RECOMMENDED STANDARDS
for
WASTEWATER FACILITIES

POLICIES FOR THE DESIGN, REVIEW, AND APPROVAL OF PLANS AND SPECIFICATIONS

FOR WASTEWATER COLLECTION AND TREATMENT FACILITIES

2004 EDITION

A REPORT OF THE WASTEWATER COMMITTEE

OF THE

GREAT LAKES -- UPPER MISSISSIPPI RIVER

BOARD OF STATE AND PROVINCIAL PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS

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EXHIBIT E

CHAPTER 10
ENGINEERING REPORTS AND FACILITY PLANS

10. GENERAL

10.1 Engineering Services

Engineering services are performed in three steps:

a. Engineering Report or Facility Plan;

b. Preparation of construction plans, specifications, and contractual documents; and

c. Construction compliance, inspection, administration, and acceptance.

Chapter 10, Engineering Reports and Facility Plans, covers only item a. above.

10.2 Preliminary Project Submittal

A preliminary project submittal may be necessary prior to preparation of an Engineering Report or Facility Plan. This submittal needs to include:

a. A description of problems or developments which have resulted in consideration of a wastewater facilities project;

b. Identification of governmental and consultant representatives authorized to provide information and seek regulatory agency approvals and decisions regarding the project; and

c. Identification of potential treated wastewater discharge locations for the purpose of regulatory agency determinations of suitable effluent quality requirements.

No approval for construction can be issued until final, detailed plans and specifications have been submitted and approved by the appropriate reviewing authority. Refer to Chapter 20.

11. ENGINEERING REPORT OR FACILITY PLAN

For federal, provincial, or state financed grant or loan projects, additional requirements may apply.

The Engineering Report or Facility Plan: identifies and evaluates wastewater related problems; assembles basic information; presents criteria and assumptions; examines alternate projects, with preliminary layouts and cost estimates; describes financing methods, sets forth 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 planning document must include sufficient detail to demonstrate that the proposed project meets applicable criteria.

The concept (including process description and sizing), factual data, and controlling assumptions and considerations for the functional planning of wastewater facilities are presented for each process unit and for the whole system. These data form the continuing technical basis for the detailed 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.

Engineering Reports must be completed for minor collection system, pump station, and interceptor projects. Comprehensive Facility Plans must be completed or have been completed for projects involving new, expanded, upgraded, or rehabilitated wastewater treatment facilities and major collection, interceptor sewer, and pump station projects. The determination of classification as major or minor collection interceptor sewer and pump station projects will be made by the reviewing authority based on review of recommended classification by the owner.

11.1 Engineering Reports

Engineering reports shall contain the following and other pertinent information as required by the reviewing authority:

11.11 Problem Defined

Description of the existing system should include an evaluation of the conditions and problems needing correction.

11.12 Flow and Organic Load

The anticipated design average and design peak flows and waste load for the existing and ultimate conditions must be established. The basis of the projection of initial and future flows and waste load must be included and must reflect the existing, or initial service area, and the anticipated future service area. Flow and organic load information and data needed for new facilities are included in Paragraphs 11.24 and 11.25.

11.13 Impact on Existing Wastewater Facilities

The impact of the proposed project on all existing wastewater facilities, including gravity sewers, lift stations, and treatment facilities must be evaluated.

11.14 Project Description

A written description of the project is required.

11.15 Drawings

Drawings identifying the site of the project and anticipated location and alignment of proposed facilities are required.

CHAPTER 30
DESIGN OF SEWERS

31. APPROVAL OF SEWERS

In general, the appropriate reviewing authority will approve plans for new systems, extensions to new areas, or replacement sanitary sewers only when designed upon the separate basis, in which rain water from roofs, streets, and other areas, and groundwater from foundation drains, are excluded.

32. DESIGN CAPACITY AND DESIGN FLOW

In general, sewer capacities 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. Where future relief sewers are planned, economic analysis of alternatives should accompany initial permit applications. See Paragraph 11.24.

33. DETAILS OF DESIGN AND CONSTRUCTION

33.1 Minimum Size

No public gravity sewer conveying raw wastewater shall be less than 8 inches (200 mm) in diameter.

33.2 Depth

In general, sewers should be sufficiently deep to receive wastewater from basements and to prevent freezing. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

33.3 Buoyancy

Buoyancy of sewers shall be considered and flotation of the pipe shall be prevented with appropriate construction where high groundwater conditions are anticipated.

33.4 Slope

33.41 Recommended Minimum Slopes

All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second (0.6 m/s), based on Manning's formula using an "n" value of 0.013. The following are the recommended minimum slopes which should be provided for sewers 42 inches (1050 mm) or less; however, slopes greater than these may be desirable for construction, to control sewer gases or to maintain self-cleansing velocities at all rates of flow within the design limits.

Nominal Sewer Size	Minimum Slope in Feet Per 100 Feet (m/100 m)
8 inch (200 mm)	0.40
10 inch (250 mm)	0.28
12 inch (300 mm)	0.22
14 inch (350 mm)	0.17
15 inch (375 mm)	0.15
16 inch (400 mm)	0.14
18 inch (450 mm)	0.12
21 inch (525 mm)	0.10
24 inch (600 mm)	0.08
27 inch (675 mm)	0.067
30 inch (750 mm)	0.058
33 inch (825 mm)	0.052
36 inch (900 mm)	0.046
39 inch (975 mm)	0.041
42 inch (1050 mm)	0.037

Sewers 48 inches (1200 mm) or larger should be designed and constructed to give mean velocities, when flowing full, of not less than 3.0 feet per second (0.9 m/s), based on Manning's formula using an "n" value of 0.013.

33.42 Minimum Flow Depths

Slopes which are slightly less than the recommended minimum slopes may be permitted. Such decreased slopes may be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. The operating authority of the sewer system will give written assurance to the appropriate reviewing authority that any additional sewer maintenance required by reduced slopes will be provided.

33.43 Minimize Solids Deposition

The pipe diameter and slope shall be selected to obtain the greatest practical velocities to minimize settling problems. Oversize sewers will not be approved to justify using flatter slopes. If the proposed slope is less than the minimum slope of the smallest pipe which can accommodate the design peak hourly flow, the actual depths and velocities at minimum, average, and design maximum day and peak hourly flow for each design section of the sewer shall

All existing waterworks units, such as basins, wells, or other treatment units, within 200 feet (60 m) of the proposed sewer shall be shown on the engineering plans.

Soil conditions in the vicinity of the proposed sewer within 200 feet (60 m) of waterworks units shall be determined and shown on the engineering plans.

38.3 Relation to Water Mains

38.31 Horizontal and Vertical Separation

Sewers shall be laid at least 10 feet (3 m) horizontally from any existing or proposed water main. The distance shall be measured edge to edge. For gravity sewers where it is not practical to maintain a 10 foot (3 m) separation, the appropriate reviewing agency may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the gravity sewer closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the gravity sewer and at an elevation so the bottom of the water main is at least 18 inches (460 mm) above the top of the sewer.

If it is impossible to obtain proper horizontal and vertical separation as described above for gravity sewers, both the water main and gravity sewer must be constructed of slip-on or mechanical joint pipe complying with public water supply design standards of the agency and be pressure tested to 150 psi (1034 kPa) to assure watertightness.

38.32 Crossings

Sewers crossing water mains shall be laid to provide a minimum vertical distance of 18 inches (460 mm) between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to maintain line and grade.

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, one of the following methods must be specified:

a. The sewer shall be designed and constructed equal to water pipe, and shall be pressure tested at 150 psi (1034 kPa) to assure watertightness.

b. Either the water main or the sewer line may be encased in a watertight carrier pipe which extends 10 feet (3 m) on both sides of the crossing, measured perpendicular to the water main. The carrier pipe shall be of materials

42.32 Protection Against Clogging

42.321 Combined Wastewater

Pumps handling combined wastewater shall be preceded by readily accessible bar racks to protect the pumps from clogging or damage. Bar racks should have clear openings as provided in Paragraph 61.121. Where a bar rack is provided, a mechanical hoist shall also be provided. Where the size of the installation warrants, mechanically cleaned and/or duplicate bar racks shall be provided. Refer to Paragraphs 42.23 and 61.13.

42.322 Separate Sanitary Wastewater

Pumps handling separate sanitary wastewater from 30 inch (750 mm) or larger diameter sewers shall be protected by bar racks meeting the above requirements. Appropriate protection from clogging shall also be considered for small pumping stations. Refer to Paragraphs 42.23 and 61.13.

42.33 Pump Openings

Pumps handling raw wastewater shall be capable of passing spheres of at least 3 inches (80 mm) in diameter. Pump suction and discharge openings shall be at least 4 inches (100 mm) in diameter.

42.34 Priming

The pump shall be so placed that under normal operating conditions it will operate under a positive suction head, except as specified in Section 43.

42.35 Electrical Equipment

Electrical systems and components (e.g., motors, lights, cables, conduits, switch boxes, control circuits, etc.) in raw wastewater wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall comply with the National Electrical Code requirements for Class I, Division 1, Group D locations. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with a watertight seal and separate strain relief. A fused disconnect switch located above ground shall be provided for the main power feed for all pumping stations. When such equipment is exposed to weather, it shall meet the requirements of weatherproof equipment NEMA 3R or 4. Lightning and surge protection systems should be considered. A 110 volt power receptacle to facilitate maintenance shall be provided inside the control panel for lift stations that have control panels outdoors.

Ground Fault Circuit Interruption (GFCI) protection shall be provided for all outdoor outlets.

42.36 Intake

Each pump shall have an individual intake. Wet well and intake design should be such as to avoid turbulence near the intake and to prevent vortex formation.

42.37 Dry Well Dewatering

A sump pump equipped with dual check valves shall be provided in the dry well to remove leakage or drainage with discharge above the maximum high water level of the wet well. 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 leakage shall be piped or channeled directly to the sump. The sump pump shall be sized to remove the maximum pump seal water discharge which would occur in the event of a pump seal failure. Refer to Section 46.

42.38 Pumping Rates

The pumps and controls of main pumping stations, and especially pumping stations operated as part of treatment facilities, should be selected to operate at varying delivery rates. Insofar as is practicable, such stations should be designed to deliver as uniform a flow as practicable in order to minimize hydraulic surges. The station design capacity shall be based on peak hourly flow as determined in accordance with Paragraph 11.24 and should be adequate to maintain a minimum velocity of 2 feet per second (0.6 m/s) in the force main. Refer to Paragraph 49.1.

42.4 Controls

Water level control sensing devices should be so located as not to be unduly affected by turbulent flows entering the well or by the turbulent suction of the pumps. Bubbler type level monitoring systems shall include dual air compressors. Provision shall be made to automatically alternate the pumps in use. Suction lift stations should be designed to alternate pumps daily instead of each pumping cycle to extend the life of the priming equipment.

42.5 Valves

42.51 Suction Line

Suitable shutoff valves shall be placed on the suction line of dry pit pumps.

42.52 Discharge Line

Suitable shutoff and check valves shall be placed on the discharge line of each pump (except on screw pumps). The check valve shall

air from the suction-lift pump. The vacuum pumps shall be adequately protected from damage due to wastewater. 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 22 feet (6.7 m).

43.2 Equipment, Wet Well Access, and Valving Location

The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent a hazardous and corrosive sewer atmosphere from entering the equipment compartment. Wet well access shall not be through the equipment compartment and shall be at least 24 inches (610 mm) in diameter. Gasketed replacement plates shall be provided to cover the opening to the wet well for pump units removed for servicing. Valving shall not be located in the wet well.

44 SUBMERSIBLE PUMP STATIONS - SPECIAL CONSIDERATIONS

Submersible pump stations shall meet the applicable requirements under Section 42, except as modified in this Section.

44.1 Construction

Submersible pumps and motors shall be designed specifically for raw wastewater use, including totally submerged operation during a portion of each pumping cycle and shall meet the requirements of the National Electrical Code for such units. An effective method to detect shaft seal failure or potential seal failure shall be provided.

44.2 Pump Removal

Submersible pumps shall be readily removable and replaceable without personnel entering or dewatering the wet well, or disconnecting any piping in the wet well.

44.3 Electrical Equipment

44.31 Power Supply and Control Circuitry

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 watertight seals.

44.32 Controls

The motor control center shall be located outside the wet well, be readily accessible, and be protected by a conduit seal or other appropriate measures meeting the requirements of the National 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. When such equipment is exposed to

that is staffed 24 hours a day. If such a facility is not available and a 24-hour holding capacity is not provided, the alarm shall be transmitted to municipal offices during normal working hours and to the home of the responsible person(s) in charge of the lift station during off-duty hours. Audio-visual alarm systems may be acceptable in some cases in lieu of a transmitting system depending upon location, station holding capacity and inspection frequency.

47 EMERGENCY OPERATION

47.1 Objective

The objective of emergency operation is to prevent the discharge of raw or partially treated wastewater to any waters and to protect public health by preventing back-up of wastewater and subsequent discharge to basements, streets, and other public and private property.

47.2 Emergency Pumping Capability

Emergency pumping capability is required unless on-system overflow prevention is provided by adequate storage capacity. Emergency pumping capability shall be accomplished by connection of the station to at least two independent utility substations, or by provision of portable or in-place internal combustion engine equipment which will generate electrical or mechanical energy, or by the provision of portable pumping equipment. Such emergency standby systems shall have sufficient capacity to start up and maintain the total rated running capacity of the station. Regardless of the type of emergency standby system provided, a portable pump connection to the force main with rapid connection capabilities and appropriate valving shall be provided outside the dry well and wet well.

47.3 Emergency High Level Overflows

For use during possible periods of extensive power outages, mandatory power reductions, or uncontrollable emergency conditions, 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 wastewater 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. Where such overflows affect public water supplies or other critical water uses, the regulatory agency shall be contacted for the necessary treatment or storage requirements.

47.4 Equipment Requirements

47.41 General

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:

47.421 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.

47.422 Operation

The engine and pump shall be equipped to provide automatic start-up and operation of pumping equipment unless manual start-up and operation is justified. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity and alarm system must meet the requirements of Paragraph 47.423.

47.423 Portable Pumping Equipment

Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity with alarm system shall be provided to allow time for detection of pump station failure and transportation and hookup of the portable equipment.

47.43 Engine-Driven Generating Equipment

Where permanently-installed or portable engine-driven generating equipment is used, the following requirements shall apply in addition to general requirements of Paragraph 47.41:

47.431 Generating Capacity

a. 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 lift station.

b. The operation of only one pump during periods of auxiliary power supply must be justified. Such justification may be made on the basis of the design peak hourly flows relative to single-pump capacity, anticipated length of power outage, and storage capacity.

c. 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.

47.432 Operation

Provisions shall be made for automatic and manual start-up and load transfer unless only manual start-up and operation is justified. 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 system must meet the requirements of Paragraph 47.433.

47.433 Portable Generating Equipment

Where portable generating equipment or manual transfer is provided, sufficient storage capacity with alarm system shall be provided to allow time for detection of pump station failure and transportation and connection of generating equipment. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

47.44 Independent Utility Substations

Where independent substations are used for emergency power, each separate substation and its associated transmission lines shall be capable of starting and operating the pump station at its rated capacity.

48 INSTRUCTIONS AND EQUIPMENT

Wastewater pumping stations and portable equipment shall be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, tools and such spare parts as may be necessary.

49 FORCE MAINS

49.1 Velocity and Diameter

At design pumping rates, a cleansing velocity of at least 2 feet per second (0.6 m/s) should be maintained. The minimum force main diameter for raw wastewater shall not be less than 4 inches (100 mm).

49.2 Air and Vacuum Relief Valve

An air relief valve shall be placed at high points in the force main to prevent air locking. Vacuum relief valves may be necessary to relieve negative pressures on force mains. The force main configuration and head conditions should be evaluated as to the need for and placement of vacuum relief valves.

49.3 Termination

The force main shall enter the receiving manhole with a smooth flow transition to the gravity sewer system at a point not more than 1 foot (0.3 m) above the flow line. Corrosion protection for the receiving manhole shall be provided in accordance with Paragraph 34.8.

49.4 Pipe and Design Pressure

Pipe and joints shall be equal to water main strength materials suitable for design conditions. The force main, reaction blocking, and station piping shall be designed to withstand water hammer pressures and associated cyclic reversal of stresses that are expected with the cycling of wastewater lift stations. The use of surge valves, surge tanks or other suitable means to protect the force main against severe pressure changes shall be evaluated.

49.5 Special Construction

Force main construction near streams or water works structures and at water main crossings shall meet applicable provisions of Sections 36, 37, and 38. There shall be at least a 10 foot (3 m) horizontal separation between water mains and sewer force mains.

49.6 Design Friction Losses

49.61 Friction Coefficient

Friction losses through force mains shall be based on the Hazen and Williams formula or other acceptable methods. When the Hazen and Williams formula is used, the value for "C" shall be 100 for unlined iron or steel pipe for design. For other smooth pipe materials such as PVC, polyethylene, lined ductile iron, etc., a higher "C" value not to exceed 120 may be allowed for design.

49.62 Maximum Power Requirements

When initially installed, force mains will have a significantly higher "C" factor. The effect of the higher "C" factor should be considered in calculating maximum power requirements and duty cycle time to prevent damage to the motor. The effects of higher discharge rates on selected pumps and downstream facilities should also be considered.

49.7 Identification

Where force mains are constructed of material which might cause the force main to be confused with potable water mains, the force main shall be appropriately identified.

49.8 Leakage Testing

Leakage tests shall be specified including testing methods and leakage limits.