale, handling, use or distribution of a crop, feed, food, animal, plant, water, produce, product or other matter permanently or for such period of time as deemed necessary;

(o) take specified precautions with respect to the treatment or decontamination of an area affected by dangerous goods, waste dangerous goods or a pest-control product;

(p) take specified precautions with respect to the future use of an area affected by dangerous goods, waste dangerous goods or a pest-control product;

(q) restrict or prohibit the use of a contaminated site, or the use of any product that comes from a contaminated site;

(r) provide security in an amount and form specified by the Department during a clean-up and afterwards for monitoring or other purposes;

(s) do all things and take all steps necessary to comply with this Act, or to repair any injury or damage, or to control, eliminate or manage an adverse effect.

Extra requirements

(2) In environmentally sensitive areas, an order under subsection (1) may impose terms and conditions in excess of requirements provided in regulations, policies,

guidelines or standards prescribed or adopted by the Department.

Contents of order

(3) In addition to any other requirements that may be included in an order issued pursuant to this Part, the order may contain provisions

(a) requiring a person, at that person's own expense, to

(i) maintain records on any relevant matter, and report periodically to the Minister or person appointed by the Minister,

(ii) hire an expert to prepare a report for submission to the Minister or person appointed by the Minister,

(iii) submit to the Minister or person appointed by the Minister any information, proposal or plan specified by the Minister setting out any action to be taken by the person with respect to the subject-matter of the order,

(iv) prepare and submit a contingency plan,

(v) undertake tests, investigations, surveys and other action and report results to the Minister,

(vi) take any other measure that the Minister considers necessary to facilitate compliance with the order or to protect or restore the environment;

(b) fixing the manner or method of, or the procedures to be used in, carrying out the measures required by the order;

(c) fixing the time within which any measure required by the order is to be commenced and the time within which the order or any portion of the order is to be complied with. 1994-95, c. 1, s. 125.

Ministerial stop order

126 Where the Minister believes on reasonable and probable grounds that there is a likelihood of an irreparable adverse effect, the Minister may make an order to shut down or stop an undertaking forthwith, either permanently or for a specified period of time. 1994-95, c. 1, s. 126.

Litter control order

127 The Minister, an administrator or an inspector may issue an order to clean up any litter that has been disposed of contrary to this Act. 1994-95, c. 1, s. 127.

Emergency order

128 (1) In an emergency situation, an administrator or other person appointed by the Minister may issue a written or oral order pursuant to Sections 125 or 126.

Ratification and confirmation

(2) Any order issued pursuant to subsection (1) shall be ratified and confirmed, in writing, by the Minister within seventy-two hours or the order is null and void. 1994-95, c. 1, s. 128.

Factors to be considered before making order

129 (1) In deciding whether to issue an order pursuant to this Part, the Minister shall be guided by the following considerations, if such information is available or accessible to the Minister:

(a) when the substance became present over, in, on or under the site;

(b) in the case of an owner, occupier or operator, or previous owner, occupier or operator of the site

(i) whether the substance was present over, in, on or under the site at the time that person became an owner, occupier or operator,

(ii) whether the person knew or ought reasonably to have known that the substance was present over, in, on or under the site at the time that person became an owner, occupier or operator,

(iii) whether the presence of the substance over, in, on or under the site ought to have been discovered by the owner, occupier or operator had the owner, occupier or operator exercised due diligence in ascertaining the presence of the substance before the owner, occupier or operator became an owner, occupier or operator, and whether the owner, occupier or operator exercised such due diligence,

(iv) whether the presence of the substance over, in, on or under the site was caused solely by the act or omission of an independent third party,

(v) the economic benefits the person may have received and the relationship between that price and the fair market value of the site had the substance not been present over, in, on or under it;

(c) in the case of a previous owner, occupier or operator whether that person disposed of the interest in the site without disclosing the presence of the substance over, in, on or under the site to the person who acquired the interest;

(d) whether the person took all reasonable care to prevent the presence of the substance over, in, on or under the site;

(e) whether a person dealing with the substance ignored industry standards and practices in effect at the time or complied with the requirements of applicable enactments in effect at the time;

(f) whether the person contributed to further accumulation or the continued release of the substance on becoming aware of the presence of the substance over, in, on or under the site;

(g) what steps the person took to deal with the site on becoming aware of the presence of the substance over, in, on or under the site;

(h) any other criteria the Minister considers to be relevant.

Contents of order

(2) An order made by the Minister pursuant to this Part may

(a) require the person to whom the order is directed to take any measures that the Minister considers are necessary to restore or secure the contaminated site and the environment affected by the contaminated site;

(b) provide for the apportionment of the cost of compliance with the order;

(c) in accordance with the guidelines or regulations, regulate or prohibit the use of the contaminated site or the use of any product that comes from the contaminated site. 1994-95, c. 1, s. 129.

Order may deal with several substances

130 (1) An order made pursuant to this Part may deal with several substances and may be directed to one or more persons.

Order in effect until revoked

(2) An order pursuant to this Part remains in effect until it is revoked by the Minister.

Order is binding on heirs and successors

(3) An order issued pursuant to this Part is binding on the heirs, successors, executors, administrators, trustees, receiver, receiver manager and assigns of the person to whom it is directed.

Extent of order

(4) An order pursuant to this Part may be issued against any person responsible regardless of whether the act or omission that resulted in issuance of the order, occurred before or after the coming into force of this Act. 1994-95, c. 1, s. 130.

Amendment or revocation of order

131 (1) The Minister may

(a) amend a term or condition of, add a term or condition to, or delete a term or condition from an order;

(b) revoke an order; or

(c) amend a typographical error in an order.

Service of copy of order

(2) A copy of an order amended or revoked pursuant to subsection (1) shall be served as prescribed in this Act on the person to whom the original order was directed. 1994-95, c. 1, s. 131.

Person to comply with order

132 (1) When an order is served on a person to whom it is directed, that person shall comply with the order forthwith or, where a period for compliance is specified in the order, within the time period specified.

Non-compliance

(2) Where the person to whom an order is directed does not comply with the order or part thereof, the Minister may take whatever action the Minister considers necessary to carry out the terms of the order.

Reasonable costs recoverable

(3) Reasonable costs, expenses or charges incurred by the Minister pursuant to this Part are recoverable by order of the Minister

(a) against the person to whom the order was directed; or

(b) directing any person who has purchased real property from the person to whom the order was directed to pay to the Minister from any money which is still owed to the vendor, a sum not to exceed the amount owing in respect of the costs, expenses or charges.

Discharge

(4) A purchaser who pays an amount to the Minister pursuant to clause (3)(b) is discharged from any obligation to pay that amount to the vendor.

Reasonable costs

(5) For the purpose of this Section, the costs referred to in subsection (3) include any costs incurred in investigating and responding to

(a) any matter to which an order relates; or

(b) the failure to comply with an order.

Certificate is proof

(6) In any claim or action under this Section, a certificate purporting to be signed by the Minister setting out the amount of the cost, expense or charge is admissible in evidence and is, in the absence of evidence to the contrary, proof

(a) of the amount of the cost, expense or charge set out in the certificate; and

(b) that the cost, expense or charge was made necessary or caused by the release of a substance, contaminant, waste or thing to which the claim or action relates.

Filing and recording of order

(7) Where an order to pay is issued by the Minister pursuant to subsection (3), the order may be filed with the prothonotary of the Supreme Court and recorded in the environmental registry and, when so filed and recorded,

(a) the order is of the same force and effect as if it were a judgment against real property that the person named in the order may now or hereafter own;

(b) a lien is established on the property referred to in clause (a) for the amount stated and it is deemed to be taxes in respect of the real property and may be collected in the same way and in the same priority as taxes under the *Assessment Act*; and

(c) the order may be enforced as if it were a judgment of the Supreme Court in civil proceedings. 1994-95, c. 1, s. 132.

Court may order compliance

133 Where a person is guilty of an offence under subsection 132(1), a court may, in addition to any other penalty it may impose, order the person to comply with subsection 132(1), the violation for which that person has been convicted. 1994-95, c. 1, s. 133.

Joint and several liability

134 (1) Where an order under this Part is directed to more than one person, all persons named in the order are jointly responsible for carrying out the terms of the order and are jointly and severally liable for payment of the costs of doing so, including any costs incurred by the Minister under Section 132.

Subsection (1) does not apply

(2) Subsection (1) does not apply to an order where the Minister and the persons responsible have agreed to an apportionment of costs.

Limitation on liability

(3) Notwithstanding subsection (1), where an order is directed to a person who is acting in the capacity of executor, administrator, receiver, receiver manager or trustee in respect of a contaminated site, the liability of that person is limited to the value of the assets the person is administering, less the reasonable costs and fees of the administration.

Subsection (3) does not apply

(4) The limitation of liability under subsection (3) does not apply if the executor, administrator, receiver, receiver manager or trustee contributes to further accumulation or the continued release of the substance on becoming aware of the presence of substance in, on or under the contaminated site.

Contribution by person not at fault

(5) Where a person named in an order did not cause or contribute to the loss, damage, cost or expense by fault or negligence, each of the persons liable to pay compensation, whether or not they are named in the order, are liable to make contribution to and indemnify that person to such degree as is determined to be just and equitable in the circumstances.

Principles of indemnification

(6) Where two or more persons are liable to pay compensation under this Part, those persons are jointly and severally liable to the person suffering the loss, damage, cost or expense but, as between those persons, in the absence of a contract or agreement, each is liable to make contribution to and indemnify each other in accordance with the following principles:

(a) where two or more persons are liable to pay compensation under this Part and one or more of them caused or contributed to the loss damage, costs or expense by fault or negligence, such one or more of them shall make contribution to and indemnify,

(i) where one person is found at fault or negligent, any other person liable to pay compensation under this Part, and

(ii) where two or more persons are found at fault or negligent, each other and any other person liable to pay compensation under this Part in the degree in which each of such two or more persons caused or contributed to the loss, damage, cost or expense by fault or negligence;

(b) for the purpose of subclause (a)(ii), if it is not practicable to determine the respective degrees in which the fault or negligence of two or more persons liable to pay compensation under this Part caused or contributed to the loss, damage, cost or expense, such two or more persons shall be deemed to be equally at fault or negligent.

Enforcement

(7) The right of contribution or indemnification under subsections (5) and (6) may be enforced by action in a court of competent jurisdiction. 1994-95, c. 1, s. 134.

Payment by insurer

135 (1) Where a person to whom an order issued pursuant to this Part is insured under an insurance policy that provides for coverage for any cost, expense, loss, damage or charge, the insurer shall, subject to the terms of the relevant policy, pay to the Minister on demand in writing any cost, expense, loss, damage or charge incurred by the Minister while acting pursuant to Section 132.

Sharing of insurance proceeds

(2) The Minister may enter into an agreement to share the proceeds of an insurance policy to which the Minister is entitled under subsection (1) on a *pro rata* basis or such other basis as the Minister considers appropriate with other persons who have incurred any cost, expense, loss, damage or charge in the circumstances described in subsection (1) and the insurer shall pay the proceeds in accordance with the agreement.

Deemed payment

(3) Where an insurer has made a payment pursuant to subsection (1) or (2), the payment is deemed to be a payment with respect to the cost, expense loss, damage or charge resulting from the event for which coverage was in effect.

Limit on payments

(4) Nothing in this Section requires an insurer to pay the Minister or any other person a sum or sums totalling in excess of the coverage limits of an insurance policy, or a sum or sums the insurer would otherwise not be obligated to pay under the policy.

Enforcement

(5) The Minister may, without restricting the rights of the Minister against the holder of the insurance policy, commence an action directly against the insurer for the purpose of enforcing the rights of the Minister under this Act. 1994-95, c. 1, s. 135.

Regulations

136 (1) The Governor in Council may make regulations

(a) respecting the issuance of orders pursuant to this Part;

(b) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 136.

PART XIV

APPEALS

Appeal to Minister

137 (1) A person who is aggrieved by a decision or order of an administrator or person delegated authority pursuant to Section 17 may appeal by notice in writing, stating concisely the reasons for the appeal, to the Minister.

Form of notice

(2) The notice of appeal may be in a form prescribed by the Minister.

Notification of decision

(3) The Minister shall notify the appellant, in writing, of the decision within thirty days of receipt of the notice of appeal.

Powers of Minister

(4) The Minister may dismiss the appeal, allow the appeal or make any decision or order the administrator could have made.

Implementation of decision

(5) The administrator and the appellant shall take such action as is necessary to implement the decision of the Minister disposing of the appeal. 1994-95, c. 1, s. 137.

Appeal to Supreme Court

138 (1) Subject to subsection (2), a person aggrieved by

(a) a regulation;

(b) a decision of the Minister pursuant to Section 137;

(c) a decision of the Minister respecting the granting or refusal of a certificate or an approval;

(d) a decision of the Minister respecting the terms or conditions of a certificate or an approval;

(e) a decision of the Minister respecting the amendment, addition or deletion of terms and conditions of a certificate or an approval;

(f) a decision of the Minister respecting the cancellation or suspension of a certificate or an approval; or

(g) an order,

may, within thirty days of the decision or order, appeal on a question of law or on a question of fact, or on a question of law and fact, to a judge of the Supreme Court, and the decision of that court is final and binding on the Minister and the appellant, and the Minister and the appellant shall take such action as may be necessary to implement the decision.

Application of subsection (1)

(2) For greater certainty, a decision of the Minister to approve or reject an undertaking registered under Part IV may not be appealed pursuant to subsection (1).

Judge may consider protection of the environment

(3) The judge on the hearing of an appeal may consider and hear evidence as to whether or not the matter that aggrieves the appellant is necessary to provide for the preservation and protection of the environment.

Time period for commencing appeal

(4) An appeal pursuant to this Part shall be commenced within thirty days of the date of the decision or the date of the order referred to in subsection (1).

Compliance not suspended

(5) The initiation of an appeal pursuant to this Part does not suspend the operation of any act or omission appealed from, including the requirement to comply with an order under Part XIII, pending the disposition of the appeal.

Decision of court final

(6) The decision of the court under subsection (1) is final and there is no further appeal to the Nova Scotia Court of Appeal. 1994-95, c. 1, s. 138.

Technical irregularity

139 An appeal in connection with any matter under this Act shall be dismissed by the Supreme Court if the sole ground for relief established on the appeal is a defect in form or a technical irregularity. 1994-95, c. 1, s. 139.

Regulations

140 (1) The Governor in Council may make regulations respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 140.

PART XV

CIVIL REMEDIES

Other civil remedies unaffected

141 No civil remedy for an act or omission is suspended or affected by reason only that the act or omission is an offence under this Act or gives rise to a civil remedy under this Act, and nothing in this Act shall be construed so as to repeal, remove or reduce any remedy available to any person under any enactment, at common law or under any Act of Parliament or of a provincial legislature. 1994-95, c. 1, s. 141.

Civil cause of action

142 Where a person is convicted of an offence under this Act, the conviction is *prima facie* evidence of negligence and any person who suffers loss or damage as a result of the conduct that constituted the offence may, in a court of competent jurisdiction, sue for an amount equal to the reason-

ably foreseeable loss or damage proved to have been suffered as a result of the conduct that constituted the offence. 1994-95, c. 1, s. 142.

Protection from liability

143 Notwithstanding anything contained in this Act, no action for damages may be commenced or maintained and no cause of action lies against

(a) an employee, as defined in the *Civil Service Act*, who is

(i) under the direction of the Minister,

(ii) acting under the direction of an employee referred to in subclause (i), or

(iii) acting pursuant to a delegation pursuant to Part II;

(b) an agent of the Government, including an emergency responder;

(c) an employee or agent of a Government agency, a municipality or the Government of Canada, any department or agency of that Government, or any person if there has been a delegation pursuant to Part II;

(d) an employee or agent of a Government agency or a municipality, or any person if there has been a transfer of administration pursuant to Part II;

(e) a municipality, or a board or commission if there has been a delegation or transfer of administration pursuant to Part II; or

(f) a person who has been retained or employed to serve on any board, advisory or *ad hoc* committee, or as a Corps leader under this Act,

if the action arises out of any act or omission of that person that occurs while that person is carrying out duties or exercising powers pursuant to this Act in good faith and, without restricting the generality of the foregoing, no person referred to in this Section is liable for damage caused by a system of inspection or the manner in which inspections are to be performed or the frequency, infrequency or absence of inspections. 1994-95, c. 1, s. 143.

Recovery of costs by Government

144 The Government may recover in debt either in an action or as prescribed in this Act or the regulations against any person who is convicted of an offence under this Act the costs and expenses incurred by the Government

(a) in responding to any matter related to the offence; and

(b) in carrying out or causing to be carried out any preventive or remedial action made necessary by the act or omission that constituted the offence. 1994-95, c. 1, s. 144.

PART XVI

TRANSBOUNDARY POLLUTION

Interpretation of Part

145 In this Part,

(a) "person" means an individual, corporation, business trust, estate, trust, partnership, association, joint venture, government in its private or public capacity, governmental subdivision or agency, or any other legal entity;

(b) "reciprocating jurisdiction" means a state of the United States of America, the District of Columbia, the Commonwealth of Puerto Rico, a territory or possession of the United States of America or a province of Canada that has enacted this Act or provides substantially equivalent access to its courts and administrative agencies. 1994-95, c. 1, s. 145.

Access to Nova Scotia courts

146 An action or other proceeding for injury or threatened injury to property or person in a reciprocating jurisdiction caused by pollution originating, or that may originate, in the Province may be brought in the Province. 1994-95, c. 1, s. 146.

Pollution originating in Nova Scotia

147 A person who suffers or is threatened with injury to the person or the person's property in a reciprocating jurisdiction caused by pollution originating, or that may originate, in the Province has the same rights to relief with respect to the injury or threatened injury, and may enforce those rights in the Province, as if the injury or threatened injury occurred in the Province. 1994-95, c. 1, s. 147.

Applicable law

148 The law to be applied in an action or proceeding brought pursuant to this Part, including what constitutes "pollution", is the law of the Province excluding choice of law rules. 1994-95, c. 1, s. 148.

Rights not superior

149 This Part does not accord a person injured or threatened with injury in a reciprocating jurisdiction any rights superior to those that the person would have if injured or threatened with injury in the Province. 1994-95, c. 1, s. 149.

Preservation of existing rights

150 The right provided in this Part is in addition to and not in derogation of any other rights. 1994-95, c. 1, s. 150.

Act binds Crown

151 This Part binds Her Majesty in right of the Province only to the extent that Her Majesty would be bound if the person were injured or threatened with injury in the Province. 1994-95, c. 1; s. 151.

Reciprocating jurisdiction

152 Notwithstanding the definition of "reciprocating jurisdiction", the Governor in Council may, by regulation, declare a jurisdiction to be a reciprocating jurisdiction for the purpose of this Part. 1994-95, c. 1, s. 152.

Uniformity of law

153 This Part shall be applied and construed to carry out its general purpose to make uniform the law with respect to the subject of this Part among jurisdictions enacting it. 1994-95, c. 1, s. 153.

Agreements

154 In addition to every power vested in the Minister, the Minister may, subject to the approval of the Governor in Council, enter into agreements with

(a) the government of a reciprocating jurisdiction;

(b) any person,

for the purpose of establishing committees or co-ordinating or implementing programs relating to transboundary pollution and may consult with and advise any such government or person with respect to policies and programs relating to transboundary pollution. 1994-95, c. 1, s. 154.

Regulations

155 (1) The Governor in Council may make regulations respecting any matter necessary or advisable to carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 155.

PART XVII

ENVIRONMENTAL INDUSTRIES, INNOVATIONS AND TECHNOLOGIES

Lead agency

156 (1) The Department is designated the lead agency of Government to promote the development and use of sustainable environmental industries, innovations and technologies.

Powers of Minister

(2) To fulfil the mandate prescribed in subsection (1), the Minister may

(a) establish a private-sector-driven management consortium that is committed to taking environmental industries, innovations and technologies from concept to commercialization;

(b) provide assistance to the consortium in the development and implementation of environmental-industry strategies;

(c) assist in the development and implementation of policies and programs to support the use and commercialization of sustainable environmental innovations, technologies and services;

(d) assist in the collection and dissemination of information to improve access to local and global markets;

(e) co-ordinate inter-departmental activities to achieve the mandate prescribed in subsection (1);

(f) harmonize strategies, programs and policies with other governments;

(g) enter into co-operative agreements;

(h) promote and host forums, trade shows and marketing workshops;

(i) assist in the delivery of government support to environmental industry in a direct, accessible, service-oriented and cost effective manner;

(j) promote such other activities as may be necessary to develop environmental industries and technologies.

Section prevails over other enactments

(3) For greater certainty, this Section shall prevail over every other enactment. 1994-95, c. 1, s. 156.

PART XVIII

PENALTIES AND PROSECUTIONS

Limitation period

157 A prosecution for an offence under this Act may not be commenced more than two years after the later of

(a) the date on which the offence was committed; or

(b) the date on which evidence of the offence first came to the attention of an inspector, an administrator or the Minister, whichever occurs first. 1994-95, c. 1, s. 157.

Offences

158 A person who

(a) knowingly provides false or misleading information pursuant to a requirement under this Act to provide information;

(b) provides false or misleading information pursuant to a requirement under this Act to provide information;

(c) does not provide information as required pursuant to this Act;

(d) hinders or obstructs an inspector or administrator who is exercising powers or carrying out duties, or attempting to do so, pursuant to this Act;

(e) knowingly contravenes a term or condition of an approval, a certificate of variance or a certificate of qualification;

(f) contravenes a term or condition of an approval, a certificate of variance or a certificate of qualification;

(g) knowingly contravenes an order;

(h) contravenes an order;

(i) contravenes Section 32, 50, 55, 59, 60, 62, 67, 68, 69, 71, 75, 76, 79, 83, 89, 115, 124 or 132; or

(j) otherwise contravenes this Act,

is guilty of an offence. 1994-95, c. 1, s. 158.

Penalty

159 (1) A person who commits an offence referred to in subsections 50(1), 67(1) or 68(1) or clauses 158(a), (e) or (g) is liable to a fine of not less than one thousand dollars and not more than one million dollars or to imprisonment for a period of not more than two years, or to both a fine and imprisonment.

Penalty

(2) A person who commits an offence referred to in Section 32, subsection 50(2), Sections 55, 59, 60 or 62, subsection 67(2), subsection 68(2), Sections 69, 71, 75, 76, 79, 83, 89, 115, 124 or 132 or clauses 158(b), (c), (d), (f) or (h) is liable to a fine of not more than one million dollars.

Penalty

(3) A person who commits an offence referred to in Section 99 is liable to a fine of not more than five thousand dollars.

Penalty

(4) A person who commits an offence referred to in any other provision of this Act is liable to a fine of not more than five hundred thousand dollars. 1994-95, c. 1, s. 159.

Due diligence defence

160 Unless otherwise provided in this Act, no person shall be convicted of an offence under this Act if the person establishes that the person

(a) exercised all due diligence to prevent the commission of the offence; or

(b) reasonably and honestly believed in the existence of facts that, if true, would render the conduct of that person innocent. 1994-95, c. 1, s. 160.

Additional fine

161 Where a person is convicted of an offence under this Act and the court is satisfied that, as a result of the commission of the offence, monetary benefits accrued to the offender, the court may order the offender to pay, in addition to a fine under Section 159, a fine in an amount equal to the estimation of the court of the amount of those monetary benefits. 1994-95, c. 1, s. 161.

Continuing offence

162 Where an offence under this Act is committed or continued on more than one day, the person who committed the offence is liable to be convicted for a separate offence for each day on which the offence is committed. 1994-95, c. 1, s. 162.

Offences by employees

163 In any prosecution for an offence under this Act, it is sufficient proof of the offence to establish that it was committed by an employee or agent of the accused, whether or not the employee or agent is identified or has been prosecuted for the offence, unless the accused establishes that the offence was committed without the knowledge or consent of the accused. 1994-95, c. 1, s. 163.

Liability of directors and officers

164 Where a corporation commits an offence under this Act or the regulations, any officer, director or agent of the corporation who directed, authorized, assented to, acquiesced in or participated in the violation of this Act or the regulations is guilty of the offence and is liable to the punishment provided for the offence, whether or not the corporation has been prosecuted. 1994-95, c. 1, s. 164.

Responsibility of lenders and trustees

165 (1) Notwithstanding anything contained in this Act or any other enactment respecting the protection or rehabilitation of the environment, receivers, receiver managers, trustees, executors or administrators of a person responsible, and their agents and employees, are not responsible for the rehabilitation of a contaminated site under any such provision beyond the value of the assets the persons are administering less the reasonable costs and fees of the administration, in relation to their position as receiver, receiver manager, trustee, executor or administrator of the assets of a person responsible, in respect of any adverse effect that occurred

(a) before the appointment of the receiver, receiver-manager, executor, administrator or trustee; or

(b) after appointment, except where the adverse effect occurred as a result of the failure of the receiver, receiver manager, trustee, executor or administrator to exercise due diligence.

Subsection (1) does not apply

(2) Subsection (1) does not apply to a person who had care, management or control, in whole or in part, of the site at the time the adverse effect occurred or imposed requirements on any person regarding the manner of treatment, disposal or handling of a substance and the control or requirements, in whole or in part, caused the site to become a contaminated site.

Secured creditor responsible for rehabilitation

(3) Notwithstanding anything contained in this Act or any other enactment, a secured creditor is responsible for rehabilitation at a contaminated site if

(a) the secured creditor at any time exercised care, management or control, in whole or in part, of the site or imposed requirements on any person regarding the manner of treatment, disposal or handling of a substance and the care, management or control or requirements, in whole or in part, caused the site to become a contaminated site; or

(b) subject to subsection (4), the secured creditor becomes the registered owner of the real property at the contaminated site unless an agreement is entered into pursuant to Section 89,

but a secured creditor is not responsible for rehabilitation where it acts primarily to protect its security interest, including, without restricting the generality of the foregoing, where the secured creditor

(c) participates only in purely financial matters related to the site;

(d) has the capacity or ability to influence any operation at the contaminated site in a way that would have the effect of causing or increasing contamination, but does not exercise that capacity or ability in such a way as to cause or increase contamination;

(e) imposes requirements on any person if the requirements do not have a reasonable probability of causing or increasing contamination at the site; or

(f) appoints a person to inspect or investigate a contaminated site to determine future steps or actions that the secured creditor might take.

Secured creditor not responsible

(4) Notwithstanding clause 3(b), a secured creditor is not responsible for the rehabilitation of a contaminated site beyond the value of the assets the secured creditor is administering.

No exemption from reporting or disclosure

(5) Nothing in this Section exempts a secured creditor, receiver, receiver manager, trustee, executor or administrator from any duty to report or make disclosure imposed by a provision of this Act. 1994-95, c. 1, s. 165.

Court orders relating to penalty

166 (1) Where a person is convicted of an offence under this Act, in addition to any other penalty that may be imposed pursuant to this Act, the court may, having regard to the nature of the offence and the circumstances surrounding its commission, make an order

(a) prohibiting the offender from doing anything that may result in the continuation or repetition of the offence;

(b) directing the offender to take any action the court considers appropriate to remedy or prevent any adverse effect that results or may result from the act or omission that constituted the offence;

(c) directing the offender to publish, in the prescribed manner and at the cost of the offender, the facts relating to the conviction;

(d) directing the offender to notify any person aggrieved or affected by the conduct of the offender, of the facts relating to the conviction, in the prescribed manner and at the cost of the offender;

(e) directing the offender to post a bond or pay money into court in an amount that will ensure compliance with any order made pursuant to this Section;

(f) on application to the court by the Minister within three years after the date of conviction, directing the offender to submit to the Minister any information with respect to the conduct of the offender that the court considers appropriate in the circumstances;

(g) directing the offender to compensate the Minister, in whole or in part, for the cost of any remedial or preventive action that was carried out or caused to be carried out by the Government and was made necessary by the act or omission that constituted the offence;

(h) directing the offender to perform community service;

(i) requiring the offender to comply with any other conditions the court considers appropriate in the circumstances for securing the good conduct of the offender and for preventing the offender from repeating the offence or committing other offences.

Publication of contravention

(2) Where a person contravenes an order made pursuant to clause (1)(c), the Minister may publish the facts in compliance with the order.

Costs are debt due the Government

(3) Where the court makes an order pursuant to clause (1)(g) or the Minister incurs publication costs pursuant to subsection (2), the costs constitute a debt due to the Government.

Coming into force of order

(4) An order made pursuant to subsection (1) comes into force on the day on which it is made or on any other day specified in the order and continues in force for the period specified in the order. 1994-95, c. 1, s. 166.

Variation of court order

167 (1) Where a court has made an order pursuant to Section 166, the court may, on application by the offender

or the Crown, require the offender to appear before it and, after hearing the offender and the Crown, may make an order

(a) changing the original order or the conditions specified in it;

(b) relieving the offender absolutely or partially from compliance with any or all of the order;

(c) reducing the period for which the original order is to remain in effect;

(d) extending the period for which the original order is to remain in effect for an additional period not to exceed one year.

Notice

(2) Before making an order pursuant to subsection (1), the court may direct that notice be given to any persons the court considers to be interested and the court may hear any such persons.

Leave of court

(3) Where an application made pursuant to this Section in respect of an offender has been heard by a court, no other application pursuant to this Section may be made with respect to the offender except with leave of the court. 1994-95, c. 1, s. 167.

Compensation for loss or damage to property

168 (1) Where a person is convicted of an offence under this Act, the court may, at the time sentence is imposed and on the application of a person aggrieved, order the offender to pay to the person an amount not to exceed five thousand dollars or such other amount as is prescribed by the regulations by way of satisfaction or compensation for loss of or damage to property suffered by that person as a result of the commission of the offence.

Filing and enforcement of order

(2) A person in whose favour an order is made pursuant to subsection (1) may file the order with the

prothonotary or clerk of the court and, on filing, the order may be enforced as if it were a judgment of the court in civil proceedings. 1994-95, c. 1, s. 168.

Recovery of costs for emergency measures

169 The costs of carrying out emergency measures are recoverable by the Minister, either by an action in debt or by a method prescribed in this Act or in the regulations, against the person who is responsible for the need to take the emergency measures. 1994-95, c. 1, s. 169.

Court order regarding hindrance or obstruction

170 Where a person hinders or obstructs an inspector or administrator contrary to clause 158(d), the Minister may apply to the Supreme Court for an order prohibiting that person from so hindering or obstructing, and the court may make any order it considers appropriate. 1994-95, c. 1, s. 170.

Regulations

171 (1) The Governor in Council may make regulations

(a) prescribing penalties in respect of offences created under this Act;

(b) respecting any matter necessary or advisable for the administration of a system of administrative penalties;

(c) respecting restitution orders under Section 168;

(d) respecting the liability of persons referred to in Section 165;

(e) generally, respecting any matter necessary or advisable to effectively carry out the intent and purpose of this Part.

Regulations Act

(2) The exercise by the Governor in Council of the authority contained in subsection (1) is regulations within the meaning of the *Regulations Act*. 1994-95, c. 1, s. 171.

PART XIX

DOCUMENTARY EVIDENCE

Documentary evidence

172 (1) In any proceeding under this Act,

(a) a report or other document of an analyst with respect to the results of an analysis purporting to be signed by an analyst;

(b) a document purporting to be signed by a person authorized to issue an approval, a certificate of qualification or a certificate of variance stating that on a specified day or during a specified period a person named in the document was or was not the holder of an approval, a certificate of qualification or a certificate of variance;

(c) a document setting out with reasonable particularity the conviction and sentence of a person for an offence under this Act purporting to be signed by

(i) the person who made the conviction, or

(ii) the prothonotary or clerk of the court in which the conviction was made;

and

(d) a statement purporting to be signed by an administrator setting out the day on which the administrator became aware of the subject-matter of any proceedings,

shall be admitted in evidence as *prima facie* proof of the contents of the document, certificate, report or statement, without proof of the signature or official character of the person signing the certificate, report or statement.

Admissibility

(2) A notice, approval, order, certificate of variance, certificate of qualification or consent purporting to be signed by the person authorized to issue, make or give it is admissible in evidence without proof of the signature or official character of the person signing it. 1994-95, c. 1, s. 172.

Appointment of analyst

173 (1) The Minister may appoint as an analyst any person who, in the opinion of the Minister, has the qualifications and experience to be so appointed.

Certificate of analyst as evidence

(2) No document of an analyst may be received in evidence unless the party intending to produce it has given to the party against whom it is intended to be produced reasonable notice of that intention together with a copy of the certificate.

Attendance of analyst

(3) The party against whom a document of an analyst is produced may, with the leave of the court, require the attendance of the analyst for the purpose of cross-examination. 1994-95, c. 1, s. 173.

PART XX

MISCELLANEOUS

Review of Act and regulations

174 The Minister shall appoint an advisory committee to initiate a comprehensive review of this Act and the regulations within five years of its coming into force and the committee shall submit to the Minister, within six months of initiating the review, a report that includes amendments, if any, recommended by the committee. 1994-95, c. 1, s. 174.

Transitional provisions

175 (1) Every permit, requirement, licence, approval, order, designation or certificate given, made or issued pursuant to one or more of the Acts listed in Section 176 that is subsisting and in force on December 31, 1994, is deemed to have been given, made or issued pursuant to this Act and continues in force until varied, cancelled, suspended or appealed in accordance with this Act.

Applicable appeal provisions

(2) Where a right of appeal existed in one or more of the Acts listed in Section 176 and an appeal arises after January 1, 1995, the appeal provisions in this Act apply. 1994-95, c. 1, s. 175.

Dangerous Goods and Hazardous-wastes Act repealed

176 (1) Chapter 118 of the Revised Statutes, 1989, the *Dangerous Goods and Hazardous-wastes Management Act*, is repealed.

Derelict Vehicles Removal Act repealed

(2) Chapter 128 of the Revised Statutes, 1989, the *Derelict Vehicles Removal Act*, is repealed.

Environmental Assessment Act repealed

(3) Chapter 149 of the Revised Statutes, 1989, the *Environmental Assessment Act*, is repealed.

Environmental Protection Act repealed

(4) Chapter 150 of the Revised Statutes, 1989, the *Environmental Protection Act*, is repealed.

Environmental Trust Act repealed

(5) Chapter 9 of the Acts of 1990, the *Environmental Trust Act*, is repealed.

Gasoline and Fuel Oil Licensing Act repealed

(6) Chapter 184 of the Revised Statutes, 1989, the *Gasoline and Fuel Oil Licensing Act*, is repealed.

Litter Abatement Act repealed

(7) Chapter 8 of the Acts of 1989, the *Litter Abatement Act*, is repealed.

Ozone Layer Protection Act repealed

(8) Chapter 331 of the Revised Statutes, 1989, the *Ozone Layer Protection Act*, is repealed.

Pest Control Products Act repealed

(9) Chapter 341 of the Revised Statutes, 1989, the *Pest Control Products (Nova Scotia) Act*, is repealed.

Recycling Act repealed

(10) Chapter 12 of the Acts of 1989, the *Recycling Act*, is repealed.

Salvage Yard Licensing Act repealed

(11) Chapter 410 of the Revised Statutes, 1989, the *Salvage Yard Licensing Act*, is repealed.

Smelting and Refining Encouragement Act repealed

(12) Chapter 431 of the Revised Statutes, 1989, the *Smelting and Refining Encouragement Act*, is repealed.

Transboundary Pollution Act repealed

(13) Chapter 15 of the Acts of 1993, the *Transboundary Pollution Act*, is repealed.

Water Act amended

(14) Section 2, subsection 3(1) and Sections 4 to 23 of Chapter 500 of the Revised Statutes, 1989, the *Water Act*, are repealed.

Well Drilling Act repealed

(15) Chapter 502 of the Revised Statutes, 1989, the *Well Drilling Act*, is repealed.

Youth Conservation Corps Act repealed

(16) Chapter 510 of the Revised Statutes, 1989, the *Youth Conservation Corps Act*, is repealed. 1994-95, c. 1, s. 176.

Effective date

177 This Act has effect on and after January 1, 1995. 1994-95, c. 1, s. 177.

SEWAGE TREATMENT PLANT EFFLUENT DISCHARGE POLICY

Legislative Authority

Environmental Protection Act, Water Act, Health Act.

Statement of Principles

This policy describes the level of treatment which will be required at new or upgraded municipal and private sewage treatment plants discharging into surface waters.

Application

This policy applies to any facility treating sanitary sewage regardless of the source.

(1) <u>Departments' Requirement of Municipal and Private Sewage Treatment Systems</u>

The Departments of the Environment and Health require that all municipalities and private sewage collection systems, treatment plants and outfalls be designed, constructed, located, operated and maintained so as to minimize pollution of the receiving waters and interference with other water uses.

(2) <u>Type of Treatment</u>

The Departments recommend the following types of treatment based on the size of the facility.

Size gallons/day	Type of Treatment
0-2000	on-site in ground systems
2000-50,000	By order of preference 1. in ground systems 2. seasonal discharge (i.e. lagoon) 3. STP* with land disposal (e.g. spray on forest) (*secondary 30/30 with no chlorination) 4. small STP based on Table 1. Criteria other than that specified in Table 1 may be accepted when based on a receiving water study
>50,000	Treatment based on study

(3) <u>Standard Level of Treatment</u>

The normal level of treatment shall be determined on the basis of the type of receiving water as documented in Table I.

(4) <u>Receiving Water Assessments</u>

The Departments recommend that a receiving water assessment be undertaken for all sewage treatment systems. A receiving water assessment is mandatory where the proposed sewage treatment system is 50,000 US gal/day or greater or where in the opinion of the Regional Manager or the Manager of Municipal Wastes and Resource Recovery it is required on the basis of the sensitivity of the receiving water.

A receiving water study shall follow the format prescribed in "Nova Scotia Standards and Guidelines Manual for the Collection, Treatment, and Disposal of Sanitary Sewage".

(5) <u>Deviations from the Standard Level of Treatment</u>

A relaxation of the standard level of treatment will only be allowed on a case-by-case basis and in accordance with the level of treatment indicated as necessary in the receiving water assessment.

Under no circumstances will the level of treatment required be less than primary treatment for facilities discharging into a coastal environment and not less than secondary treatment when discharging to fresh water or inland water systems.

5.2 <u>Higher than Standard Treatment</u>

Higher than standard levels of treatment up to and including no discharge to surface waters may be imposed based on a site specific receiving water assessment.

(6) <u>Review of Treatment Plants</u>

The level of treatment required for individual sewage treatment systems shall be subject to periodic review as necessary (especially when expansions of sewage treatment systems are contemplated).

More stringent treatment requirements may be imposed as found necessary by a site specific receiving water assessment.

(7) <u>Effluent Monitoring and Compliance</u>

A monitoring program, including regular sampling of sewage treatment system effluent and recording of flows will be undertaken by the systems operating authority and/or owner.

This monitoring program should be carried out in compliance with the "Policy with Respect to Sampling and Analysis Requirements for Municipal and Private Sewage Treatment Works".

(8) **Operator Certification**

To ensure the facilities are properly maintained and operated, all facilities shall be under the direct supervision of a certified operator.

(9) **Effluent Disinfection**

Effluent disinfection requirements will be established by the Nova Scotia Department of Health.

(10) **Deviation from Policies and Guidelines**

Any deviation or relaxation from the policies listed above must receive the approval of the Director of the Resource Management and Pollution Control Division and the Director of Public Health Engineering.

Table I

Point of Discharge	Fecal Coliform	Required Effluent Quality (A) (B) BOD_5/SS (mg/l)
Fresh water lakes low flow streams (5-10 times dilution)*	200/100 mls	5/5
Rivers & estuaries	1000/100 mls	20/20
Open coastline	5000/100 mls	30/30

(A) Effluent quality may be stipulated as a result of a receiving water assessment. Under no circumstances will less than secondary treatment be acceptable for a fresh water discharge or primary for a coastal discharge. (The receiving water study may indicate that no discharge is permissible).

(B) Nutrient removal may also be specifically required.

* <5 times dilution may require periods of no discharge.

Environment Canada / Environnement Canada

Appendix D

Prince Edward Island Legislation

New Nouveau Brunswick

LAWS OF PRINCE EDWARD ISLAND

Environmental Protection Act

R.S.P.E.I. 1988, Cap. E-9

Charlottetown

Printed and Published by Authority of
Gordon Babineau, Queen's Printer

CHAPTER E-9

ENVIRONMENTAL PROTECTION ACT

INTERPRETATION

1. In this Act Definitions

(a) "beach" means that portion of land between the ordinary or mean high water mark and the water's edge and includes a distance of three miles seaward of the mean high water mark, and may contain sand, gravel, rock, clay or other earthen material; beach

(b) "contaminant" includes any solid, liquid, gas, waste, odour, sound or a combination of any of them that is foreign to or in excess of the natural constituents of the environment into which it is being introduced and contaminant

(i) adversely affects the aesthetic, natural, physical, chemical or biological quality of the environment,

(ii) is or may be injurious to the health or safety of persons, or injurious or damaging to property or to plant or animal life, or

(iii) interferes with or is likely to interfere with the comfort, well-being, livelihood or enjoyment of life by a person;

(c) "Department" means the Department of Community and Cultural Affairs; Department

(d) "discharge" includes any drainage, deposit, release, spill, leak or emission; discharge

(e) "Division" means the Environmental Management Division; Division

(f) "environment" includes environment

(i) air, land and water,

(ii) plant and animal, including human, life,

and any feature, part, component, resource or element thereof;

(g) "environment officer" means a government employee so designated or appointed by the Minister; environment officer

(h) "environmental health" means those aspects of human health that are or can be affected by contaminants or changes in the environment; environmental health excavation pit

(i) "excavation pit" means any excavation in the ground opened for the purpose of searching for or removing clay, gravel, sand, shale, subsoil, topsoil, rock or any other surface or subterranean deposit, but does not include an excavation made within the boundaries of a highway;

litter

(j) "litter" as a verb, means to discard trash, garbage, rubbish or any other objects, and, as a noun, means trash, garbage or other objects so discarded;

Minister

(k) "Minister" means the Minister of Community and Cultural Affairs;

motor vehicle

(l) "motor vehicle" means a vehicle that is powered, drawn, propelled or driven by any means other than muscular power;

municipality

(m) "municipality" has the same meaning as in the *Municipalities Act* R.S.P.E.I. 1988, Cap. M-13 but includes the City of Charlottetown and the Town of Summerside;

person

(n) "person" includes a firm, corporation, association and a municipality;

sand dune

(o) "sand dune" means a wind or wave-deposited formation of vegetated or drifting wind-blown sand that lies generally parallel to and landward of the beach and between the upland limit of the beach and the foot of the most inland dune slope;

undertaking

(p) "undertaking" includes any construction, industry, operation or other project or any alteration or modification of any existing undertaking which will or may

(i) cause the emission or discharge of any contaminant into the environment,

(ii) have an effect on any unique, rare or endangered feature of the environment,

(iii) have a significant effect on the environment or necessitate further development which is likely to have a significant effect on the environment, or

(iv) cause public concern because of its real or perceived effect or potential effect on the environment,

but excludes all undertakings mentioned in sections 10, 12 and 13;

waste treatment system

(q) "waste treatment system" means any plant or installation used, or intended to be used to treat a contaminant prior to disposal on land, or into air or water and includes a sewerage system;

water

(r) "water" includes surface and ground water;

watercourse

(s) "watercourse" means the full width and length, including the bed and shore of every stream, river, estuary, lake, pond, creek, spring, ravine and gulch or any part thereof, whether the same contains water or not;

(t) "water supply system" means a water works for the collection, treatment, purification, storage, supply or distribution of water to water supply system

(i) five or more households, or

(ii) any business, public building or place of assembly;

(u) "well" means an artificial opening in the ground well

(i) from which water is obtained, or

(ii) made for the purpose of exploring for or obtaining water;

(v) "wetland" includes all freshwater and tidal areas that are or may be submerged or periodically submerged under fresh or salt water, including all bodies of water or areas commonly referred to as marshes, salt marshes, swamps, sloughs, bogs, beaches and flats. 1988,c.19,s.1. wetland

PURPOSE

2. The purpose of this Act is to manage, protect and enhance the environment. 1988,c.19,s.2. Purpose

ADMINISTRATION

3. (1) The Minister may take such action as he considers necessary in order to manage, protect or enhance the environment including Powers of Minister

(a) investigating and inquiring into any activity or situation that causes, appears to be the cause of, or may cause, contamination of the environment;

(b) coordinating the work and efforts of public departments, boards, commissions, agencies and interest groups in the province respecting management of the environment;

(c) preparing and publishing policies, strategies, objectives and standards;

(d) planning, designing, constructing, operating and maintaining works and undertakings;

(e) exercising exclusive control over

(i) the use or alteration of all surface, ground and shore waters and all beaches, sand dunes, and wetlands within the jurisdiction of the province,

(ii) the allocation of the use of water,

(iii) preservation of the environment within the jurisdiction of the province;

(f) entering into agreements;

(g) delegating any of his functions under this Act or the regulations;

(h) performing such other functions as may be assigned to him by the Lieutenant Governor in Council.

Environmental awareness program

(2) For the purpose of increasing environmental awareness in the province, the Minister may support and encourage the development of educational programs respecting environmental management. 1988,c.19,s.3.

Council

4. (1) The Lieutenant Governor in Council shall appoint an Environmental Advisory Council.

Functions

(2) The Council shall

(a) serve as an advisory board to the Minister;

(b) perform such functions as may be prescribed by regulations.

Composition

(3) The Council shall consist of not less than ten and not more than fifteen members appearing to the Minister to be representative of the public, including representation of the interests of agriculture, tourism, fisheries and industry and one member nominated by the Federation of Prince Edward Island Municipalities.

Powers of Cabinet

(4) The Lieutenant Governor in Council

(a) shall designate a chairman and vice-chairman of the Council from the membership thereof;

(b) may authorize payment of a daily allowance and expenses to members of the Council;

(c) may appoint local advisory boards for specified areas, or designate an existing board, commission, or other body as a local advisory board.

Term of office

(5) Members of the Council shall be appointed for a three year term and, subject to subsection (6), are eligible for reappointment.

Reappointment

(6) A person who has served two consecutive terms as a member of the Council is not, during the twelve months following the completion of his second term, eligible for reappointment to the Council.

Vacancies

(7) Where a member dies, retires or is removed from office, the Lieutenant Governor in Council may appoint a person to serve the unexpired term of that member.

Annual reports

(8) The Council shall submit annual reports to the Minister on matters dealt with by the Council including

(a) submissions received by the Council;

(b) investigations conducted by the Council;

(c) reports made by the Council;

(d) recommendations of the Council.

(9) Upon receiving an annual report from the Council, the Minister shall lay the report before the next ensuing session of the Legislature. Tabling report

(10) The Council may, with the approval of the Minister, engage the services of persons having special technical or other knowledge in connection with any public hearing, investigation or study under this Act. 1988,c.19,s.4. Specialist services

5. (1) The Lieutenant Governor in Council may establish an Environmental Coordinating Committee to be made up of the Deputy Ministers of such departments as he may determine and such other persons as he considers appropriate. Environmental Coordinating Committee

(2) The Deputy Minister of the Department shall be chairman of the Committee. Chairman

(3) The Committee Powers

(a) may inquire into any matter pertaining to the environment

(i) referred to it by the Minister, or

(ii) on its own initiative;

(b) may review any policies, programs or projects of government departments and agencies as they relate to the environment;

(c) shall make recommendations to the Minister respecting its inquiries and reviews under clauses (a) and (b). 1988,c.19,s.5.

6. (1) There is hereby established a division of the Department to be known as the Environmental Management Division. Environmental Management Division

(2) The functions of the Division are to manage, protect and enhance the quality of the environment and protect environmental health and it is responsible for Functions

(a) the administration and enforcement of this Act and the regulations and orders made hereunder;

(b) the development of policies and strategies;

(c) the establishment and maintenance of means to ensure public involvement in environmental decision making;

(d) research, monitoring, studies and investigations and the acquisition of knowledge it considers necessary to perform its functions;

(e) the provision of technical and analytical services for the environment and environmental health;

(f) the provision of information to the public with respect to the quality and use of the environment;

(g) such other matters relating to the environment as the Lieutenant Governor in Council may direct.

Environment officers

(3) The Minister may designate employees of the government as environment officers for the purposes of this Act. 1988,c.19,s.6.

Orders

7. (1) Where the Minister has reason to believe that an act or omission of a person, is or may be a contravention of this Act or the regulations or otherwise be a threat to the environment or environmental health, the Minister may, in writing and subject to such terms and conditions as may be specified in the order, order the person to

(a) permit inspection of the premises in question at a designated time;

(b) permit testing and sampling;

(c) cease the activity specified in the order;

(d) clean or repair, at that person's own cost, the area affected;

(e) restore the environment to a condition satisfactory to the Minister within a period specified in the order; or

(f) do any or all of those things specified in clauses (a) to (e).

Application to judge for order

(2) Where a person fails to comply with an order made under subsection (1) or the terms and conditions thereof, the Minister may, upon notice to the person, apply to a judge of the Supreme Court for an order authorizing an environment officer to enter the affected area and take such steps as he thinks necessary.

Application without notice

(3) Where the giving of notice pursuant to subsection (2) is not practicable, or where the Minister believes that any delay may result in irreparable or costly contamination to the environment, the Minister may make the application referred to in subsection (2) without notice to the person, in which case the judge therein may grant an order pursuant to subsection (2) subject to such terms and conditions as he thinks just.

Powers of entry

(4) Notwithstanding clause (1)(a), an environment officer, or any person authorized by the Minister, may at any time, without notice, enter upon and examine any land, air or water in the province, excluding structures erected thereon, where he believes on reasonable and probable grounds that a contravention of the Act or regulations is occurring or may occur.

Idem

(5) An environment officer acting pursuant to subsection (4) may be accompanied by any person authorized by the Minister.

Evidence

(6) Where the environment officer believes on reasonable and probable grounds that an offence against this Act or the regulations

has been or is being committed he may, upon having gained entry to the premises pursuant to this section, take or secure such evidence as he considers relevant to the prosecution of the offence. 1988,c.19,s.7.

8. (1) The Minister may, for purposes of this Act or the regulations, designate any person as an analyst, and the person so designated may, with respect to any sample analyzed by him, issue a certificate of analysis. Analysis

(2) A certificate of an analyst stating that he has analyzed or examined a sample submitted by an environment officer or other person authorized by the Minister and stating the results of his analysis or examination, is admissible in evidence in any legal proceeding or prosecution under this Act or the regulations, without proof of the signature or official character of the person appearing to have signed the certificate of analysis and, in the absence of any evidence to the contrary, is proof of the statements contained in the certificate of analysis. Certificate

(3) The party against whom a certificate of analysis is produced under subsection (1) may, with leave of the court, require the attendance of the analyst for purposes of cross-examination. 1988,c.19,s.8. Attendance of analyst in court

ENVIRONMENTAL IMPACT ASSESSMENT

9. (1) No person shall initiate any undertaking unless that person first files a written proposal with the Department and obtains from the Minister written approval to proceed with the proposed undertaking. Undertakings

(2) The Minister, in considering a proposal submitted pursuant to subsection (1), may Environmental impact information

(a) require the person submitting it to supply such additional information as the Minister considers necessary;

(b) require that person to carry out an environmental impact assessment and submit an environmental impact statement;

(c) notify the public of the proposal and provide opportunity for comment.

(3) An environmental assessment and environmental impact statement shall be in such form and have such content as the Minister may direct. Form and content

(4) The approval required by this section is in addition to any other requirement imposed by the province or a municipality. 1988,c.19,s.9. Saving

WATERCOURSES

Permit required for alteration of watercourse

10. No person shall, without a permit from the Minister, alter a watercourse, or wetland, or any part thereof, or water flow therein, in any manner including

(a) constructing a control dam, river diversion or drainage diversion;

(b) draining, pumping, dredging, excavating, or removing soil, mud, sand, gravel, aggregate of any kind, or rubbish from any watercourse or wetland;

(c) deliberately dumping, infilling, or depositing in any watercourse or on any wetland any soil, stones, sand, gravel, mud, rubbish, litter or material of any kind;

(d) erecting or placement of structures, driving of piles or placing of obstructions in any watercourse or any wetland. 1988,c.19,s.10.

Review

11. The Minister may appoint a watercourse alteration review committee to review applications for watercourse alteration permits and to advise the Minister on watercourse alteration and diversion projects. 1988,c.19,s.11.

WELLS

Wells

12. Except in accordance with the regulations, no person shall

(a) engage in the business of drilling wells;

(b) undertake the construction of a well; or

(c) undertake any operation incidental to the reconstruction or abandonment of a well. 1988,c.19,s.12.

WASTE TREATMENT AND WATER SUPPLY SYSTEMS

Approval required

13. (1) No person shall undertake the establishment of a waste treatment system or water supply system, or shall change any existing system, without first obtaining written approval from the Minister.

Plans and detailed information

(2) An application for approval pursuant to subsection (1) shall be supported by the plans and specifications of the waste treatment system or water supply system and the work to be undertaken, and such other information as the Minister may require.

Investigation and remedial action

(3) Where it appears to the Minister that any person has contravened subsection (1), the Minister may order an investigation of the violation and may order the person to take such action as the Minister considers necessary. 1988,c.19,s.13.

14. (1) Where the Minister is satisfied that for the purpose of protecting the environment or environmental health it is necessary to do so he may, by order, require that an area be served by a water supply system or waste treatment system. **Minister may order system**

(2) An order under subsection (1), shall be directed to the person causing or likely to cause the hazard to the environment or environmental health. 1988,c.19,s.14. ***Idem***

15. Where water in any existing water supply system is not fit for human consumption or any existing water supply system is inadequately maintained so as to affect public health, the Minister may order such alterations or additions as he considers necessary, to be made by the municipal authority or person operating the system and in such manner and within such time as he may direct. 1988,c.19,s.15. **Alterations**

16. Waste treatment and water supply systems shall at all times be maintained and operated in such manner and with such facilities as the Minister may direct. 1988,c.19,s.16. **Maintenance**

17. When the Minister finds it necessary that any public utility locate any portion of a waste treatment system or water supply system on private property and that no agreement can be reached with the owner, the Minister may order, subject to the approval of the Lieutenant Governor in Council, on such terms and conditions and subject to the payment of such compensation, if any, as may seem just, that the public utility have leave to enter upon the private property and there locate any portion of a system and have access thereto at all times for repairing, operating or maintaining the same. 1988,c.19,s.17. **Entry on private property**

18. (1) The Lieutenant Governor in Council may, by order, create a body to acquire, construct, establish, alter, extend, control, manage, maintain, or operate any waste treatment system or water supply system, and may constitute a body so created a body corporate for the purposes of the Act and may **Water and sewerage corporations**

(a) prescribe its name, composition and functions;

(b) prescribe the manner of appointment of its members and their terms of office and remuneration;

(c) prescribe the functions of the corporation; and

(d) exempt the corporation and any works operated by it in whole or in part from the provisions of the *Public Utilities Commission Act* R.S.P.E.I. 1988, Cap. P-33, and the *Water and Sewerage Act* R.S.P.E.I. 1988, Cap. W-2.

Powers

(2) A corporation constituted under subsection (1), or the Minister, may

(a) acquire, construct, establish, alter, extend, control, manage, and operate waste treatment systems and water supply systems;

(b) provide and supply water to a municipality or person;

(c) receive, treat, or dispose of sewage for a municipality or person;

(d) make agreements with a municipality or person with respect to the operation of a waste treatment system or water supply system, or the reception, treatment and disposal of sewage;

(e) acquire, alienate, hold, dispose of real or personal property;

(f) engage and pay personnel;

(g) assess, charge, and collect fees for services to a municipality or person;

(h) operate a waste treatment system or water supply system on behalf of government, municipality or person; and

(i) perform any function authorized by the Lieutenant Governor in Council.

Power to levy rates

(3) A corporation constituted under subsection (1) may levy rates in respect of water and sewerage services.

Maximum frontage upon which rate may be levied

(4) Rates may be levied by a corporation constituted under subsection (1) for water or sewerage services by means of frontage charges and where rates are so levied, the maximum frontage of any parcel of land in respect of which rates may be levied is five hundred feet if the parcel qualifies for a farm assessment under the *Real Property Assessment Act* R.S.P.E.I. 1988, Cap. R-4.

Lien

(5) Rates levied pursuant to subsection (3) constitute a lien on the real property on which the rate is levied until payment is made and that lien has priority over every claim, privilege or encumbrance of every person, except the Crown against that property. 1988,c.19,s.18.

Saving

19. The power vested in the Public Utilities Commission to set sewer and water rates is not affected by this Act except where otherwise provided under clause 18(1)(d). 1988,c.19,s.19.

DISCHARGE OF CONTAMINANTS

Spills

20. Except as permitted by the regulations or by the Minister in writing, no person shall discharge, or cause or permit to be discharged, any contaminant into the environment. 1988,c.19,s.20.

21. Every person who, without permission under section 20, discharges, or causes or permits to be discharged, a contaminant into the environment, or, who owns or has control of a contaminant which is discharged into the environment, shall forthwith notify the Department and take such remedial measures as the Minister may direct. 1988,c.19,s.21. **Notice and remedial measures**

SAND DUNES AND BEACHES

22. No person shall, without written permission of the Minister, operate a motor vehicle on a sand dune or carry out any other activity that may **Operation of motor vehicles prohibited**

(a) interfere with the natural supply or movement of sand to or within a sand dune system; or

(b) alter, remove or destroy natural stabilizing features, including dune vegetation. 1988,c.19,s.22.

23. (1) No person shall operate a motor vehicle on a beach without written permission by the Minister. ***Idem***

(2) Subsection (1) does not apply to activity related to the legal harvesting of a fishery resource or the legal removal of beach materials. 1988,c.19,s.23. **Exception**

LITTERING

24. No person shall litter **Litter**

(a) upon any land that is owned by another person;

(b) upon any land that is vested in the Crown;

(c) into or upon any water. 1988,c.19,s.24.

REGULATIONS

25. (1) The Lieutenant Governor in Council may make regulations for the enhancement and protection of the environment, and in particular, **Regulations**

(a) respecting environmental impact assessments and ensuring specific opportunity for public involvement in the screening and assessment of undertakings;

(b) establishing environmental quality standards for part or all of the province;

(c) respecting the procedures to be followed with regard to applications for licenses or permits required under the Act or the regulations and the issuance, refusal, revocation and suspension of licenses or permits and respecting appeals;

(d) respecting fees payable on application for licenses, permits or inspections;

(e) respecting the design, location, configuration, construction, adaption, alteration, operation, maintenance and installation of undertakings;

(f) respecting plumbing standards, prescribing the use and application of the plumbing standards, and requiring a person to obtain a permit before plumbing is installed or altered;

(g) respecting the design, construction, adaption, alteration, operation, maintenance, and installation of systems, processes or works to abate or control contamination or other environmental damage, including waste disposal and landfill sites, waste treatment systems and incinerators;

(h) respecting the method of collection, treatment, distribution and disposal of contaminants;

(i) prescribing limits, terms and conditions on the release of contaminants and the prohibition of release of contaminants from any undertaking;

(j) regulating or prohibiting the use of any product, container, including beverage containers, or other substance that may adversely affect the environment;

(k) respecting wells and attachments thereto and the licensing of well drillers;

(l) regulating, controlling, prohibiting, directing or providing for the withdrawal, use, storage and handling of water from any natural or artificial source;

(m) regulating, controlling, prohibiting, or providing for alteration of any kind of the natural features of any watercourse, beach, sand dune or wetland, including draining, diverting, dredging, infilling, excavating or removing of soil, mud, sand, gravel, rubbish or other material of any kind;

(n) requiring an environmental permit for the construction or operation of certain undertakings, and the issuance or withdrawal of the permits;

(o) respecting the methods of analyzing samples and prescribing the equipment or apparatus or structures to be used for taking samples;

(p) respecting chemical or petroleum storage tank systems;

(q) regulating the disposal of litter;

(r) prescribing forms;

(s) respecting wastewater emissions;

(t) respecting emissions into the air;

(u) respecting excavation pits;

(v) controlling, restricting or prohibiting any act for the purpose of abating noise or controlling noise levels.

Adoption of codes

(2) A regulation made under subsection (1) may adopt by reference in whole or in part, with such changes as the Minister considers necessary, any code or standard, or any regulation made by any other government in Canada or recognized technical organization, and may require compliance with any code, standard or regulation so adopted. 1988,c.19,s.25.

GENERAL

False information

26. No person shall knowingly give false information in any application, return, or statement made to the Minister, an environment officer, or any employee of the Department, in respect of any matter under this Act or the regulations. 1988,c.19,s.26.

Obstruction

27. No person shall prevent or obstruct any person lawfully carrying on the enforcement of this Act or the regulations. 1988,c.19,s.27.

Variation of authority

28. The Minister may, by order, with respect to any authority or approval to be granted or already granted under this Act

(a) revoke the authority or approval; or

(b) impose or alter such terms and conditions as he considers necessary in the public interest. 1988,c.19,s.28.

Evidence

29. Any order issued pursuant to this Act or the regulations

(a) shall be personally served on the person to whom it is directed; and

(b) shall be *prima facie* proof in proceedings in any court not only that the order was legally made, but also that every administrative prerequisite necessary to enable the making of the order was done and satisfied, and no further proof than the mere production of the original order or a copy thereof certified by the Minister or his authorized representative, is necessary. 1988,c.19,s.29.

Liability of officers

30. The Minister, environment officers, or any other persons acting under the authority of this Act or the regulations are not personally liable for any loss or damage suffered by any person by reason of anything in good faith done or omitted to be done in the purported exercise of any powers given by this Act or the regulations. 1988,c.19,s.30.

Injunction

31. (1) In addition to any other remedy provided by law, any contravention or violation of this Act or the regulations may be restrained by injunction at the instance of the Minister upon application to the Supreme Court, and the court shall grant the injunction upon being satisfied that the granting of the injunction is advisable to ensure compliance with this Act or the regulations.

Form

(2) An injunction granted pursuant to subsection (1) may be prohibitive or mandatory in nature, and where mandatory, may require the taking of action to clean or restore the environment. 1988,c.19,s.31.

Offence and penalty

32. (1) Any person who contravenes or violates any provision of the Act or the regulations or fails to comply with any term or condition or other provision of any order, license, approval, or permit issued by the Minister or an environmental officer made pursuant to this Act or the regulations, is guilty of an offence and is liable on summary conviction

(a) in the case of an individual, to a fine of not less than $200 and not more than $10,000 or to imprisonment for ninety days or both;

(b) in the case of a corporation, to a fine of not less than $1,000 and not more than $50,000;

(c) in either case, to pay such restitution as the judge thinks fit to any person aggrieved by the contravention or violation.

Personal liability of corporate officers

(2) Any officer, director or agent of a corporation who directed, authorized, assented to, acquiesced in or participated in the commission of an offence by that corporation is a party to and guilty of the offence and is liable on conviction to the punishment set out in clause (1)(a).

Continuing offence

(3) Where a contravention or violation of any provision of the Act or the regulations, or a failure to comply with an order, license, permit, approval or instruction of the Minister or an environment officer, or any terms or conditions therein, continues for more than one day, the offender is guilty of a separate offence for each day that the contravention, violation, or failure continues.

Limitation period

(4) Proceedings in respect to an offence under this Act or the regulations may be instituted at any time within two years after the time when the subject matter of the proceedings arose. 1988,c.19,s.32.

Remedial action

33. Where contamination or damage of any kind is caused by failure of any person to comply with the provisions of this Act or the regulations, the Minister may

(a) take action to remedy the contamination or damage; and

(b) recover the costs and expenses of such remedial action by action against such person in the Supreme Court. 1988,c.19,s.33.

LAWS OF PRINCE EDWARD ISLAND

An Act to Amend the Environmental Protection Act

Charlottetown

Printed and Published by Authority of
Gordon Babineau, Queen's Printer

1989

CHAPTER 1

An Act to Amend the Environmental Protection Act

(Assented to May 2nd, 1989)

BE IT ENACTED by the Lieutenant Governor and the Legislative Assembly of the Province of Prince Edward Island as follows:

1. Section 32 of the *Environmental Protection Act* R.S.P.E.I. 1974, Cap. E-8.2 is repealed and the following is substituted therefor:

32. (1) The contravention of or failure to comply with any term or condition or other provision of any order, license, approval or permit issued by the Minister or an environmental officer under this Act or the regulations constitutes a violation of this Act. Violation

(2) Any person who contravenes or violates any provision of the Act or the regulations is guilty of an offence and is liable on summary conviction Offence and penalty

(a) in the case of an individual, to a fine of not less than $200 and not more than $10,000 or to imprisonment for ninety days, or both;

(b) in the case of a corporation, to a fine of not less than $1,000 and not more than $50,000;

(c) in either case, to pay such restitution as the judge thinks fit to any person aggrieved by the contravention or violation.

(3) Any officer, director or agent of a corporation who directed, authorized, assented to, acquiesced in or participated in the commission of an offence by that corporation is a party to and guilty of the offence and is liable on conviction to the punishment set out in clause (2)(a). Personal liability of corporate officers

(4) Where a contravention or violation of any provision of the Act or the regulations continues for more than one day, the offender is guilty of a separate offence for each day that the contravention or violation continues. Continuing offence

(5) Proceedings in respect to an offence under this Act or the regulations may be instituted at any time within two years after the time when the subject matter of the proceedings arose. Limitation period

LAWS OF PRINCE EDWARD ISLAND

An Act to Amend the Environmental Protection Act

Charlottetown

Printed and Published by Authority of
P. Joseph Murphy, Acting Queen's Printer

1991

CHAPTER 10

An Act to Amend the Environmental Protection Act

(Assented to May 9, 1991)

BE IT ENACTED by the Lieutenant Governor and the Legislative Assembly of the Province of Prince Edward Island as follows:

1. Section 1 of the *Environmental Protection Act* R.S.P.E.I. 1988, Cap. E-9 is amended

(a) by the repeal of clauses (a) and (b) and the substitution therefor of the following:

(a) "beach" includes that portion of the shoreline land commencing at — beach

(i) the base of the bank or slope where the terrestrial land meets the shoreline, or

(ii) the seaward extremity of a sand dune,

as may be relevant in the circumstances and extending seaward a distance of three miles, and containing water, sand, gravel, rock, shale or other earthen material;

(b) "contaminant" includes any solid, liquid, gas, waste, odour, vibration, radiation, sound, or a combination of them — contaminant

(i) which is foreign to or in excess of the natural constituents of the environment into which it is being introduced,

(ii) which will or may adversely affect, either directly or indirectly, the natural, physical, chemical, or biological quality of the environment,

(iii) which is or may be injurious to the health or safety of a person or be damaging to property or to plant or animal life,

(iv) which interferes with or is likely to interfere with the comfort, well-being, livelihood, or enjoyment of life of a person, or

(v) which is declared by regulation to be a contaminant.

(b) by the repeal of clause (n);

(c) by the insertion of the following as clause (o.1):

(o.1) "source of contaminant" means anything that discharges a contaminant into the environment; — source of contaminant

(d) by the repeal of clauses (r) and (s) and the substitution therefor of the following:

water

(r) "water" includes liquid and frozen surface and ground water;

watercourse

(s) "watercourse" means the full width and length, including the bed, shore, bank, and adjacent land, within 10 metres of the high water mark of every stream, river, estuary, lake, pond, creek, spring, ravine, and gulch, or any part thereof, whether the same contains water or not;

(e) by the repeal of subclause (t)(ii) and the substitution therefor of the following:

(ii) a public building or place of assembly.

2. Subsection 6(2) of the said Act is repealed.

3. Section 7 of the said Act is repealed and the following is substituted therefor:

Application

7. (1) This section applies to natural persons.

Orders

(2) Where the Minister believes, on reasonable and probable grounds,

(a) that a contaminant has been, is being, or is going to be, discharged into the environment, or, otherwise, that an act or omission of a natural person is or may be a contravention of this Act or the regulations or otherwise be a threat to the environment or environmental health; and

(b) that it is necessary or advisable for the protection of the environment or the prevention or control of danger to human life or health or of damage to property,

he may issue an order to

(c) the natural person who is the owner or previous owner of the source of the contaminant;

(d) the natural person who is or was in occupation of the source of the contaminant;

(e) the natural person who has, or had, the charge, management, or control of the source of the contaminant;

(f) the natural person whose act or omission is or may be a contravention of this Act or the regulations or otherwise be a threat to the environment or environmental health; or

(g) one or more of the above persons.

Terms, conditions and requirements

(3) An order issued pursuant to subsection (2) may specify terms and conditions, including time limits, and may require the natural person to whom it is directed, at his own cost, if any, to

(a) permit inspection;

(b) permit testing and sampling;

(c) carry out inspections, testing, and sampling, including professional hydro-geological or engineering investigations, to determine the extent and effects of the contaminant;

(d) cease an activity specified in the order;

(e) clean, repair, and restore the area affected by the contaminant to the extent indicated in the order or, otherwise, to the satisfaction of the Minister;

(f) take specified action to prevent or avoid danger to human life or health or damage to property;

(g) submit a written report with respect to his activities pursuant to clauses (c), (e) and (f);

(h) do any or all of those things specified in clauses (a) to (g).

(4) For the purpose of investigating threats to the environment or environmental health or otherwise ensuring compliance with this Act or the regulations, an environment officer, or a peace officer may **Powers of environment officers**

(a) subject to subsections (5), (6) and (7), at any reasonable time, enter and inspect any place in which he believes on reasonable grounds there is a contaminant or any other thing in respect of which this Act or the regulations apply;

(b) examine any contaminant or suspected contaminant, or any other thing in respect of which this Act or the regulations apply and take samples of it;

(c) require any natural person to produce for inspection or copying, in whole or in part, any record or other document that the environment officer or peace officer believes on reasonable grounds contains any information relevant to the administration of this Act or the regulations; and

(d) conduct any tests or analyses or take any measurements.

(5) An environment officer or a peace officer may not enter a dwelling-place except with the consent of the occupant of the dwelling-place or under the authority of a warrant. **Entry to dwelling-place**

(6) Where on *ex parte* application a justice is satisfied by information on oath that **Authority to issue warrant**

(a) the conditions for entry described in subsection (4) exist in relation to a dwelling-place;

(b) entry to the dwelling-place is necessary for any purpose relating to the administration of this Act or the regulations; and

(c) entry to the dwelling-place has been refused or there are reasonable grounds to believe that entry will be refused,

the justice may at any time sign and issue a warrant authorizing the environment or peace officer named in the warrant to enter the dwelling-place, subject to any conditions that may be specified in the warrant.

Use of force

(7) An environment officer who executes a warrant shall not use force unless he is accompanied by a peace officer and the use of force is specifically authorized in the warrant.

Seizure

(8) Where an environment officer or a peace officer believes on reasonable grounds that an offence under this Act or the regulations has been committed, he may seize and detain any thing

(a) by means of or in relation to which he believes on reasonable grounds the offence was committed; or

(b) that he believes on reasonable grounds will afford evidence in respect of the commission of an offence under this Act or the regulations.

Warrant

(9) Where on *ex parte* application a justice is satisfied by information on oath that there are reasonable grounds to believe that there is in any place any thing

(a) by means of or in relation to which an offence under this Act or the regulations has been committed or is suspected of having been committed; or

(b) that there are reasonable grounds to believe will afford evidence in respect of the commission of an offence under this Act or the regulations,

the justice may at any time sign and issue a warrant authorizing the environment officer or peace officer named in the warrant to enter and search the place for the thing and, subject to any conditions that may be specified in the warrant, to seize and detain it.

Things liable to seizure

(10) The environment officer or peace officer who executes a warrant may exercise the powers described in subsection (4) and may seize and detain, in addition to any thing mentioned in the warrant, any other thing

(a) by means of or in relation to which the inspector believes on reasonable grounds an offence under this Act or regulations has been committed; or

(b) that the inspector believes on reasonable grounds will afford evidence in respect of the commission of an offence under this Act.

Execution of warrant

(11) A warrant shall be executed by day unless the justice authorizes its execution by night.

(12) A peace officer or an environment officer may exercise any of the powers referred to in subsections (9) and (10) without a warrant if the conditions for obtaining a warrant exist, but, by reason of exigent circumstances, it would not be practical to obtain a warrant.

Where warrant not necessary

(13) A peace officer or environment officer who seizes and detains a thing under this Act or the regulations shall, as soon as is practicable, advise the owner of the thing or the natural person having possession, care, or control of it at the time of its seizure, of the reason for the seizure.

Notice of reason for seizure

(14) A peace officer or environment officer who seizes and detains a thing under this Act or the regulations or any person designated by such officer, may

Storage, removal etc.

(a) store, treat, or dispose of the thing at the place where it was seized or move it to any other place for storage, treatment, or disposition; or

(b) recommend to the Minister that an order be issued pursuant to subsection (2) directing the natural person who owns or had the possession, care, or control of it at the time of its seizure, to store, treat, or dispose of it or move it to any other place and store, treat, or dispose of it, in which case the Minister may make such an order.

(15) Subject to subsection (16), a thing that is seized and detained under this Act shall not be detained after

Detention

(a) a determination by a peace officer or an environment officer that the thing or use of it is in conformity with the Act or regulations or will not afford evidence in respect of a commission of an offence under this Act or the regulations; or

(b) the expiration of one hundred and eighty days after the day of seizure,

unless before that time proceedings are instituted in relation to the thing, in which case the thing may be detained until the proceedings are finally concluded.

(16) Where the Minister believes on reasonable and probable grounds that a thing is a threat to the environment or environmental health, or where proceedings mentioned in subsection (15) are instituted within the time provided in that subsection, and at the final conclusion thereat the court orders the forfeiture of the thing that was seized and detained, the Minister may dispose of the thing as he sees fit.

Disposal of forfeited things

(17) Where subsection (16) does not apply, the thing shall be returned to the natural person who owns the thing or who had the possession, care or control of it at the time of its seizure.

Return of things seized where no forfeiture ordered

Samples, disposition of

(18) A sample taken under this Act or regulations may be disposed of in such manner as the Minister considers appropriate.

Liability

(19) The Crown, nor any agent or employee thereof is not liable for any costs, loss or damage, resulting from the exercise in good faith of powers pursuant to this Act or the regulations.

Order to bind successors in title

(20) An order issued pursuant to subsection (2) shall run with the land and shall be binding upon the successor or assignee of the natural person to whom it is directed.

Copies of order on request

(21) Upon the written request of any person as to whether an order has been issued against a particular person, the Minister shall provide the information and if an order has been issued, make a copy available.

Application

7.1 (1) This section applies to corporations.

Orders

(2) Where the Minister believes, on reasonable and probable grounds,

(a) that a contaminant has been, is being, or is going to be, discharged into the environment, or, otherwise, that an act or omission of a corporation is or may be a contravention of this Act or the regulations or otherwise be a threat to the environment or environmental health; and

(b) that it is necessary or advisable for the protection of the environment or the prevention or control of danger to human life or health or of damage to property,

he may issue an order to

(c) the corporation which is the owner or previous owner of the source of the contaminant;

(d) the corporation which is or was in occupation of the source of the contaminant;

(e) the corporation which has, or had, the charge, management, or control of the source of the contaminant;

(f) the corporation whose act or omission is or may be a contravention of this Act or the regulations or otherwise be a threat to the environment or environmental health; or

(g) one or more of the above persons.

Terms, conditions and requirements

(3) An order issued pursuant to subsection (2) may specify terms and conditions, including time limits, and may require the corporation to whom it is directed, at its own cost, if any, to

(a) permit inspection;

(b) permit testing and sampling;

(c) carry out inspections, testing, and sampling, including professional hydro-geological or engineering investigations, to determine the extent and effects of the contaminant;

(d) cease an activity specified in the order;

(e) clean, repair, and restore the area affected by the contaminant to the extent indicated in the order or, otherwise, to the satisfaction of the Minister;

(f) take specified action to prevent or avoid danger to human life or health or damage to property;

(g) submit a written report with respect to its activities pursuant to clauses (c), (e) and (f);

(h) do any or all of those things specified in clauses (a) to (g).

Powers of environment officers

(4) For the purpose of investigating threats to the environment or environmental health or otherwise ensuring compliance with this Act or the regulations, an environment officer, or a peace officer may,

(a) subject to subsections (5), (6) and (7), at any reasonable time, enter and inspect any place in which he believes on reasonable grounds there is a contaminant or any other thing in respect of which this Act or the regulations apply;

(b) examine any contaminant or suspected contaminant, or any other thing in respect of which this Act or the regulations apply and take samples of it;

(c) require any corporation to produce for inspection or copying, in whole or in part, any record or other document that the environment officer or peace officer believes on reasonable grounds contains any information relevant to the administration of this Act or the regulations; and

(d) conduct any tests or analyses or take any measurements.

Entry to dwelling-place

(5) An environment officer or a peace officer may not enter a dwelling-place except with the consent of the occupant of the dwelling-place or under the authority of a warrant.

Authority to issue warrant

(6) Where on *ex parte* application a justice is satisfied by information on oath that

(a) the conditions for entry described in subsection (4) exist in relation to a dwelling-place;

(b) entry to the dwelling-place is necessary for any purpose relating to the administration of this Act or the regulations; and

(c) entry to the dwelling-place has been refused or there are reasonable grounds to believe that entry will be refused, the justice may at any time sign and issue a warrant authorizing the environment or peace officer named in the warrant to enter the dwelling-place, subject to any conditions that may be specified in the warrant.

Use of force

(7) An environment officer who executes a warrant shall not use force unless he is accompanied by a peace officer and the use of force is specifically authorized in the warrant.

Seizure

(8) Where an environment officer or a peace officer believes on reasonable grounds that an offence under this Act or the regulations has been committed, he may seize and detain any thing

(a) by means of or in relation to which he believes on reasonable grounds the offence was committed; or

(b) that he believes on reasonable grounds will afford evidence in respect of the commission of an offence under this Act or the regulations.

Warrant

(9) Where on *ex parte* application a justice is satisfied by information on oath that there are reasonable grounds to believe that there is in any place any thing

(a) by means of or in relation to which an offence under this Act or the regulations has been committed or is suspected of having been committed; or

(b) that there are reasonable grounds to believe will afford evidence in respect of the commission of an offence under this Act or the regulations,

the justice may at any time sign and issue a warrant authorizing the environment officer or peace officer named in the warrant to enter and search the place for the thing and, subject to any conditions that may be specified in the warrant, to seize and detain it.

Things liable to seizure

(10) The environment officer or peace officer who executes a warrant may exercise the powers described in subsection (4) and may seize and detain, in addition to any thing mentioned in the warrant, any other thing

(a) by means of or in relation to which the inspector believes on reasonable grounds an offence under this Act or regulations has been committed; or

(b) that the inspector believes on reasonable grounds will afford evidence in respect of the commission of an offence under this Act.

Execution of warrant

(11) A warrant shall be executed by day unless the justice authorizes its execution by night.

(12) A peace officer or an environment officer may exercise any of the powers referred to in subsections (9) and (10) without a warrant if the conditions for obtaining a warrant exist, but, by reason of exigent circumstances, it would not be practical to obtain a warrant. **Where warrant not necessary**

(13) A peace officer or environment officer who seizes and detains a thing under this Act or the regulations shall, as soon as is practicable, advise the owner of the thing or the corporation having possession, care, or control of it at the time of its seizure, of the reason for the seizure. **Notice of reason for seizure**

(14) A peace officer or environment officer who seizes and detains a thing under this Act or the regulations or any person designated by such officer, may **Storage, removal etc.**

(a) store, treat, or dispose of the thing at the place where it was seized or move it to any other place for storage, treatment, or disposition; or

(b) recommend to the Minister that an order be issued pursuant to subsection (2) directing the corporation which owns or had the possession, care, or control of it at the time of its seizure, to store, treat, or dispose of it or move it to any other place and store, treat, or dispose of it, in which case the Minister may make such an order.

(15) Subject to subsection (16), a thing that is seized and detained under this Act shall not be detained after **Detention**

(a) a determination by a peace officer or an environment officer that the thing or use of it is in conformity with the Act or regulations or will not afford evidence in respect of a commission of an offence under this Act or the regulations; or

(b) the expiration of one hundred and eighty days after the day of seizure,

unless before that time proceedings are instituted in relation to the thing, in which case the thing may be detained until the proceedings are finally concluded.

(16) Where the Minister believes on reasonable and probable grounds that a thing is a threat to the environment or environmental health, or where proceedings mentioned in subsection (15) are instituted within the time provided in that subsection, and at the final conclusion thereat the court orders the forfeiture of the thing that was seized and detained, the Minister may dispose of the thing as he sees fit. **Disposal of forfeited things**

(17) Where subsection (16) does not apply, the thing shall be returned to the corporation which owns the thing or which had the possession, care or control of it at the time of its seizure. **Return of things seized where no forfeiture ordered**

Samples. disposition of

(18) A sample taken under this Act or regulations may be disposed of in such manner as the Minister considers appropriate.

Liability

(19) The Crown, nor any agent or employee thereof is not liable for any costs, loss or damage, resulting from the exercise in good faith of powers pursuant to this Act or the regulations.

Order to bind successors in title

(20) An order issued pursuant to subsection (2) shall run with the land and shall be binding upon the successor or assignee of the corporation to which it is directed.

Copies of order on request

(21) Upon the written request of any person as to whether an order has been issued against a particular person, the Minister shall provide the information and if an order has been issued, make a copy available.

4. Section 10 of the said Act is amended

(a) in clause (b)

(i) by adding the word "water" after the word "soil", and

(ii) by deleting the word "rubbish" and substituting the word "litter";

(b) in clause (c) by adding the word "water" after the word "soil";

(c) by repealing clause (d) and substituting the following:

(d) placing or removing structures, including wharves, breakwaters, slipways, or placing or removing obstructions, including bridges, culverts, or dams;

(d) by adding the following clauses:

(e) operating machinery on the bed of a watercourse or wetland;

(f) disturbing the ground, either by excavating or depositing earthen or other material, within 10 metres of a watercourse or wetland;

(g) carrying out any type of instream activity, including debris removal, habitat development, or placement of instream structures.

5. Section 11 of the said Act is repealed and the following is substituted therefor:

Advisory Committee

11. The Minister may appoint a watercourse alteration advisory committee to review applications for watercourse or wetland alteration permits and to advise the Minister on proposed watercourse and wetland alteration projects.

6. Section 18 of the said Act is amended

(a) in clause (1)(b), by deletion of the words "and remuneration";

(b) in subsection (2), by the addition of the following clause:

(j) prescribe the remuneration of its members.

7. Section 22 of the said Act is repealed and the following is substituted therefor:

22. (1) No person shall, without written permission of the Minister, Operation of motor vehicles

(a) operate a motor vehicle on a beach or a sand dune;

(b) carry out any activity that will or may

(i) interfere with the natural supply or movement of sand to or within a beach or a sand dune,

(ii) alter, remove, or destroy natural stabilizing features, including vegetation, of a beach or a sand dune.

(2) Clause (1)(a) does not apply to the operation of a motor vehicle on a beach for the conduct of activities related to the legal harvesting of a fishery resource or the legal removal of beach material. Activities related to moss harvesting etc. excepted

8. Section 23 of the said Act is repealed.

9. Section 27 of the said Act is repealed and the following is substituted therefor:

27. (1) This Act and the regulations may be enforced by Enforcement

(a) the Minister;

(b) an environment officer;

(c) any officer or member of the Prince Edward Island Provincial Police, as defined in the *Police Act* R.S.P.E.I. 1988, Cap. P-11;

(d) any officer or member of the Royal Canadian Mounted Police;

(e) a game officer appointed under the *Fish and Game Protection Act* R.S.P.E.I. 1988, Cap. F-12;

(f) a fisheries officer designated under the *Fisheries Act* (Canada) R.S.C. 1985, Chap. F-14.

(2) No person shall obstruct or attempt to obstruct any person lawfully carrying out the enforcement of this Act or the regulations. Obstruction

10. Section 32 of the said Act is repealed and the following is substituted therefor:

Violation, natural person

32. (1) The contravention of, or failure on the part of a natural person, to comply with any term or condition or other provision of any order, license, approval or permit issued by the Minister or an environment officer under this Act or the regulations, constitutes a violation of this Act.

Penalty

(2) Any natural person who contravenes or violates any provision of this Act or the regulations is guilty of an offence and is liable on summary conviction to a fine of not less than $200 and not more than $10,000, or to imprisonment for ninety days, or both, and to pay such restitution as the judge thinks fit to any person aggrieved or affected by the contravention or violation.

Contravention, corporation

(3) The contravention of, or failure, on the part of a corporation, to comply with any term or condition or other provision of any order, license, approval or permit issued by the Minister or an environment officer under this Act or the regulations, constitutes a violation of this Act.

Penalty

(4) Any corporation which contravenes or violates any provision of this Act or the regulations is guilty of an offence and is liable on summary conviction to a fine of not less than $1,000 and not more than $50,000, and to pay such restitution as the judge thinks fit to any person aggrieved or affected by the contravention or violation.

Personal liability of corporate officers

(5) Any officer, director, or agent of a corporation who directed, authorized, assented to, acquiesced in, or participated in, the commission of an offence by that corporation is guilty of the offence set out in subsection (1), and is liable on conviction to the penalty set out in subsection (2).

Continuing offence

(6) Where a contravention or violation of any provision of the Act or the regulations continues for more than one day, the offender is guilty of a separate offence for each day that the contravention or violation continues.

Limitation period

(7) Proceedings with respect to an offence under this Act or the regulations may be instituted at any time within two years after the time when the subject matter of the proceedings arose.

11. This Act comes into force on such date as may be fixed by proclamation of the Lieutenant Governor in Council.

LAWS OF PRINCE EDWARD ISLAND

An Act to Amend the Environmental Protection Act

Charlottetown

Printed and Published by Authority of
P. Joseph Murphy, Acting Queen's Printer

1992

CHAPTER 21

An Act to Amend the Environmental Protection Act

(Assented to May 6, 1992)

BE IT ENACTED by the Lieutenant Governor and the Legislative Assembly of the Province of Prince Edward Island as follows:

1. Section 1 of the *Environmental Protection Act* R.S.P.E.I. 1988, Cap. E-9 is amended by the insertion of the following clauses:

(p.1) "waste" includes materials discarded by persons in the course of their daily activities at home or at commercial businesses, industries and institutions or other related activities; waste

(p.2) "waste management" means a system or process for the collection, transportation, separation, treatment or disposal of waste and includes disposal sites and landfill sites; waste management

(u.1) "well-head protection area" means the surface and subsurface area surrounding a well, supplying any water supply system, through which contaminants may or are reasonably likely to move toward and reach such well; well head protection area

2. Subclause 3(1)(e)(i) of the said Act is amended by the deletion of the word "use" and the substitution therefor of the words "quality, use, protection".

3. Section 4 of the said Act is amended

(a) in subsection (1), by the deletion of the word "shall" and the substitution therefor of the word "may";

(b) in subsection (5), by the deletion of the words "a three year term" and the substitution therefor of the words "such term as the Lieutenant Governor in Council may determine in the case of each member".

4. Clause 10(f) of the said Act is amended by the deletion of the words "within 10 metres of" and the substitution therefor of the words "in or on".

5. Section 15 of the said Act is repealed.

6. Section 20 of the said Act is repealed and the following is substituted therefor:

Spills

20. Except as permitted by the regulations or by the Minister in writing, no person shall

(a) discharge, or cause or permit to be discharged;

(b) being the owner or person having control of a contaminant, discharge or cause or permit to be discharged,

a contaminant into the environment.

7. Section 21 of the said Act is repealed and the following is substituted therefor:

Notice and remedial measures

21. (1) Every person who, without permission under section 20, discharges, or causes or permits to be discharged, a contaminant into the environment, or who owns or has control of a contaminant which is discharged into the environment shall

(a) immediately notify the Department; and

(b) take such action as the Minister may direct

(i) to investigate and define the extent, nature and impact of the contaminant,

(ii) to repair, restore and remedy the environment or to confine or contain the effects of the contaminant.

Injunction

(2) Where any person fails to take such action as is directed by the Minister pursuant to subsection (1), and where the discharge of a contaminant into the environment has caused, is causing or may cause a threat to the environment or environmental health, the Minister may make application to the Supreme Court for an injunction requiring that person to carry out that action.

8. Subsection 25(1) is amended

(a) in clause (d), by the deletion of the words "or inspections" and the substitution therefor of the words "inspections or waste management";

(b) by the repeal of clause (g) and the substitution therefor of the following:

(g) respecting the design, construction, adaption, alteration, operation, maintenance and installation of systems, processes or works to abate, manage, dispose of or control contaminants, waste or other environmental damage, and those systems, processes or works may include waste management sites, waste treatment systems and incinerators;

(c) by the repeal of clause (l) and the substitution therefor of the following:

(l) regulating, controlling, prohibiting, directing, or providing for the withdrawal, use, quality, quality monitoring, storage and handling of water from any natural or artificial source including any water supply system;

(l.1) requiring delineation of well-head protection areas and respecting the implementation of controls on activity within the well-head protection area which may include the restriction and prohibition of any activity in the area.

9. Section 33 of the said Act is amended

(a) by designating the existing section as subsection (1); and

(b) by the addition of the following:

Order of court authorizing remedial action

(2) Where the Minister has issued an order or given a direction under this Act and the person to whom the order or direction is given has failed to comply with it, the Minister may apply to the Supreme Court for an order authorizing the Minister to take such remedial action as may be specified in the order.

Costs

(3) The Minister may recover as a debt due to the Crown the costs of remedial action pursuant to an order under subsection (2) from the person to whom the original order or direction was given.

LAWS OF PRINCE EDWARD ISLAND

An Act to Amend the Environmental Protection Act

Charlottetown

Printed and Published by Authority of
Allan W. O'Keefe, Queen's Printer

1994

CHAPTER 16

An Act to Amend the Environmental Protection Act

(Assented to May 19, 1994)

BE IT ENACTED by the Lieutenant Governor and the Legislative Assembly of the Province of Prince Edward Island as follows:

1. Section 32 of the *Environmental Protection Act* R.S.P.E.I. 1988, Cap. E-9 is amended by the addition of the following subsection:

(8) For the purposes of subsections (3) and (4), Her Majesty in right of the province or in right of Canada is deemed to be a corporation. Prosecution of Crown

LAWS OF PRINCE EDWARD ISLAND

An Act to Amend the Environmental Protection Act

Charlottetown

Printed and Published by Authority of
Beryl J. Bujosevich, Queen's Printer

1995

CHAPTER 11

An Act to Amend the Environmental Protection Act

(Assented to May 4, 1995)

BE IT ENACTED by the Lieutenant Governor and the Legislative Assembly of the Province of Prince Edward Island as follows:

1. Clauses 7(2)(c), (d) and (e) of the *Environmental Protection Act* R.S.P.E.I. 1988, Cap. E-9 are amended by the insertion before the word "source" of the words "contaminant or the".

2. Clauses 7.1(2)(c), (d) and (e) of the said Act are amended by the insertion before the word "source" of the words "contaminant or the".

3. Section 18 of the said Act is amended

(a) in subsection (1) by the insertion after the words "waste treatment system" of the words ", waste management system";

(b) in clause (2)(a), by the insertion after the words "waste treatment systems" of the words " , waste management systems";

(c) in subsection (2), by the addition of the following:

(k) establish a system for the collection, transportation, separation, treatment or disposal of waste;

4. Section 28 of the said Act is repealed and the following is substituted:

Powers to revoke, impose conditions, etc.

28. The Minister may, by order, with respect to any permit, license, certificate, approval or other authority to be granted or already granted under this Act

(a) revoke it;

(b) impose or alter such terms and conditions in relation to it as he considers necessary in the public interest.

5. Section 33 of the said Act is repealed and the following is substituted:

Remedial action authorized by court

33. (1) Where the Minister has issued an order or given a direction under this Act and the person to whom the order or direction is given has failed to comply with it, the Minister may apply to the Supreme Court for an order authorizing the Minister to take such remedial action as may be specified in the order.

Order for costs of remediation

(2) After taking remedial action under a court order pursuant to subsection (1), the Minister may issue an order for the costs of the remedial action against the person to whom the original order or direction was given.

Immediate action required, order or direction

34. (1) Where the Minister has issued an order or given a direction under this Act and the person to whom the order or direction was given has failed to comply with it, and where the order or direction relates to a matter which in the opinion of the Minister requires immediate action to prevent further injury to the environment, the Minister may take the appropriate remedial action to carry out the terms of the order.

Order for costs

(2) After taking remedial action under subsection (1) the Minister may issue an order for the costs of the remedial action against the person to whom the original order or direction was given.

Immediate action required, no order or direction

35. (1) Where contamination or damage of any kind is caused by failure of any person to comply with the provisions of this Act or regulations and where the contamination or damage relates to a matter which in the opinion of the Minister requires immediate action to prevent further injury to the environment, the Minister may take the appropriate remedial action to clean up the contamination or damage.

Order for costs

(2) After taking remedial action under subsection (1) the Minister may issue an order for the costs of the remedial action against the person who has caused the contamination or damage.

Filed order has effect as judgment

36. An order for cost of remediation under subsection 33(2), 34(2) or 35(2) may be filed with the Registrar of the Supreme Court at any time thirty days after it is issued and, when so filed, the order is of the same force and effect as if it were a judgment.

LAWS OF PRINCE EDWARD ISLAND

Water and Sewerage Act

R.S.P.E.I. 1988, Cap. W-2

Charlottetown

Printed and Published by Authority of
Gordon Babineau, Queen's Printer

CHAPTER W-2

WATER AND SEWERAGE ACT

1. In this Act — Definitions

(a) "Commission" means the Public Utilities Commission appointed under the *Public Utilities Commission Act* R.S.P.E.I. 1988, Cap. P-33; — Commission

(b) "person" includes an association, a body corporate, a partnership, and a municipality; — person

(c) "public utility" means any person engaged in constructing, altering, extending, managing or controlling any system for providing the service of water or sewerage or water and sewerage for the public in any area within Prince Edward Island. R.S.P.E.I. 1974, Cap. W-2,s.1; 1983,c.33,s.66. — public utility

2. Notwithstanding any statute of this province, the Commission has and shall exercise general supervision and control over all public utilities as defined in this Act, and the provisions of the *Public Utilities Commission Act* extend and apply to the Commission in the exercise of the duties imposed by this Act. R.S.P.E.I. 1974, Cap. W-2,s.2. — Powers of Commission

3. Before commencing the construction, alteration, or extension of any water or sewerage system, every public utility shall obtain from the Commission a permit in writing authorizing the same, and shall submit to the Commission at least one copy of all plans, engineer's reports and estimates of costs, together with such other information and data as the Commission may require. R.S.P.E.I. 1974, Cap. W-2,s.3; 1988,c.68,s.1. — Permit for public utility

4. The Commission may approve any application in whole or in part and may amend or vary the same as it sees fit. R.S.P.E.I. 1974, Cap. W-2,s.4; 1988,c.68,s.1. — Approval of Commission

5. When the Commission approves, amends or varies an application, it shall issue a permit to the public utility which shall carry out the work according to any conditions of the permit. R.S.P.E.I. 1974, Cap. W-2,s.5; 1988,c.68,s.1. — Issuance of permit

Equipment and material to comply

6. No equipment or material shall be used in the construction, extension or alteration of any water or sewerage system that does not comply with the requirements of the Commission. R.S.P.E.I. 1974, Cap. W-2,s.6.

Entry on private property

7. When the Commission finds that it is in the public interest that any public utility locate any portion of any water or sewerage system on private property and that no agreement can be reached with the owner of the property, the Commission may order, on such terms and conditions and subject to the payment of such compensation, if any, as may seem just, that the public utility have leave to enter upon the private property and there locate any portion of any water or sewerage system and have access thereto at all times for repairing, operating or maintaining the same, but at no time doing unnecessary damage. R.S.P.E.I. 1974, Cap. W-2,s.7.

Measurement of service

8. The Commission may prescribe the method by which any service under this Act shall be measured and may require any public utility to install all equipment and fittings necessary to comply with such method and may make regulations governing the classification of the methods of measurement and determining the person or persons to whom the classifications apply. R.S.P.E.I. 1974, Cap. W-2,s.8.

Rates and charges fixed by Commission

9. Notwithstanding any statute of this province or any agreement or usage to the contrary all rates and charges for the supplying of water or sewage disposal shall be fixed and determined by or approved by the Commission. R.S.P.E.I. 1974, Cap. W-2,s.9.

Basis for rates and charges

10. (1) The rates and charges shall be fixed and determined in accordance with the generally accepted public utility practices after taking into consideration local conditions and circumstances.

Classification & prescription of rates & charges

(2) Where considered necessary by the Commission such rates and charges may be classified and prescribed as follows:

(a) an initial charge for constructing and establishing connection from the main water or sewerage line of a public utility to any building or structure on the land and premises of any person for the purpose of supplying water or sewage disposal;

(b) monthly, quarterly or other periodical rates or charges for supplying water to a premises based on the method of measurement prescribed by the Commission in accordance with section 8;

(c) monthly, quarterly or other periodical rates and charges for sewage disposal where the Commission considers the same to be necessary and equitable;

(d) such other rates and charges for construction or for service provided as the Commission may approve. R.S.P.E.I. 1974, Cap. W-2,s.10.

11. (1) Every public utility shall carry a proper and adequate depreciation account when the Commission, after investigation, shall determine that the depreciation account can be reasonably required. **Depreciation account**

(2) The Commission shall ascertain and determine what are proper and adequate rates of depreciation for the several classes of property or material of each public utility. R.S.P.E.I. 1974, Cap. W-2,s.11. **Rates of depreciation, determination of**

12. The Commission may prescribe the forms of all books, accounts, papers and records required to be kept by a public utility, and every public utility is required to keep and render its books, accounts, records and papers accurately and faithfully in the manner and form prescribed by the Commission and to comply with all directions of the Commission relating to the books, accounts, papers and records. R.S.P.E.I. 1974, Cap. W-2,s.12. **Form of records prescribed by Commission**

13. The Commission may cause to be prepared suitable blank forms and shall, when necessary, furnish the forms to each public utility, which shall make thereon such reports to the Commission as it may require. R.S.P.E.I. 1974, Cap. W-2,s.13. **Forms, reports on by public utility**

14. The Commission may direct that a public utility shall make certain provisions for the amortization of any sums allowed for organization expenses and expenses of valuation, and may direct that the sum required annually for the amortization shall be charged as an operating expense. R.S.P.E.I. 1974, Cap. W-2,s.14. **Amortization for organization expenses**

15. (1) When any public utility wishes to vary any existing rates, or charges, or to establish any new rates or charges it shall submit for the approval of the Commission a schedule of the proposed rates and charges. **Schedule of new rates presented to Commission**

(2) The Commission may approve the schedule of rates, and charges either in whole or in part, or may amend or vary the same as it sees fit. **Approval of rates & charges**

(3) On the approval the rates and charges are the lawful rates and charges of the public utility until altered or modified under this Act. R.S.P.E.I. 1974, Cap. W-2,s.15; 1988,c.68,s.2. **Effect of approval**

16. (1) All rules and regulations of any public utility relating to the kind of service to be supplied to customers and the manner by which the service shall be supplied, shall be subject to approval by the **Service rules and regulations, powers of Commission**

Commission and, after approval, those rules and regulations shall govern the service.

Commission, power to make rules and regulations

(2) Notwithstanding subsection (1), the Commission may make rules and regulations relating to the kind of service and the manner by which the service shall be supplied to customers of a public utility. 1988,c.68,s.3.

Interim approval where no previous schedule

17. When a public utility submits for the approval of the Commission a schedule of rates and charges that apply only to a service for which no schedule of rates and charges has previously been approved, the Commission may grant an interim approval of the schedule, and thereafter until otherwise ordered by the Commission, the schedule of rates and charges are the lawful rates and charges to be made by the public utility with respect to the services therein mentioned. R.S.P.E.I. 1974, Cap. W-2,s.16.

Public hearing

18. The Commission may order a public hearing in respect of any schedule of rates and charges submitted for approval under this Act, and reasonable notice thereof shall be given to such public utility and to the public. R.S.P.E.I. 1974, Cap. W-2,s.17.

Written complaint against rates, etc.

19. Upon written complaint to the Commission, against any public utility, by any five persons, that any of the rates, charges or schedules, whether fixed by or the subject of a signed contract or agreement or otherwise, are unreasonable or discriminatory, or that any regulation, practice or act affecting or relating to the supplying of water and sewerage, or any services in connection therewith are unreasonable, insufficient, or discriminatory or that the service is inadequate, or unobtainable, the Commission shall, after notice to the public utility, investigate such complaint, and may order that such rates, charges or schedules be modified or altered, or that the regulations, measurement, practice or acts be modified or changed, or may order, on such terms and subject to such conditions as may seem just, that the public utility furnish reasonable and adequate service and facilities and make such alterations, extensions and additions as may be required. R.S.P.E.I. 1974, Cap. W-2,s.18.

Deposit to cover costs of investigation

20. The Commission, when called upon to institute any investigation, may in its discretion, require from the complainants, the deposit of a reasonable amount of money or other security to cover the costs of the investigation, which money shall be dealt with as the Commission may direct should the decision be given against the complainants. R.S.P.E.I. 1974, Cap. W-2,s.19.

21. When in the opinion of the Commission any ground exists for a complaint against any public utility, the Commission may, on its own motion, investigate such ground in the same manner and with the same powers as are set forth in section 19. R.S.P.E.I. 1974, Cap. W-2,s.20.

Investigation of complaint by Commission

22. For the purpose of carrying out its duties under this Act the Commission by its engineers, accountants, valuators and others shall have access, at all reasonable hours, to inspect all books, records, equipment and material of any public utility. R.S.P.E.I. 1974, Cap. W-2,s.21.

Inspection of records etc. by Commission

23. Subject to this Act no person shall knowingly solicit, accept or receive any rebate, concession or discrimination with respect to any service or affecting or relating to any public utility whereby any such services are, by any device whatsoever, rendered free or at a lesser rate than named in the schedule in force, as provided herein, or whereby any service or advantage is received other than as is herein specified. R.S.P.E.I. 1974, Cap. W-2,s.22.

No free or lesser rates than in schedule

24. (1) If any person serviced with water and sewerage by any public utility neglects or refuses to pay the amount of the rates or charges due for the same, the public utility may discontinue the service and stop the water supply.

Discontinuance of service

(2) Where the public utility discontinues the service and stops the water supply the officers or agents of the public utility may after forty-eight hours notice, enter the premises of such person between the hours of nine o'clock in the forenoon and four o'clock in the afternoon, and separate and take away any meter or other equipment belonging to the public utility, and disconnect any pipes or fittings, whether its property or not, from the system of such public utility. R.S.P.E.I. 1974, Cap. W-2,s.23.

Removal of meters & disconnect pipes

25. If a customer of any public utility installs or connects or is desirous of installing or connecting any service or equipment which, in the opinion of the public utility, is or may be detrimental to the service being rendered, the matter may be referred to the Commission and the Commission may make such order thereon as appears reasonable and just. R.S.P.E.I. 1974, Cap. W-2,s.24.

Detrimental equipment to service of public utility

26. Every person or public utility neglecting or refusing to obey, comply with or carry into effect any rule or order of the Commission, made under this Act, or who violates any provision of this Act for which no penalty is provided is liable to a penalty of not less than $5 nor more than $500, which may be imposed by the Commission, and

Penalty for offences

if the same is not paid within fifteen days after the imposition thereof, the Commission may proceed to collect the same in the same manner as is prescribed for the recovery of assessment under the *Public Utilities Commission Act*. R.S.P.E.I. 1974, Cap. W-2,s.25.

Penalties to go to consolidated revenue

27. Every penalty or fine imposed or collected under this Act goes to and forms part of the Consolidated Fund of the province. R.S.P.E.I. 1974, Cap. W-2,s.26.

Judicial review

28. Notwithstanding section 26, proceedings in the Supreme Court by way of application for judicial review lie against any person or public utility which fails to carry out any order of the Commission made under this Act or which performs or commences to perform any act in contravention of any order of the Commission made under this Act. R.S.P.E.I. 1974, Cap. W-2,s.27.

LAWS OF PRINCE EDWARD ISLAND

An Act to Amend the Water and Sewerage Act

Charlottetown

Printed and Published by Authority of
Allan W. O'Keefe, Queen's Printer

1994

CHAPTER 66

An Act to Amend the Water and Sewerage Act

(Assented to May 19, 1994)

BE IT ENACTED by the Lieutenant Governor and the Legislative Assembly of the Province of Prince Edward Island as follows:

1. Section 2 of the *Water and Sewerage Act* R.S.P.E.I. 1988, Cap. W-2 is amended

(a) by designating the existing section as subsection (1);

(b) by the addition of the following:

(2) Notwithstanding subsection (1), the Commission does not have general supervision and control over sewerage and water public utilities owned, operated, managed or controlled by the City of Charlottetown, City of Summerside or the Towns of Charlottetown South or Charlottetown West and in relation to those utilities this Act shall apply as if for references to the Commission there were substituted references to the relevant municipal council. Application to certain water and sewerage utilities

2. This Act comes into force on such date as may be fixed by proclamation of the Lieutenant Governor in Council.