Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems

Part 3
Wastewater Systems Standards for Performance and Design
of a Total of 5 Parts

March 2013

Alberta Government

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Part 3 WASTEWATER SYSTEM STANDARDS FOR PERFORMANCE AND DESIGN
March 2013

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Additional Parts published separately are:

Part 1 Standards for Municipal Waterworks
Part 2 Guidelines for Municipal Waterworks
Part 4 Wastewater Systems Guidelines for Design, Operating and Monitoring Requirements
Part 5 Stormwater Management Guidelines

FOREWORD TO PART 3 WASTEWATER SYSTEMS STANDARDS FOR PERFORMANCE AND DESIGN (2013)

Alberta Environment and Sustainable Resource Development (AESRD) has the regulatory mandate, in accordance with the Environmental Protection and Enhancement Act and Regulations, for the Drinking Water and Wastewater Programs serving large public systems in Alberta. AESRD considers the establishment of standards and guidelines for municipal waterworks, wastewater and storm drainage facilities an integral part of our regulatory program directed at ensuring public health and environmental protection. AESRD's objective is to develop comprehensive and scientifically defensible standards and guidelines that are effective, reliable, achievable and economically affordable.

Since publication of the last revision of the Standards and Guidelines, Alberta Environment and Sustainable Resource Development has embarked on a process of "decoupling" the various components of the January 2006 document into functionally-associated sections to aid those using the document. This process started with the publication of the January 2006 version of the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems in the Alberta Gazette. A program of separating the component parts of this document is under way and new parts will eventually replace the corresponding sections in the January 2006 Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems. Until the process of "decoupling" is completed with new "Parts" the existing sections of the 2006 Standards and Guidelines document will remain in operation. This part (Part 3 – Wastewater Systems Standards for Performance and Design) has all activities and / or system components that relate to protection of the environmental and human health. System components that are guidance to best practices are included under "Part 4 – Wastewater Systems Guidelines for Design, Operating and Monitoring Requirements".

The system owners / utilities are responsible for meeting AESRD's regulatory requirements and for the collection, treatment and disposal or use of treated wastewater. They are also responsible for maintaining the wastewater collection system up to the service connection. Engineering consultants and / or the system owners / utilities are responsible for the detailed project design and satisfactory construction and operation of the waterworks and wastewater systems.

In accordance with the Wastewater and Storm Drainage Regulation (119/1993) a wastewater system and storm drainage system will be designed so that it meets, as a minimum, the performance standards and design requirements set out in the Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, published by AESRD, as amended or replaced from time to time, or, any other standards and design requirements specified by the Regional Director.

AESRD last revised its Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems in January 2006. The changes in this version from the January 2006 Standards include correction of some clerical error, updating Tables 3.6 and 3.7 to be consistent with Subdivision and Development Regulation, and the renumbering of Sections 3 Wastewater Systems Performance Standards and Section 4 Wastewater Systems Design Standards into a single document. The original 2006 Appendix F appears in this document as Appendix 3-A.

This part details all the critical elements of Wastewater Systems Performance and Design. These are mandatory requirements with which owners are required to comply. If at any time, the performance standards are compromised, the approval / registration holder shall immediately report to the Regional Director, either:

1. by telephone at 1-800-222-6514; or
2. by a method:
    a. in compliance with the release reporting provisions in the Act and the regulations, or
    b. as authorized in writing by the Regional Director.

DEFINITIONS / ABBREVIATIONS

AO	-	Aesthetic Objectives
AESRD	-	Alberta Environment and Sustainable Resource Development
AWWA	-	American Water Works Association
BDOC	-	Biodegradable Dissolved Organic Carbon
BNR	-	Biological Nutrient Removal
BPJ	-	Best Professional Judgement
BPR	-	Biological Phosphorus Removal
BPT	-	Best Practicable Technology
CBOD	-	Carbonaceous Biochemical Oxygen Demand at 5 days and 20 ^{o}C
CFID	-	Continuous feed and intermittent discharge
DAF	-	Dissolved Air Flotation
DBP	-	Disinfection By-product
DCS	-	Distributed Control System
DO	-	Dissolved Oxygen
DWSP	-	Drinking Water Safety Plan
DOC	-	Dissolved Organic Carbon
EPEA	-	Environmental Protection and Enhancement Act
F/M	-	Food to Microorganism ratio
G	-	Velocity Gradient
GCDWQ	-	Guidelines for Canadian Drinking Water Quality
GWUDI	-	Groundwater under the direct influence of surface water
HPC	-	Heterotrophic Plate Count
HRT	-	Hydraulic Retention Time
IFID	-	Intermittent feed and intermittent discharge
MAC	-	Maximum Acceptable Concentration
MLSS	-	Mixed Liquor Suspended Solids
NH_3-N	-	Ammonia nitrogen
NSF	-	National Sanitation Foundation
NTU	-	Nephelometric Turbidity Unit
ORP	-	Oxidation Reduction Potential
OU	-	Odour Unit
PLC	-	Programmable Logic Controllers
QA/QC	-	Quality Assurance / Quality Control
RBC	-	Rotating Biological Contactor
SAR	-	Sodium Adsorption Ratio
SBR	-	Sequencing Batch Reactor
SRT	-	Sludge Retention Time
TBOD	-	Total Biochemical Oxygen Demand at 5 days and 20 ^{o}C
TOC	-	Total Organic Carbon
TP	-	Total Phosphorus
TSS	-	Total Suspended Solids
TTHM	-	Total Trihalomethanes
UC	-	Uniformity Coefficient
USEPA	-	United States Environmental Protection Agency
UV	-	Ultraviolet
WHO	-	World Health Organization

Average daily design flow - The product of the following:

- design population of the facility, and
- the greatest annual average per capita daily flow which is estimated to occur during the design life of the facility.

Co-op - An organization formed by the individual lot owners served by a waterworks system, wastewater system or storm drainage system.

Granular filter media:

1. Effective Size (D_{10}) - Size of opening that will just pass 10% of representative sample of the granular filter media.
2. Uniformity Coefficient - A ratio of the size opening that will just pass 60% of the sample divided by the opening that will just pass 10% of the sample.

Groundwater - All water under the surface of the ground.

Maximum daily design flow (water) - Maximum three consecutive day average of past-recorded flows, times the design population of the facility. If past records are not available, then 1.8 to 2.0 times the average daily design flow.

Maximum hourly design flow (water) - 2.0 to 5.0 times the maximum daily design flow depending on the design population.

Owners - Owners of the waterworks systems as defined in the regulations.

Peak demand design flow (water) - the maximum daily design flow plus the fire flow.

Potable water – As defined in the EPEA. Other domestic purposes in the EPEA definition include water used for personal hygiene, e.g. bathing, showering, washing, etc.

Septage – The liquid, solid or semisolid material removed from septic tanks, portable toilets, and holding tanks that receive sewage from domestic sources. This does not include wastes from grease traps, industrial or commercial processes.

Sodium adsorption ratio - A ratio of available sodium, calcium and magnesium in the soil solution which can be used to indicate whether or not the accumulation of sodium in the soil exchange complex will lead to a degradation of soil structure.

$$SAR = \frac{Na}{\left[\frac{Ca}{2} + \frac{Mg}{2}\right]^{1/2}}$$

Note : All concentrations expressed in milliequivalents per litre

Surface water - Water in a watercourse.

Watercourse - As defined in the EPEA.

3.0 Wastewater Systems - Performance and Design Standards

3.1 Treated Effluent Disposal to Surface Waters

3.1.1 Treated Effluent Quality

The treated effluent quality for a wastewater treatment facility shall be based on the more stringent of the quality resulting from the "Best Practicable Technology" (Section 3.1.2) or the quality required based on receiving water assessments (Section 3.1.3).

Exceptions to this rule are:

- the seasonal discharges to a receiving watercourse from wastewater lagoons designed and operated in accordance with AESRD standards (Section 3.4.1). No receiving water assessments are required for such releases; and

- when a water quality based limit is not technically attainable. In this case, an advanced technology limit may be adopted as an interim effluent limit.

3.1.2 Best Practicable Technology Standards

Only those technologies identified in Tables 3.1 and 3.2 are considered 'Best Practicable Technologies', and the corresponding effluent standards as 'Best Practicable Technology Standards'.

3.1.3 Receiving Water Quality Based Standards

Receiving water quality based standards shall be derived by calculating the maximum amount of substances that can be discharged under worst-case conditions while still maintaining instream water quality guidelines.

Detailed procedure for determining the receiving water quality based standards is included in the Water Quality Based Effluent Limits Procedures Manual published by AESRD.

3.1.4 Disposal Criteria

Continuous discharge of effluent from treatment plants to a receiving watercourse shall be permitted if the recorded minimum mean monthly watercourse flow is ten times the total average daily discharge of treated effluent, and receiving water assessment indicates that there are no appreciable water quality impacts. However, if it can be demonstrated with a high level of certainty that no appreciable water quality impacts are projected to occur at 10:1 dilution, then discharge may be permitted at less than 10:1 dilution. Alternative methods of disposal and / or effluent storage facilities may be required if these conditions cannot be met.

Seasonal discharge of effluent from treatment plants, other than wastewater lagoons, to a receiving watercourse shall be reviewed on a site-specific basis; duration and timing of discharges will be determined based on receiving water assessment.

Continuous or seasonal discharges of effluent to lakes or other stagnant water bodies are generally discouraged. Such releases shall be reviewed on a site-specific basis, and will be permitted only if there are no water quality impacts. Water quality impacts will be assessed based on the anti-degradation policy, "Municipal Effluent Limits - Policy and Overview" in the Municipal Policies and Procedures Manual.

TABLE 3.1
BEST PRACTICABLE TECHNOLOGY STANDARDS
FOR MUNICIPALITIES WITH CURRENT POPULATION <20,000

Type	Parameter	Standard	Sample	Comments
Secondary (mechanical)	CBOD TSS	25 mg/L 25 mg/L	Composite Composite	Monthly average of daily samples Monthly average of daily samples
Aerated lagoons	CBOD	25 mg/L	Grab	Monthly average of weekly samples
Wastewater lagoons 2 or 4 anaerobic cells (2 day retention time in each cell) 1 facultative cell (2 month retention time) 1 storage cell (12 month retention time)	None defined	None defined	None defined	Lagoons built to the specified design configuration and drained once a year between late spring and fall do not have a specified effluent quality standard. Early spring discharges may be allowed under exceptional circumstances to comply with any local conditions. Discharge period should not exceed three weeks unless local conditions preclude this rate of discharge.

Note:

1. Current population for municipalities served by the system shall be determined by taking into consideration the equivalent population for industrial waste discharges into the system. If site-specific information is not available, then equivalent population for industrial wastes shall be based on 70 g CBOD per person per day.
2. Sampling frequencies are based on continuous discharge of effluent to a body of water.
3. See Table 3.5 for the basis for selecting either 0 or 2 or 4 anaerobic cells in wastewater lagoons.

TABLE 3.2
BEST PRACTICABLE TECHNOLOGY STANDARDS
FOR MUNICIPALITIES WITH CURRENT POPULATION >20,000

Type	Parameter	Standard	Sample	Comments
Tertiary (mechanical)	CBOD	20 mg/L	Composite	Monthly average of daily samples
	TSS	20 mg/L	Composite	Monthly average of daily samples
	TP	1 mg/L	Composite	Monthly average of daily samples
	NH_3-N	-	Composite	Need assessed on a site specific basis
	Total Coliform	1000/100 mL	Grab	Geometric mean of daily samples in a calendar month
	Fecal Coliform	200/100 mL	Grab	Geometric mean of daily samples in a calendar month
Aerated lagoons	CBOD	20 mg/L	Grab	Monthly average of weekly samples
	TP	1 mg/L	Grab	Monthly average of weekly samples
	NH_3-N	-	Grab	Need assessed on a site specific basis
	Total Coliform	1000/100 mL	Grab	Geometric mean of weekly samples in a calendar month
	Fecal Coliform	200/100 mL	Grab	Geometric mean of weekly samples in a calendar month
Wastewater lagoons 2 or 4 anaerobic cells (2 day retention time in each cell) 1 facultative cell (2 month retention time) 1 storage cell (12 month retention time)	None defined	None defined	None defined	Lagoons built to the specified design configuration and drained once a year between late spring and fall do not have a specified effluent quality standard. Early spring discharges may be allowed under exceptional circumstances to comply with any local conditions. Discharge period should not exceed three weeks unless local conditions preclude this rate of discharge.

Note:
1. Current population for municipalities served by the system shall be determined by taking into consideration the equivalent population for industrial waste discharges into the system. If site-specific information is not available, then equivalent population for industrial wastes shall be based on 70 g CBOD per person per day.
2. Sampling frequencies are based on continuous discharge of effluent to a body of water.
3. Facilities producing effluent with nitrogenous oxygen demand may be required to monitor for TBOD. The need for TBOD monitoring, and subsequent limit on NH_3-N will be assessed on a site-specific basis.
4. Bacteriological quality standards for total coliforms may be relaxed, if the owner demonstrates with some certainty that the wastewater being considered for disinfection is not typical of other municipal wastewaters.
5. Any sample yielding more than 400 total coliforms/100 mL shall be further investigated. Minimum action should consist of immediate re-sampling of the site.
6. Frequency of sampling for total and fecal coliforms may be reduced if it can be demonstrated with some certainty that bacteriological quality of effluent is consistent and the possibility of variance is minimal.
7. See Table 3.5 for the basis for selecting either 0 or 2 or 4 anaerobic cells in wastewater lagoons.

3.2 Treated Effluent Disposal to Land

3.2.1 Wastewater Irrigation

3.2.1.1 Minimum Treatment Requirement

If wastewater irrigation is chosen as the only method for the disposal of treated effluent, the minimum wastewater treatment shall be as follows:

1. Primary treatment (anaerobic cells in series or a facultative cell) followed by at least seven months of storage; or

2. Secondary treatment with or without storage.

3.2.1.2 Treated Effluent Quality Standards

The treated effluent quality for wastewater irrigation shall meet the standards specified in Table 3.3.

TABLE 3.3
TREATED EFFLUENT QUALITY STANDARDS FOR WASTEWATER IRRIGATION

Parameter	Standard	Type of Sample	Comments
Total Coliform*	<1000/100 mL	Grab	Geometric mean of weekly samples (if storage is provided as part of the treatment) or daily samples (if storage is not provided), in a calendar month
Fecal Coliform*	<200/100 mL	Grab	Geometric mean of weekly samples (if storage is provided as part of the treatment) or daily samples (if storage is not provided), in a calendar month
CBOD	<100 mg/L	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
COD	<150 mg/L	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
TSS	<100 mg/L	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
EC	<2.5 ds/m	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
SAR	<9	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event
pH	6.5 to 9.5	Grab/composite**	Samples collected twice annually prior to and on completion of a major application event

* For golf courses and parks only.
** Grab sample would suffice if storage is provided; Composite sample is required if storage is not provided.

3.2.2 Rapid Infiltration

3.2.2.1 Minimum Treatment Requirement

For rapid infiltration, a minimum of primary treatment shall be provided.

The system shall be designed in accordance with the joint Alberta Environmental Protection - City of Red Deer publication entitled Rapid Infiltration - A Design Manual.

3.2.3 Wetlands Disposal

3.2.3.1 Minimum Treatment Requirement

For wetlands disposal, a minimum of secondary or tertiary treatment shall be provided and the effluent quality shall meet the standards specified in Tables 3.1 and 3.2.

Wetlands shall be evaluated and designed in accordance with Alberta Environmental Protection publication entitled Guidelines for the Approval and Design of Natural and Constructed Treatment Wetlands for Water Quality Improvement.

3.3 Wastewater Collection

3.3.1 Sanitary Sewers

3.3.1.1 Minimum Pipe Diameter

Minimum pipe diameter for gravity sewer, in general, shall be 200 mm in diameter. However, under limited circumstances, sewers of not less than 150 mm diameter may be allowed if the owner can demonstrate that a 150 mm diameter sewer is adequate and will not be detrimental to the operation and maintenance of the sewer system.

The hydraulic capacity of a gravity sewer should be based on consideration of factors such as projected in-service roughness coefficient, slope, pipe material and actual in-service flows. In general, sewers larger than the minimum size required shall be chosen so that the minimum velocity at the average flow is not less than 0.6 m/s for self cleansing purposes, and the maximum velocity at the peak design flow is not greater than 3.0 m/s to minimize turbulence and erosion. Under exceptional circumstances, where velocities greater than 3.0 m/s are attained, provision shall be made to protect against displacement by erosion and impact.

For small diameter low pressure or vacuum sewer collection systems, the designer shall provide hydraulic calculations and / or supporting information to verify the proposal.

3.3.1.2 Minimum Pipe Slope

All gravity sewers between manholes shall be laid with uniform slopes equal to or greater than the minimum slopes outlined in Table 3.4.

These minimum slopes are not based on an assumed specific pipe roughness coefficient, but rather on historical satisfactory operation of sewers meeting or exceeding these slopes under varying flow conditions. Under special conditions, slopes slightly less than those shown may be permitted. If the proposed slope is less than the minimum slope of the smallest pipe which can accommodate the peak wastewater design flow, the actual depths and velocities at average, and peak wastewater design flow for each design section of the sewer shall be calculated by the designer and submitted to AESRD. (See Sections 3.3.1.3 and 3.3.1.4).

For new construction, the pipe slope shall be determined using the minimum pipe diameter necessary for the design volume of wastewater. Further, a manhole outlet pipe diameter shall not be reduced to be smaller than the inlet pipe diameter to compensate for increased slope in the outlet line. In retrofit situations, where the minimum slope cannot be achieved due to site constraints, lower than the minimum slopes may be allowed. Under this situation, the owners shall make a commitment to undertake additional operation and maintenance measures to prevent solids deposition in the line.

3.3.1.3 Minimum Flow Depths

As per Section 3.3.1.2, slopes slightly less than those recommended for the 0.6 m/s 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 average design flow. The owner of the sewer system shall give written assurance to AESRD that any additional sewer maintenance required as a result of reduced slopes will be provided.

3.3.1.4 Solids Deposition

The pipe diameter and slope shall be selected to obtain practical velocities to minimize settling problems. As per Section 3.3.1.2, oversize sewers will not be approved on new constructions, to justify using flatter slopes. If the proposed slope is less than the minimum slope of the smallest pipe which can accommodate the peak wastewater design flow, the actual depths and velocities at average, and peak wastewater design flow for each design selection of the sewer shall be calculated by the designer and submitted to AESRD.

3.3.1.5 Alignment

Curvilinear alignment of sewers may be allowed in the design of the collection system. Where curved sewers are used, the designer shall not exceed the maximum angle at which the joints remain tight. Curved sewers shall be laid with a radius of at least 60 m unless otherwise supported by manufacturer's specifications.

The minimum slopes for curved sewers shall be 50 percent greater than the minimum slopes required for straight runs; this requirement will be waived if the designer submits calculations to demonstrate that increased slope is not required to achieve self-cleansing velocity.

3.3.1.6 Frost Protection

Frost protection criteria for sewers is the same as for water mains (see Section 1.9.2.1 for details).

3.3.1.7 Cross Connections

Cross connection prevention is the same as for water supply (see Section 1.9.3 for details).

TABLE 3.4
MINIMUM DESIGN SLOPES FOR SANITARY SEWERS

Sewer Diameter (mm)	Minimum Design Slope (m/100 m)
200	0.40
250	0.28
300	0.22
375	0.15
450	0.12
525	0.10
600	0.08

3.3.2 Wastewater Pump Stations

3.3.2.1 Site Constraints

Wastewater pump station structures and electrical and mechanical equipment should be protected from physical damage by the 100-year flood. Wastewater pump stations should remain fully operational and accessible during the 25-year flood.

3.3.2.2 Pumps

Wastewater pump station shall be designed with multiple pump units. Where only two units are provided, they shall be of the same size. Units shall have capacity such that, with any unit out of service, the remaining units will have capacity to handle the peak wastewater design flow.

Safety Ventilation

1. General

   Adequate ventilation shall be provided for all pump stations. Ventilation systems, including fresh air intake louvers / openings shall be designed to function year round; screen openings should be sized to avoid build-up of frost during winter to prevent subsequent blockages. Where the dry well is below the ground surface, mechanical ventilation is required. If screens or mechanical equipment requiring maintenance or inspection are located in the wet well, permanently installed ventilation is required. There shall be no interconnection between the wet well and dry well ventilation systems.

   Where ventilation of pump stations results in odour problems / complaints, the owner shall take steps to control the odour in accordance with Section 4.3.3.

2. Air Inlets and Outlets

   In dry wells over 5.0 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.

   In dry wells under 5.0 m deep, the fresh air shall be forced into the well at a point 150 mm above the pump floor and allowed to escape through vents in the roof; in wet wells, the fresh air shall be forced into the well at a point 150 mm above the high water level and allowed to escape through vents to the atmosphere.

3. Electrical Controls

Switches for operation of ventilation equipment shall 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 operation is used. The manual lighting ventilation switch shall override the automatic controls.

4. Fans, Heating and Dehumidification

The fan wheel shall be fabricated from non-sparking material. Automatic heating and dehumidification equipment shall be provided in all dry wells.

5. Wet Wells

Wet well ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least six complete air changes per hour; if intermittent, at least 30 complete air changes per hour during the period the wet well is occupied.

Air shall be forced into the wet well by mechanical means. For continuous ventilation, to facilitate free movement of air, the wet well may be exhausted at the highest elevation level in the structure at a rate not exceeding three air changes per hour; this rate shall not be exceeded to maintain positive pressure in the well.

Portable ventilation equipment shall be provided for use at submersible pump stations and wet wells with no permanently installed ventilation equipment.

6. Dry Wells

Dry well ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least six complete air changes per hour; if intermittent, at least 30 complete air changes per hour for ten minutes before entering the dry well and six complete air changes per hour to conserve heat during the period the dry well is occupied. A system of two-speed ventilation with an initial ventilation rate of 30 changes per hour for 10 minutes and automatic switch over to six changes per hour may be used.

7. Monitoring

Provision should be made in the system design to verify that the ventilation fan is operational, and that air change capacity is achieved. Portable or built-in sensing equipment for measurement of hydrogen sulphide, oxygen depletion, and combustibles should also be provided.

3.3.2.3 Separation

Dry wells, including their superstructure, shall be completely separated from the wet well. Common walls must be gas tight. All penetrations, e.g. electrical conduits, through the common wall shall be sealed.

3.3.2.4 Access

Suitable and safe means of access to dry wells and to wet wells shall be provided for inspection and cleaning. The access into the wet well shall not be through the superstructure where the pumping equipment and appurtenance may be housed. Gasketed replacement plates shall be provided to cover the opening to the wet well for pump units removed for servicing. To minimize the need for entry to the wet well, valving shall not be located in the wet well.

3.3.2.5 Water Supply

There shall be no physical connection between any potable water supply and a wastewater 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 should comply with conditions stipulated under Section 3.4.3.4 (3). In-line backflow preventers are not acceptable.

3.3.3 Screens and Grit Removal Facilities

3.3.3.1 Access and Ventilation

Screens located in pits more than 1.2 m deep shall be provided with stairway access. Access ladders, in lieu of stairways, are acceptable for pits less than 1.2 m deep.

Screening devices, installed in a building where other equipment or offices are located, shall be:

- isolated from the rest of the building,
- provided with separate outside entrances, and
- provided with separate and independent fresh air supply.

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 six 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 also be provided.

For grit removal facilities housed above or below grade, ventilation shall be provided either continuously at a rate of six complete air changes per hour, or intermittently at a rate of 30 air changes per hour.

3.3.4 Health and Safety Act

The design and construction of all components of the wastewater collection system shall conform to the safety provisions of the *Alberta Occupational Health and Safety Act, Regulation and Code*.

3.4 Wastewater Treatment and Disposal

3.4.1 Wastewater Lagoons

3.4.1.1 General Requirements

The minimum design standards for wastewater lagoons are a function of the average daily design flow. AESRD has established acceptable cell configurations based on design flow; the following sections outline the respective component configurations required to meet the minimum standards for wastewater lagoons. Addition of a mechanical aeration system or mixing units to a wastewater lagoon designed to meet the minimum standards for wastewater lagoons will not change the system to an aerated lagoon or mechanical system. For aerated lagoon systems see Section 3.4.4.

3.4.1.2 System Components and Configuration

1. Anaerobic Cells

   Anaerobic cells shall operate at a minimum depth of 3.0 m and retain influent flow for a 2-day period based on average daily design flow.

   In order to provide a cell bottom of at least 3.0 metres square for adequate mobility of construction equipment and sufficient bottom area for sludge accumulation, the minimum practical design volume of an anaerobic cell with 3:1 inside slopes and 3 m of operating depth is approximately 500 m^3. Therefore, the minimum average daily design flow at which an anaerobic cell is practical is approximately 250 m^3/d.

   When design flows warrant the provision of anaerobic cells, there shall be a minimum of two and a maximum of four cells operated in series. The number of anaerobic cells is a function of design daily flows as illustrated in Table 3.5 and Figure 3.1.

   In designing the anaerobic cells, consideration shall be given to incorporate desludging features.

2. Facultative Cells

   The facultative cell shall operate at a maximum depth of 1.5 m and retain influent wastewater for at least 60 days based on average daily design flow. The purpose of this cell is to biologically stabilize the wastewater under predominantly aerobic conditions. The cell(s) follows the anaerobic treatment (in cases where anaerobic cells are warranted), precedes long-term detention storage, and is a requirement for all wastewater lagoon systems in Alberta. Refer to Figure 3.1.

FIGURE 3.1
Typical Wastewater Lagoons

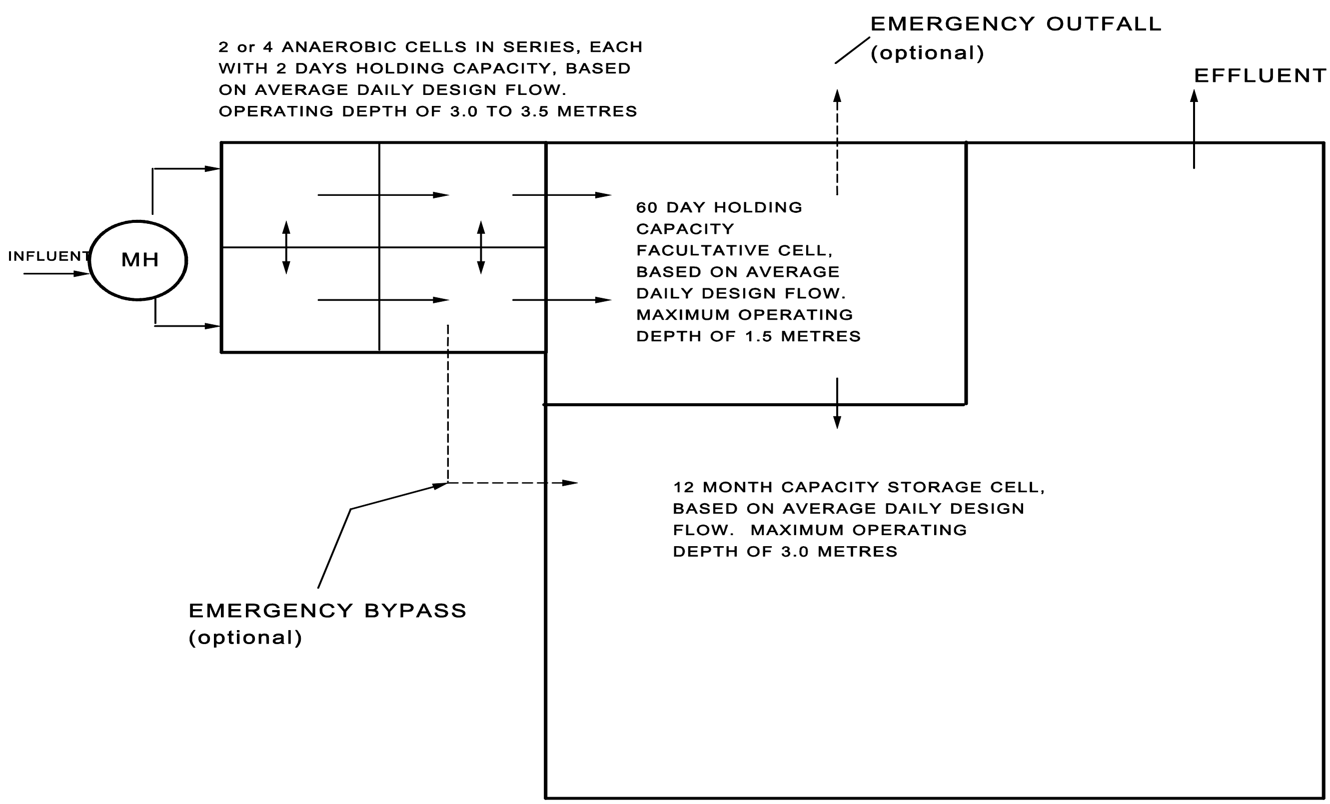

TABLE 3.5
WASTEWATER LAGOON REQUIREMENTS

Average Daily Design Flow (m^3)	Number of Anaerobic Cells	Requirement for Facultative Cell(s)	Requirement for 12 month Storage Cell(s)
Less than 250	0 Min. depth = 3.0 m	Yes Max. depth = 1.5 m	Yes Max. depth = 3.0 m
250-500	2 Min. depth = 3.0 m	Yes Max. depth = 1.5 m	Yes Max. depth = 3.0 m
Greater than 500	4 Min. depth = 3.0 m	Yes Max. depth = 1.5 m	Yes Max. depth = 3.0 m

3. Storage Cell(s)

The storage cell(s) shall operate at a maximum depth of 3.0 m and shall retain influent wastewater for a minimum retention period of 12 months based on average daily design flows. However, if historical climatology data shows that average evaporation exceeds the average precipitation, then the net evaporation may be taken into account in sizing the storage cells. Under this scenario, the minimum "free-board" shall be increased to accommodate additional flows in an anomalous precipitation year.

The purpose of storage is to provide additional wastewater treatment (including nutrient removal) under facultative conditions, and to reduce the environmental impact on the receiving drainage course by facilitating the annual discharge of high quality effluent wastewater.

3.4.1.3 Design Considerations

There are a number of siting and design features which must be considered in order to protect pubic health, to maximize public safety, and also to meet the minimum standards for wastewater lagoon design.

1. Isolation of Cells

For maintenance purposes, the cells may have to be by-passed for brief periods of time. The design shall take this into account and have provisions built-in to isolate any cell.

2. Setback Distances

Setback distances from wastewater lagoons are required to buffer the effect of potential odours and to provide a margin of public safety. Setbacks also serve to protect the physical integrity of nearby buildings and roads.

Table 3.6 outlines the minimum horizontal setback distances for wastewater lagoons.

3. Site Constraints

The facility shall be protected from physical damage by the one hundred year flood. Treatment works should remain fully operational and accessible during the twenty-five year flood. On a site-specific basis, it may also be necessary to provide an adequate setback distance to an adjacent drainage course.

4. Fencing

The wastewater lagoons shall be enclosed with a fence. The fence shall be designed and constructed to preclude the entrance of children and to discourage trespassing. The fence shall also serve to preclude the entrance of livestock. Where the lagoons are located near developed areas, a chain link fence may be required to preclude children from gaining entry.

Fences shall be located away from the outside toe of the berms in order to facilitate mowing and maintenance operations. In addition, an access gate shall be provided to allow entry of maintenance equipment, and this gate shall be provided with a lock to preclude entrance of unauthorized personnel.

5. Signs

Warning signs shall be provided at appropriate locations along the fenced perimeter of the wastewater lagoons. Each sign should identify the facility (by municipality or owner), advise against trespassing, and provide emergency contact phone numbers and / or addresses.

6. Access

All-weather access to the wastewater lagoons shall be provided.

7. Surface Runoff

Wastewater lagoons shall have adequate site drainage to divert surface runoff which would otherwise cause damage to the system.

TABLE 3.6
SETBACK DISTANCES FROM WASTEWATER LAGOONS

Minimum setback distance (m) from the "working area"* of the wastewater lagoon to:	
The property line of the land where the lagoon is located	30
The designated right-of-way of a rural road or railway	30
The designated right-of-way of a primary or secondary highway	100
A “building site”** for school, hospital, food establishment or residential use	300

* "Working area," means, those areas of a parcel of land that are currently being used or will be used for the processing of wastewater.

** “Building site” means a portion of the land on which a building exists, or can or may be constructed

Note:

- Minimum setback distance from the “working area” of the wastewater lagoon to a “building site” on the property of a “privately owned development” which the lagoon serves may be reduced to 100 m.
- Setback distances may be varied with the written consent of the “Director”.

3.4.1.4 Seepage Control

The following sections are a summary of the Alberta Environment and Sustainable Resource Development publication entitled "Design and Construction of Liners for Municipal Wastewater Stabilization Ponds in Alberta". To obtain additional detail, reference should be made to this publication.

1. Control Criteria

   The control of seepage from wastewater lagoons is one of the most important aspects of pond design, construction, operation and maintenance. The maximum allowable hydraulic conductivity for pond liners consisting of in-situ material, compacted clay, bentonite and sand, asphalt concrete or other porous materials in which seepage is:

$$Maximum\ K_T = \frac{C\ x\ T}{2+T}$$

   governed by Darcy's Law, shall be calculated using the following equation:

   where:

   K_T = maximum hydraulic conductivity of liner in the field, being at least one order of magnitude greater than the laboratory value, m/s
   T = required or proposed thickness of liner, m
   C = 5.2×10^{-9} m/s.

2. Site Selection and Investigations

   Potential sites for wastewater lagoons shall be critically evaluated in terms of their ability to meet the requirements for seepage control. Preliminary site selection should be based on existing and pertinent topographical, geological, hydrogeological and geotechnical data. The most suitable site(s) based on these considerations shall then be investigated in detail.

   The detailed site investigation shall include a review of groundwater use in the area, a reconnaissance of surface features (such as bedrock outcrops and drainage courses) and a subsurface exploration consisting of a minimum of either five (5) boreholes or one (1) borehole per 2 ha of cell area, whichever is greater. The number of boreholes drilled will depend on the complexity of the geology determined by the initial drilling program. Additional boreholes would be required to delineate a site with features such as sand layers or large sand lenses. Each borehole should be drilled to a depth of 6 m below the proposed invert elevation and at least one borehole should be drilled to a depth of either 20 m or to auger refusal in bedrock, whichever occurs first. At least three boreholes should penetrate the groundwater table in order to determine groundwater conditions including water-table elevations, flow direction and gradient. In situations where a shallow aquifer has been identified as part of the site reconnaissance or drilling programs, nests of wells should be installed to evaluate vertical groundwater flow conditions. Each borehole should be logged and soil samples taken; upon completion of the site investigation each borehole not developed as a monitor well shall also be properly sealed. In-situ and laboratory soil tests as outlined in the Manual for Design and Construction of Liners for Municipal Wastewater Stabilization Ponds in Alberta should be conducted.

   Monitor wells would be used to measure water levels and, once the levels have stabilized, permeability tests can be conducted to determine the hydraulic conductivity of the material in which the monitor well is completed. The wells should be surveyed with respect to elevation and location in order to determine groundwater elevation and the direction of groundwater flow.

Sites in flood plains, sites located above buried channel aquifers, or sites having either hilly terrain, high bedrock, fissured rock formations or high water tables should be avoided to protect against possible groundwater pollution problems and to prevent adjacent lands from being adversely affected by seepage. Areas of high water table should be avoided due to possible construction / design problems. The bedrock surface should be a minimum of 3.0 m below the invert of any cell.

3. Liner Design

The following design requirements shall be used when designing and constructing waste stabilization pond liners:

a. Natural in-situ liners shall have a minimum thickness of 0.9 m below the entire bottom, shall be relatively uniform, and shall be completely free of hydrogeologic windows such as sand and silt. Engineered side slope liners shall be provided if the horizontal hydraulic conductivity of the in-situ liner does not meet the seepage control criterion or if berms are constructed with fill material;

b. Compacted Clay Liners shall have a minimum thickness of 0.6 m on the bottom and 1.2 m on the side slope (measured perpendicular to the slope). The liner should be constructed in 150 to 200 mm lifts and compacted to the required density, within the required moisture content range, to achieve the required seepage control criterion. When determining whether the seepage control criterion is met, the actual hydraulic conductivity of the liner in the field shall be assumed to be at least one order of magnitude greater than laboratory values;

c. Bentonite and Sand Admix Liners. Bentonite shall only be considered for lagoon liners where mixing with native sands or silts allows a uniform bentonite and sand / silt admix. Only moderate to high swelling sodium bentonite shall be used. The bentonite application rate required to meet the seepage control criterion should be determined by laboratory permeability tests and then increased by 25% to allow for field conditions. The admix liner shall be at least 100 mm thick after compaction, and any portion of the liner which is susceptible to weathering when exposed shall be covered with suitable soil material;

d. Asphalt Liners. The only asphalt liners recommended for use in wastewater lagoons are spray-on bitumen over hydraulic asphalt concrete and spray-on bitumen over soil asphalt. Hydraulic asphalt concrete liners shall be a minimum of 100 mm thick comprising two 50 mm lifts with staggered joints. Soils asphalt liners should be mixed with 150 mm of native sandy soil. In all cases asphalt shall be placed over non-frost susceptible base courses or sub grades. The spray-on bitumen covering the hydraulic asphalt concrete or soil asphalt surface should provide a uniform 2 mm thick membrane; and

e. Flexible Polymeric Membrane Liners. The minimum thickness of membranes used to line wastewater lagoons is 5×10^{-3}mm (20 mils). Membranes less than 15×10^{-3}mm (60 mils) thick shall be covered with a 300 mm layer of fine-grained soil on the pond side slopes to prevent liner damage. PVC and other membrane liner materials that are susceptible to weathering when exposed shall be covered with soil on both the side slopes and bottom. A stable and well prepared subgrade and proper membrane installation (with particular emphasis on seaming) is necessary for successful performance of the liner. A system for venting gas generation beneath the liner should be considered.

4. Groundwater Monitoring

A post-construction groundwater monitoring program is required to assess the performance of the liner.

The monitor wells installed during the detailed site investigation could be used for groundwater monitoring after completion of the ponds and associated facilities. If some or all of the wells have been lost during construction, new monitor wells should be installed where required.

Monitor wells should be constructed of at least schedule 40 PVC pipe that is a minimum of 50 mm in diameter. The screen should be of the same materials and should be machine slotted. Pipe connections should be threaded rather than glued to prevent the introduction of contaminants into the well. A sand or gravel pack must be placed in the annulus around the screened section and should extend not more than half a metre above the screen. The remaining annulus should be sealed to surface with bentonite or a cement slurry. The portion of the pipe sticking up above ground should have a metal protector or other appropriate barrier system installed around it. Wells should be provided with lockable caps to prevent tampering.

Monitor wells shall be located close to the toe of the perimeter berms. The depth of completion will be governed by the information obtained during the site investigation phase. It is important, however, that wells intersect the water table. A minimum of four wells shall be placed around the pond with the well spacing ideally not to exceed 100 metres.

The following groundwater monitoring program shall be instituted for all new wastewater lagoons:

a. Wells shall be analyzed for physical, chemical and biological parameters four times in each quarter of the first year of operation. This will provide the baseline data to be compared with future analysis.

b. The first analysis from each monitoring well shall be undertaken prior to putting a new lagoon into operation. The following three analyses shall be carried out approximately three months apart to cover all seasons in the year.

c. Water samples shall be analyzed for routine water chemistry, total Kjeldahl nitrogen and chemical oxygen demand.

d. Wells shall be monitored for water levels whenever a sample is collected for chemical analysis, and also during the lagoon discharge period. During the lagoon drainage period, one set of readings shall be taken:

   i. immediately before discharge,

   ii. immediately after discharge, and

   iii. approximately one month after the end of the discharge period.

3.4.1.5 Construction Features

There are a number of design and construction features which should be followed in order to facilitate good operation and maintenance of the wastewater lagoons.

1. Berms

    a. Embankment tops shall have a minimum width of 3 m to provide a driving surface for maintenance vehicles;

    b. Embankment slopes shall be as steep as the safe operation of equipment will permit and the local soil condition will allow. Slopes for (a) the outside of the berm of 4:1 to 5:1 (horizontal to vertical), and (b) the inside of the berm of 3:1 or less, are recommended;

    c. Inside embankment slopes on the windward side of the prevailing wind shall be armoured with rip-rap or other suitable material. The required size of riprap may be greater where large cells are constructed in high wind areas;

    d. The "freeboard", the vertical distance between the high water level and the top of the berm, shall be a minimum of 0.6 m to allow for fluctuation of the operating high water level in the cell. Increased 'freeboard' may be required where high winds and steep embankments result in water scouring or to accommodate additional flows in an anomalous precipitation year when evaporation losses are taken into account in sizing the storage cells; and

    e. Special soils conditions may require the berm(s) to be "keyed" into the subsoil in order to preclude the horizontal seepage across the base of the berm. Determination of whether the "keying in" or "cut-off" procedure is appropriate for berm construction will be based on a geotechnical evaluation and engineering soils report.

2. Inlet Structures

    Control manholes are commonly used for access to inlet piping and to regulate the flow from the influent pipeline to the anaerobic or facultative cells. The invert of the influent pipeline entering the control manhole should be above the maximum operating level of the anaerobic or facultative cell. The inlet pipe from the manhole to the anaerobic or facultative cell should enter the cell at approximately 1/3 to 2/3 the cell depth.

    In the design of inlet structures, consideration should also be given to receive truck-haul sewage from holding tanks.

3. Outlet and Drain Structure

    The drain from the final storage cell shall be installed to ensure that a minimum of 150 mm of liquid is retained. A manhole shall be provided to house a valve and vertical overflow pipe for the drainage pipe, and the drainage valve shall be equipped with a long stem so that it can be operated without entering the manhole. Erosion protection shall also be provided at the location of effluent discharge.

    The drain from the final storage cell shall have capacity to ensure that the annual discharge of final effluent is completed in a period of three weeks or less.

4. Flow Measurement

Section 4.2.4.2 (5) outlines the requirements for wastewater flow measurement at pumping stations. In cases where the system is a total gravity system, i.e. no pumping station is required to transport flows to the wastewater lagoons, and the system has a capacity greater than 500 m^3/d, a portable or permanent flow measuring device shall be provided at the inlet of the wastewater lagoons.

3.4.2 Wastewater Evaporation Lagoons

Where conventional wastewater lagoons or mechanical plant are impractical because of effluent discharge restrictions, it may be necessary to consider the provision of wastewater evaporation lagoons.

3.4.2.1 System Components and Configuration

For systems with average daily design flows of less than 250 m^3, the system may be designed with one evaporation cell. Provision must be made at the inlet to the cell for settlement and removal of sludge. For systems with flows larger than 250 m^3/d, the evaporation cell shall be preceded by two anaerobic <u>or</u> two facultative cells.

1. Anaerobic Cells

   Anaerobic cells shall operate at a minimum depth of 3.0 m and for each cell to retain influent flow for a two-day period based on average daily design flow.

2. Facultative Cells

   Facultative cells shall be designed with a maximum operating depth no greater than 1.5 m, and for each cell to retain influent flow for a thirty-day period based on average daily design flow.

3. Evaporation Cells

   When establishing the size of an evaporation lagoon, consideration shall be given to local meteorological conditions such as rainfall, evaporation, and evapotranspiration. These factors shall be combined with the design influent flows to calculate the required surface area of the cell(s). In no case shall an evaporation lagoon provide less than three years of storage capacity based on average daily design flows. In practice, more than three years of storage will be required in all but the most southern areas of Alberta. Evaporation cells shall have a depth of no greater than 1.5 m.

3.4.2.2 Design Considerations

Design requirements outlined for wastewater lagoons in Sections 3.4.1.3, 3.4.1.4 and 3.4.1.5 also apply to evaporation lagoons.

3.4.3 Mechanical Wastewater Treatment

3.4.3.1 General Requirements

Mechanical wastewater treatment plants shall be designed such that the treated effluent quality meets the performance standards stipulated under Section 3.1 if the effluent is discharged to surface waters, and the standards stipulated under Section 3.2 if the effluent is disposed to land.

3.4.3.2 Design Considerations

1. Setback Distances

   Setback distances from mechanical wastewater treatment plants are required to prevent the occurrences of objectionable odours in subdivision when plants are operated normally and within designed capacities. Table 3.7 outlines the minimum horizontal setback distances from mechanical plants including aerated lagoons.

2. Others

   Design features for site constraints, fencing, signs and access shall be in accordance with Sections 3.4.1.3 (3), (4), (5) and (6) respectively.

TABLE 3.7
SETBACK DISTANCES FROM MECHANICAL TREATMENT PLANTS INCLUDING AERATED LAGOONS

Minimum setback distance (m) from the "working area"* of the operating mechanical treatment plants or aerated lagoon to:	
The property line of the land where the operating mechanical treatment plant or aerated lagoons is located	30
The designated right-of-way of a rural road or railway	30
The designated right-of-way of a primary or secondary highway	100
A “building site”** for school, hospital, food establishment or residential use	300

***** "Working area,” means, those areas of a parcel of land that are currently being used or will be used for the processing of wastewater.

** “Building site” means a portion of the land on which a building exists, or can or may be constructed

Note:

- Minimum setback distance from the “working area” of the operating mechanical treatment plant or aerated lagoons to a “building site” on the property of a “privately owned development” which the lagoon serves may be reduced to 100 m.
- Setback distances may be varied with the written consent of the “Director”.

3.4.3.3 Safety

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:

1. Enclosure of the plant site with a fence and signs designed to discourage the entrance of unauthorized persons and animals;

2. Hand rails and guards around tanks, trenches, pits, stairwells, and other hazardous structures. Height and size of handrails to conform to Alberta Building Code standards. Materials to be non-corrosive;

3. Gratings over appropriate areas of treatment units where access for maintenance is required. Grating material to be non-corrosive (carbon steel not acceptable);

4. First aid equipment;

5. "No Smoking" signs in hazardous areas;

6. Protective clothing and equipment, such as self-contained breathing apparatus, gas detection equipment, goggles, gloves, hard hats, safety harnesses, etc.;

7. Portable blower and sufficient hose;

8. Portable lighting equipment;

9. Gas detectors;

10. 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.;

11. Provision for confined space entry in accordance with Alberta Occupational Health and Safety Act and Regulations; and

12. Provision for anaerobic digesters and sludge holding tanks in accordance with the latest edition <u>CAN/CGA - B105, Code for Digester Gas and Landfill Gas Installations</u>.

3.4.3.4 Water Supply and Sanitary Facilities

1. General

   For mechanical wastewater treatment plants, an adequate supply of potable water under pressure should be provided for use in the laboratory and for general cleanliness around the plant. 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.

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;
   b. water closet;
   c. laboratory sink (with vacuum breaker);
   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 unit.

3. Indirect Connections

Where a potable water supply is to be used for any purpose in a plant other than those listed in subsection 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, hydrant, or sill cock located on the water system beyond the break tank to indicate that the water is not safe for drinking.

4. 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 system outlets shall be posted with a permanent sign indicating the water is not safe for drinking.

5. Sanitary Facilities

Toilet, shower, lavatory, and locker facilities should be provided in sufficient numbers and convenient locations to serve the expected plant personnel.

3.4.4 Aerated Lagoons

3.4.4.1 General Requirements

Aerated lagoons shall be of the "completely mixed type". The design of completely mixed aerated lagoons requires enough oxygen transfer to satisfy the applied BOD loading and sufficient mixing to maintain a uniform solids concentration in the complete mix cells.

The system shall be designed such that the treated effluent quality meets the performance standards stipulated under Section 3.1 if the effluent is discharged to surface waters, and the standards stipulated under Section 3.2 if the effluent is disposed to land.

3.4.4.2 System Components and Configuration

Typical completely mixed aerated lagoons, treating domestic wastewater, shall consist of the following:

1. A completely mixed cell, having a total retention time of at least two days based on maximum monthly average daily design flow. Aeration equipment in this cell shall be designed to achieve complete mixing by maintaining a uniform solids concentration;

2. A minimum of two partially mixed aerated cells, having a total retention time of at least 28 days based on maximum monthly average daily design flow. The two aerated cells may operate in series or in parallel, with each cell sized to 50% of the maximum monthly average daily design flow; cells in series are preferred for continuous discharge of treated effluent. Aeration equipment in this cell shall be designed to maintain a total dissolved oxygen concentration of at least 2.0 mg/L during peak loading periods; and

3. A polishing cell having a minimum hydraulic retention of five days based on maximum monthly average daily design flow is required for continuous discharge systems.

Operating depths of 5 m are recommended for good mixing efficiency and to reduce heat loss during winter months.

The foregoing configuration and the retention times may be varied if the influent characteristics are considerably different from the typical characteristics of domestic wastewater (BOD - 200 mg/L, TSS - 200 mg/L). Any variation shall be substantiated by the municipality submitting the design calculations for the modified lagoon system.

3.4.4.3 Design Considerations

A number of the design requirements outlined for wastewater stabilization ponds and mechanical wastewater treatment plants also apply to aerated lagoon systems. These design features which shall be applied to aerated lagoons include:

1.	Site constraints	-	3.4.1.3 (3)
2.	Fencing	-	3.4.1.3 (4)
3.	Signs	-	3.4.1.3 (5)
4.	Access	-	3.4.1.3 (6)
5.	Surface Runoff	-	3.4.1.3 (7)
6.	Seepage Control	-	3.4.1.4 (1-4)
7.	Construction Features	-	3.4.1.5 (1-4)
8.	Setback Distances	-	3.4.3.2 (1)

3.4.5 Disinfection

3.4.5.1 General Requirements

Municipalities serving current population greater than 20,000 and discharging to surface waters shall provide disinfection of the effluent to meet the performance standards stipulated in Section 3.1. The need for wastewater disinfection for municipalities serving a current population less than 20,000 with continuous discharge will be determined on a site specific basis, based on receiving water assessment. Municipalities disposing on land (golf courses, parks, wetlands) shall also provide disinfection of the effluent to meet the performance standards stipulated in Section 3.2. In general, where a public health hazard may be created by discharge of wastewater plant effluent, disinfection shall be required.

Ultraviolet irradiation, chlorine or chlorine derivatives are commonly approved and used for wastewater disinfectants in Alberta; alternatives include ozone, bromine, iodine, and gamma radiation. The choice of wastewater disinfectant should be based on a number of factors including flow rates, impact on the receiving stream, disinfectant application and demand rates, wastewater pH, the costs and availability of feed equipment, the costs and availability of specific chemicals, and the operation and maintenance factors.

When chlorine is used as the disinfectant, dechlorination of wastewater effluent is required to reduce the toxicity due to chlorine residuals. End of pipe limit for chlorine will be based on receiving water assessment. When chlorine or one of its compounds is used in the treatment of wastewater, the average concentration of total residual chlorine in the effluent discharged to the environment shall not exceed 0.02 mg/L. The total residual chlorine sampling frequency and averaging period shall be consistent with the CBOD requirements.

3.4.6 Wastewater Treatment Chemicals

Chemicals selected for use in wastewater treatment plants must be such that they will not adversely affect the operation of the wastewater or sludge treatment processes and will not leave dangerous residuals in the effluent or sludge leaving the plant. The purity of chemicals proposed to be used should be determined. Waste streams from industry, such as ferrous chemicals, can be used provided that they are not contaminated with other hazardous materials.

See Section 2.3.9, "Water Treatment Chemicals" for information on Labels and Material Safety Data Sheets and Storage Handling.

3.4.7 Effluent Disposal

3.4.7.1 Disposal to Surface Waters

1. Seasonal Discharges

   The drainage course receiving seasonal discharges from a wastewater treatment plant must be capable of transporting the effluent to the ultimate receiving watercourse without the occurrence of either flooding of adjacent lands or erosion of the drainage course itself.

   Wastewater lagoons shall be drained once a year between late spring and fall; the discharge period should not exceed three weeks unless the local conditions preclude this rate of discharge. Prior to each discharge, the discharge course and receiving environment should be inspected to identify and address constraints. Early spring discharges may be allowed only under exceptional circumstances to comply with any local conditions.

   Where drainage course improvements are required to handle a seasonal pond discharge, prior approval must be obtained under the Water Act in Alberta. In addition, the owner of the facility should obtain easements across privately owned land along the drainage course in areas where flooding problems are foreseen.

2. Continuous Discharges

   The drainage course receiving discharges from a wastewater treatment plant must be capable of transporting the effluent to the ultimate receiving watercourse without the occurrence of either flooding of adjacent lands or erosion of the drainage course itself.

   Piped systems are the preferred method of transporting continuous effluent discharge to an approved receiving watercourse. Under some conditions, however, it may be permissible to use a manmade or intermittent natural drainage course to convey the continuous discharge for a short distance to the receiving watercourse.

3.4.7.2 Disposal to Land

In Alberta, the most common method of land disposal of effluent is through wastewater irrigation, and to a lesser extent through wetlands. Rapid infiltration is generally uncommon, and, so far, has not been practiced by any municipality in Alberta.

1. Wastewater Irrigation

   Minimum treatment requirement and treated effluent quality standards for wastewater irrigation are outlined in Section 3.2.1.

   Wastewater irrigation, as an effluent disposal option, should be considered only when it is environmentally acceptable and agriculturally beneficial. This may be suitable in regions where additional moisture can be utilized for improved crop production. Application amounts should be based on the net consumptive use of the crop being grown while taking into account the seasonal moisture deficiencies, application efficiencies, and any additional needs as may relate to leaching requirements. The primary objective should be the enhancement of crop production. The root zone of productive soils can also serve as one of the most active media for the decomposition, immobilization, or utilization of municipal wastes. An added benefit of wastewater irrigation is that wastewater may be safely released to the environment at somewhat lower levels of treatment than would apply for other disposal options.

Wastewater suitability for irrigation purposes is based on specific water quality parameters. These parameters should be tested prior to and during their release. Site acceptability is to be based on pertinent soil and geologic properties, topography, hydrology, climate, and zoning and cropping intentions.

Land application of wastewater shall be in accordance with the latest edition of Guidelines for Municipal Wastewater Irrigation, published by AESRD.

2. Rapid Infiltration

In the rapid infiltration process, wastewater is applied at high rates for a period from several days to several weeks, and allowed to infiltrate and percolate into the soil. A rest period is then required for the infiltration and treatment capacity of the soil to be restored. The process can be used for wastewater treatment where soil and geologic conditions provide rapid infiltration and high permeability. This process may have a deleterious effect on both groundwater and surrounding surface water.

Design of rapid infiltration (sometimes referred to as infiltration-percolation) systems shall be done in accordance with the joint Alberta Environment and Sustainable Resource Development - City of Red Deer publication entitled Rapid Infiltration - A Design Manual. In general, the following shall apply:

a. a minimum of primary treatment;

b. a minimum of two wastewater storage cells to provide for periodic basin maintenance during the rest period;

c. detailed multidisciplinary site investigations that include, but is not limited to soils, hydrology, hydrogeology, topography, and climate;

d. subsurface groundwater flow definition; and

e. subsurface drains, as required.

3. Wetlands Disposal

Disposal of effluent on wetlands shall be considered only if the wastewater has received secondary or tertiary treatment and the effluent quality meets the standards specified in Tables 3.1 and 3.2.

Wetlands shall be evaluated and designed in accordance with the Alberta Environmental Protection publication entitled Guidelines for the Approval and Design of Natural and Constructed Treatment Wetlands for Water Quality Improvement.

3.4.8 Biosolids (Sludge) Disposal

Biosolids are principally organic in nature, and contain varying quantities of metals, nutrients, salts, grit, synthetic organics and pathogenic organisms. The exact composition of biosolids is a function of the wastewater being treated and can vary significantly from municipality to municipality depending on the quantity and quality of industrial, commercial and institutional inputs. The quantity, quality and characteristics of biosolids from wastewater treatment may be altered by employing various treatment techniques (see Section 4.4).

In general, as treatment efficiency increases the volume of biosolids increases. Biosolids must be disposed of in an environmentally acceptable manner if wastewater treatment, as a whole, is to be considered effective. Commonly employed biosolids disposal methods include:

1. Sanitary landfilling;
2. Incineration;
3. Permanent lagoon storage; and
4. Land application.

Of these disposal methods, the only ways of re-utilizing and conserving the useful constituents in biosolids are through application to land or generation of energy by incineration (provided a positive energy balance is achieved). With proper management, these methods are consistent with the objective of disposing of biosolids in an environmentally acceptable manner.

The application of biosolids to agricultural lands can benefit both municipalities and farmers. To municipalities land application is often the most practical method of biosolids disposal and to farmers biosolids is an excellent potential soil conditioner and fertilizer.

Land application of biosolids shall be carried out in accordance with the latest edition of Guidelines for the Application of Municipal Wastewater Sludges to Agricultural Lands published by AESRD. The purpose of these guidelines is to:

1. Discuss the risks and benefits associated with the use of biosolids on agricultural land; and

2. Outline biosolids application rates and procedures that should be used when applying biosolids to agricultural land in Alberta.

Although a potential soil conditioner and fertilizer, biosolids may also contain pathogenic organisms and quantities of elements and chemicals that can adversely affect crop quality and yield and result in pollution of surface and groundwaters, if improperly managed. These guidelines provide management requirements that will maximize the benefits associated with land application of biosolids while minimizing the potential risks.

3.4.9 Health and Safety Act

The design and construction of all components of the wastewater system shall conform to the safety provisions of the *Alberta Occupational Health and Safety Act, Regulation and Code*.

APPENDIX 3-A

TEST TIME CALCULATION FOR LOW-PRESSURE AIR TESTING OF INSTALLED PVC SEWER PIPE

(Reproduced from Uni-Bell PVC
Pipe Association Standard UNI-B-6-90,
Recommended Practice for Low-pressure
Air Testing of Installed Sewer Pipe - May 1990)

1.1 TEST TIME CRITERIA

The Ramseier test time criteria requires that no test section shall be accepted if it loses more than Q cubic feet per minute per square foot of internal pipe surface area for any portion containing less than 625 square feet internal pipe surface area. The total leakage from any test section shall not exceed 625 Q cubic feet per minute.

1.2 ALLOWABLE AIR LOSS RATE

A Q value of 0.0015 cubic feet per minute per square foot shall be utilized to assure the Owner of quality pipe materials, good workmanship and tight joints.

1.3 TEST TIME CALCULATION

All test times shall be calculated using Ramseier's equation:

$$T = 0.085 \frac{DK}{Q}$$

Where: T = Shortest time, in seconds, allowed for the air pressure to drop 1.0 psig,

K = 0.000419 DL, but not less than 1.0,

Q = 0.0015 cubic feet/minute/square feet of internal surface,

D = Nominal pipe diameter in inches, and

L = Length of pipe being tested in feet.

For more efficient testing of long test sections and / or sections of larger diameter pipes, a timed pressure drop of 0.5 psig may be used in lieu of the 1.0 psig timed pressure drop. If a 0.5 psig pressure drop is used, the appropriate required test times shall be exactly half as long as those obtained using Ramseier's equation for T cited above.

1.4 SPECIFIED TIME TABLES

To facilitate the proper use of this recommended practice for air testing, the following tables are provided. Table I contains the specified minimum times required for a 1.0 psig pressure drop from a starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipe's invert. Table II contains specified minimum times required for a 0.5 psig pressure drop from a starting pressure of at least 3.5 psig greater than the average back pressure of any groundwater above the pipe's invert.

TABLE I

MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

1 Pipe Diameter (in.)	2 Minimum Time (min: sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5.40	5.40	5.40	5.40	5.40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28.51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

TABLE II

MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

1 Pipe Diameter (in.)	2 Minimum Time (min: sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	46:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

9 781460 102947