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London
CANADA

Chapter 4

Sewage Pumping Stations

Design Specifications & Requirements Manual

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City of London

Design Specifications and Requirements Manual

The design information contained in this manual is intended to provide guidance beyond legislative and standard design practices for use in the City of London (the City). There will be site specific situations where the design will depart from these practices as it is not possible nor is it the intention of the City to anticipate every situation. The City intends to review and revise the Manual from time to time. The City also acknowledges that other references such as the 'Standard Contract Documents for Municipal Construction Projects' are to be used in conjunction with this manual. The 2012 update of this manual incorporates design information from the City's former 'Subdivision & Development Guide Manual' to provide consistent and current design information for development projects.

The City of London maintains its right to accept or refuse any design submissions and requires an acceptable design for any given circumstance.

Index

Chapter 1	Introduction
Chapter 2	Transportation
Chapter 3	Sanitary Sewer Collection System
Chapter 4	Sewage Pumping Stations
Chapter 5	Storm Sewer Collection System
Chapter 6	Stormwater Management Requirements
Chapter 7	Water Distribution System
Chapter 8	Water Pumping Stations
Chapter 9	Grading
Chapter 10	Erosion and Sediment Control
Chapter 11	Parks and Open Space
Chapter 12	Tree Planting and Protection Guidelines
Chapter 13	Material Substitutions for City of London Projects
Chapter 14	Contact Information
Chapter 15	Installation, Inspection of Water and Sewer Works
Chapter 16	Noise Attenuation Measures
Chapter 17	Trenchless Technologies (for New Construction)
Chapter 18	Drafting and Design Requirements
Chapter 19	Development Compliance Procedure
Chapter 20	Area-specific Streetscape Standards

Contents

4	Sewage Pumping Stations	4-1
4.1	Definition and Purpose	4-1
4.2	Permitted Uses	4-1
4.3	Design Criteria	4-1
4.3.1	General.....	4-1
4.3.2	Site Layout and Servicing.....	4-2
4.3.3	Structural	4-3
4.3.4	Flow Capacity	4-3
4.3.5	Pumps	4-4
4.3.6	Channels	4-5
4.3.7	Pump Controls.....	4-5
4.3.8	Valves and Fittings	4-5
4.3.9	Flow Measurement.....	4-6
4.3.10	Wet Wells	4-6
4.3.11	Heating and Ventilation	4-6
4.3.12	Water Supply	4-7
4.3.13	Access.....	4-8
4.4	Suction-lift Pump Stations.....	4-8
4.5	Submersible Pump Stations	4-9
4.6	Alarm and Monitoring Systems.....	4-10
4.7	Emergency Operation	4-10
4.7.1	Emergency Power	4-10
4.7.2	By-pass Overflows.....	4-11
4.7.3	Instructions and Equipment	4-11
4.8	Forcemains	4-11
4.9	Safety.....	4-12
4.10	Erosion & Sediment Control Plan	4-13

4 Sewage Pumping Stations

4.1 Definition and Purpose

A pumping station is a component of the sanitary sewage collection system that conveys domestic and other suitable sewage to a sewage treatment facility. The need for pumping sewage arises when:

- The existing topography and required minimum sewer grades create deep sewers that have high construction costs. The sewage is raised and then conveyed by gravity.
- Basements are too low to discharge sewage to the main sewer.
- Sewage must be conveyed over a ridge.
- The sewage must be raised to get head for gravity flow through a treatment plant.
- Discharge outlets are below the level of the receiving body of water.
- An existing gravity system is not imminently available. A pumping station will enable development and growth in accordance with the applicable Community Plan.

4.2 Permitted Uses

Discharges to sanitary sewer systems shall comply with:

- The City of London [Waste Discharge By-Law \(WM-16\)](#)
- The City of London [Drainage By-law \(WM-4\)](#)

4.3 Design Criteria

4.3.1 General

The design of the pumping station must conform to the current City of London standard, SEWAGE PUMPING STATION PHILOSOPHY, as described in the SCADA standard on the City's website, and all other related standards, codes and regulations, unless authorized and approved by the City Engineer and other approval authorities.

The following information is to be provided prior to the commissioning of any pumping station:

- Provide a pre-start health and safety review as per OHSA, NFPA-820 and the Ontario Electrical Safety Code.

- Provide a plastic laminate fact sheet on the pumping station, including lowest basement elevation, location of forcemain outlet to gravity system and bypass invert elevation. The fact sheet shall be a minimum size of 11" x 17" and mounted adjacent to the control panel.
- Provide a plastic laminate with process flow diagram indicating valves and key interlocks shall also be included.
- A separate information document providing firm design range for inflow rate, optimum inflow rate for station that they are designing to, estimated operating costs for the pumping station including HVAC, heating and odour control, estimated pump life, retention time, volume and drain time of the forcemain, life of pumping station and when next upgrade is required due to estimated projected flow, detention time in forcemain and odour potential considerations.

4.3.2 Site Layout and Servicing

Pumping stations and access to pumping stations are to be located above the 100 year flood limits unless approved otherwise by the City Engineer and other regulatory agencies. The site shall have good vehicular access and maneuvering area, and minimize potential adverse environmental impacts. The facilities layout shall allow for future expansion, and comply with front, rear and side yard setbacks according to the applicable zoning and site plan standard and requirements, and convenient location of portable generator.

Building construction shall be architecturally pleasing, in relation to surrounding community, and low maintenance. Permanent structures shall be masonry or concrete construction. Temporary structures shall not be of wood frame construction. Cladding for temporary structures shall be of pre-formed FRP or pre-finished metal and include provisions to protect the building from vehicles.

Building insulation requirements, interior finish, and minimum interior building temperature shall be as directed by the City Engineer.

Building design, layout and construction materials shall be to the satisfaction of the City Engineer. Facility design and layout shall have regards to making confined space entry user friendly, optimizing sight and retrieval lines and comply with OSHA regulation.

Landscaping of the site shall be low maintenance and architecturally pleasing, well-graded, minimal grass areas and landscaped to the satisfaction of the City Engineer. Site drainage shall not drain onto adjacent private property.

Fencing shall be 1.8m high chain link fence with lockable gates that are sized appropriately. Include warning and municipal address signage as per current City standards. Barbed wire fence shall be used as per current City fence by-law PS-1, and as directed by the City Engineer.

Provide adequate exterior lighting of the pumping station facilities such as access, parking, provide security hardware and alarms for all exterior doors, windows and exterior equipment to the satisfaction of the City Engineer.

Exterior lighting may be controlled by motion sensor or photo-eye as directed by the City Engineer.

All control equipment and panels shall be indoors unless approved by the City Engineer.

All utility meters such as gas, hydro, water meter reader, shall be mounted on the exterior of the building.

Access to the site shall include provision for parking of maintenance vehicles and standby/emergency equipment. Roads shall be asphalt surfaced in parking and maneuvering areas and provide convenient removal and storage of snow, and turn around for trucks, tankers and heavy equipment.

All utilities including phone and computer communications servicing the site shall be underground unless authorized by the City Engineer. Design, installation and planning of services shall be according to requirements of applicable codes, regulations and the local utility authority.

4.3.3 Structural

The pumping station shall be evaluated for uplift and resistance to all combined or single loadings considering soil conditions, ground water level, and frost action. Uplift shall be determined when the structure is completely empty and dry, free of equipment, roof slab removed, and the structure watertight. Design the base slab to withstand all earth loadings when the structure is completely filled to maximum level, roof slab on, and all equipment installed. Provide crane and hoist design including appropriately sized hatches for convenient pump and equipment removal.

Location of crane, hoist, and hatches, and arrangement of piping, pumps and equipment shall be such to facilitate ease of removal and installation of equipment.

4.3.4 Flow Capacity

The pumping station flow capacity shall be based on the peak hourly flow rate determined from the peak flow calculation as outlined in Section 3.0, SANITARY SEWER DESIGN and consider low flow conditions, as approved by the City Engineer. The flow capacity of the pumping station should be able to maintain a desirable cleansing velocity of 0.9m/s with a minimum velocity of 0.60m/s, and a maximum velocity of 3.0m/s in all piping. The design of new pumping stations shall allow for future modification or expansion to meet the requirements of the tributary area of the pumping station.

4.3.5 Pumps

Multiple pumps shall be provided and sized to provide firm capacity. When two pumps are used, firm capacity shall be maintained by one pump and shall be of the same size.

When multiple pumps are used, firm capacity shall be maintained by the remaining pumps when the largest pump is out of service. The capacity of the largest pump will be equal to the required firm capacity. All pumps must undergo a hydrostatic and operating test performed by the manufacturer prior to installation.

All pumping stations that are required to handle screenings shall be designed to handle the screenings in a method that is in keeping with the low maintenance philosophy of the pollution control operation. Pumping stations shall be equipped with in-channel grinders upstream of pumps and shall be installed so that sewage flow by-passes the grinders through coarse screens in the event the grinders fail or require maintenance. Pumping stations equipped with chopper pumps or inline grinders and screens shall match the model and manufacturer of equipment currently being installed in the City's sanitary collection system.

Pumps handling raw wastewater shall be capable of passing spheres of at least 76mm diameter. Pump suction and discharge openings shall be at least 100mm in diameter.

Pumps shall be positioned so that under normal operating conditions, they will operate under a positive suction head. When the pump is a suction-lift type, it shall be a self-priming or a vacuum-priming type pump.

Electrical equipment and components such as motors, lights, cables, conduits, switch boxes, control circuits, etc., shall comply with the Ontario Electrical Safety Code (OESC), CSA approved, and comply with the City SCADA Standards. A copy of the SCADA standard can be found on the City website.

Each pump shall have a separate intake. The configuration of the wet well and pump intakes shall prevent vortex formation and air locking.

Design a sump with two pumps in the dry well to remove leakage or drainage and discharge above the maximum high water level of the wet well. Provide dual check valves and gauges on discharge and suction lines for each sump pump. Do not connect water ejectors to a potable water supply. Provide drainage for all floor and walkway surfaces. Pump seal leakage is to be conveyed via appropriately sized channel/s complete with grating directly to the sump. Size the sump pump to convey the maximum pump seal water discharge that would occur in the event of a pump seal failure and provide necessary alarm activation. All sump pumps are to be submersible.

The pumps and controls of pumping stations, and pumping stations operated as part of treatment facilities, shall be selected to operate at varying delivery rates and designed to deliver as uniform a flow as practicable in order to minimize hydraulic surges.

The minimum efficiency, duty life, type and materials of construction for pump and impeller shall be approved by the City Engineer. Preferred voltage is 600 VAC, 3PH.

Dry pit submersible pumps are to be considered in areas susceptible to flooding.

Design all pumps to prevent air locking.

4.3.6 Channels

Dual channels will be utilized and equipped to allow isolating and de-watering each unit. The channel invert shall be 75-150mm below the inlet of the sewer and the entrance to channels shall be designed for equal flow distribution. Design guards to protect maintenance personnel from equipment and drainage to prevent slippery floor areas.

4.3.7 Pump Controls

All controls shall comply with the City SCADA Standards that are located on the City's website.

4.3.8 Valves and Fittings

Provide suitable shut off valves on the suction line of dry pit pumps. Pump suction lines should be designed using 90o short radius down-turned flared elbows; wall pipe shall be flanged with water stop collar; all valves including eccentric reducer shall be flanged; all flanges welded; minimum pipe size shall be NPS-4. All isolation valves shall be located inside chambers for access.

Shutoff and check valves with suitable guards are required on the discharge line of all pumps except screw type pumps. Locate check valves between the shut off valve and pump. Use appropriate check valves and install horizontally on the discharge piping. Ball checks may be installed vertically on the discharge pumping. All valves shall be capable of withstanding normal pressure and water hammer. All valves shall be operable from the floor level and be readily accessible for maintenance. Use outside levers for swing check valves with suitable guarding. All valves, valve operators, fittings, concentric increasers, elbows, double branch elbows, and risers shall be flanged, all flanges welded. Spacers shall be 150-300mm long with one flanged end and one grooved end for Victaulic coupling.

Valves, check valves, drains, fittings and headers shall be of stainless steel, 316 or better, construction. Pipe materials shall be approved by the City Engineer. Identification including flow direction of all piping is required. Painting of non-stainless piping is also required.

Pump discharge to connect to main header pipe with a "Y" connection above the spring-line so that any gravel in the system doesn't flow back into the discharge pipe causing blocking of check valves.

4.3.9 Flow Measurement

Flow measurement devices are required for all pumping stations and properly located for accurate readings with valving and fittings for maintenance with minimum downtime. Flow monitoring equipment shall be able to determine and record rate of flow, duration, volumetric sum, and frequency for each pump and each bypass, and interface with City SCADA requirements.

Provide a spool piece for each mag meter and provide a spool piece for each bypass as directed by the City Engineer. The spool piece depends on forcemain location and wet well retention time. If it is determined that enough time is available to remove the forcemain and install a spool piece safely, then a forcemain by-pass would not be required.

4.3.10 Wet Wells

All pumping stations with a capacity greater than 100 litres/sec shall have divided wet wells that are properly interconnected. The wet well shall have provisions such as a shear or sluice gate or knife valve to facilitate continuous operation during maintenance and to allow dewatering of one portion of the wet well.

The volume of the wet well shall be based on the design average flow with a filling time of a minimum of 30 minutes between the firm capacity start and by-pass. When the wet well is designed for flow equalization, provisions to prevent septicity shall be included. Factors to consider when determining the size are: the volume required for pump cycling based on the pump manufacturer's duty cycle recommendations; appropriate dimensions to minimize turbulence; vertical separation between pump control points; sewer inlet elevation; capacity required between alarm levels, basement flooding and overflow elevations; and the number, spacing and size of pumps. The high water level shall be set 300mm below the invert of the inlet sewer and the low water level shall be 300mm minimum or twice the pump suction diameter above the centre line of the pump volute. The wet well floor shall have adequate slope to the intake hopper and the horizontal area of the hopper shall be kept to a minimum.

Provision for air displacement in wet wells shall be made by natural means consisting of 0.10% of the well cross-sectional area, or a minimum two 100mm diameter inverted "j" or gooseneck pipes with insect screens extending 900mm above finished grade. One vent pipe should extend to within 300mm above the obvert of the inlet sewer. The other vent pipe should extend to the underside of the wet well roof slab.

Wet wells are to be designed to be self-cleaning and to minimize grit accumulation.

4.3.11 Heating and Ventilation

Adequate ventilation, as per O.H.S., Building Code and NFPA shall be provided for all pumping stations. Underground dry wells and wet wells with screens or mechanical

equipment require mechanical ventilation. The ventilating fan should be orientated to direct fresh air into the wet well at a point 900mm above the alarm level rather than just exhaust from the wet well. Interconnection between the wet well and dry well is not allowed and vents shall not open or be connected to any building ventilation system. Where continuous ventilation is required, air shall be pre-heated. Consideration for the installation of air scrubbers shall be made as directed by the City Engineer.

For dry wells, over 4.6m deep, multiple air inlets and outlets should be used. Dampers, fine screens or other obstructions are not to be used on exhaust or fresh air ducts.

Switches and controls to operate ventilation equipment shall be conveniently located and marked. All intermittently operated ventilation equipment shall be interconnected with the respective lighting system. Consideration should also be given to automatic controls where intermittent operation is used. The manual lighting and ventilation switch shall override the automatic controls.

The fan blades shall be fabricated from non-sparking material. Automatic heating and dehumidification equipment shall be designed for all dry wells. The electrical equipment and components shall meet the requirements for electrical equipment in Section 4.3.5.

Wet well ventilation may be either continuous or intermittent. Continuous or intermittent ventilation shall meet or exceed the number of complete air changes per hour as required by NFPA 820. Air shall be forced into the wet well by mechanical means rather than solely exhausted from the wet well. The air change requirements shall be based on 100 percent fresh air. When permanent ventilation equipment is not practical, portable ventilation equipment shall be designed for use at submersible pump stations and wet wells.

Dry well ventilation may be either continuous or intermittent. Continuous or intermittent ventilation shall meet or exceed the number of complete air changes per hour as required by NFPA 820. A two-speed ventilation system may be used to conserve heat. The air change requirements are based on 100 percent fresh air.

Locate the fan switch for ventilation equipment to the satisfaction of the City Engineer.

An engineered heat recovery system that considers energy efficiency and recovery is to be designed where:

- There is a requirement for 100% fresh air into a space within a pumping station;
- An air scrubber system is required for wet well odour control.

Engineering designs should consider potential for a heat recovery system in the sewage wet well such as a glycol recovery system to capture and return heat to the station.

4.3.12 Water Supply

Water supply shall be potable unless authorized by the City Engineer.

Water supply shall be equipped with back-flow preventers to prevent contamination of the water system and all plumbing shall conform to the Ontario Building Code.

Water supply shall be a minimum 25mm.

4.3.13 Access

Access shall consider the City's Confined Space Entry procedures and policy. Provision shall be made to facilitate easy and efficient removal of pumps, motors, and other mechanical and electrical equipment. A suitable and safe means of access for persons wearing self-contained breathing apparatus shall be provided to wet and dry wells and valve chambers.

Stairs shall be provided for vertical heights greater than 1.2 metres. Maximum vertical distance between work platforms and landings shall be 3 metres. Safety landings shall be constructed as work platforms.

Provide davit base anchors where required for DBI Sala standard equipment that complies with City confined space standards.

Equipment such as access hatches, ladders, service platforms, guards, grates and handrails, shall be constructed of a suitable material when exposed to wet/and or corrosive conditions.

4.4 Suction-lift Pump Stations

Suction lift pumps shall also meet the applicable design requirements of Section 4.3 above.

Suction-lift pumps shall be of the self-priming or vacuum-priming type. Suction-lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved upon submission of factory certification of pump performance and detailed calculations indicating satisfactory performance under the proposed operating conditions. Such detailed calculations must include static suction-lift as measured from "lead pump off" elevation to centerline of pump suction, friction, and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head, and a safety factor of at least 1.8 m.

Self-priming pumps shall be capable of rapid priming and re-priming at the "lead pump on" elevation. Such self-priming and re-priming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed 7.6 m in total length. Priming lift at the "lead pump on" elevation shall include a safety factor of at least 1.2 m from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction-lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed 6.7 m.

Vacuum-priming pump stations shall be equipped with dual vacuum pumps capable of removing air from the suction-lift pump automatically and completely. 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 6.7 m.

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 1m by 1m clear opening with spring-loaded, shock assist hatches. 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.

4.5 Submersible Pump Stations

Submersible pumps shall meet the applicable requirements under Section 4.3, except as modified in this Section.

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 Ontario Hydro Electrical Safety Code and CSA for such units. An effective method to detect shaft seal failure or potential seal failure shall be provided.

Submersible pumping stations shall be designed so that pumps are readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well. Location of crane, hoist, and hatches, and arrangement of piping, pumps and equipment shall be such to facilitate ease of removal and installation of equipment.

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 outside the wet well. Controls shall be designed in accordance with City SCADA Standards.

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 Ontario Hydro Electrical Safety 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.

Pump motor power cords shall be designed for flexibility and serviceability under conditions of extra hard usage. They shall meet the requirements of the Ontario Hydro Electrical Safety Code standards for flexible cords in wastewater pump stations. Ground-fault interruption protection shall be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal-fittings shall be corrosion resistant and constructed in a manner to prevent the entry of moisture into the

cable. They shall also be provided with strain relief appurtenances and be designed to facilitate field connecting.

Valves required under Section 4.3.8 shall be located in a separate valve chamber. Provisions shall be made to remove or drain accumulated water from the valve chamber. The valve chamber may be dewatered to the wet well through a drain line with a gas and watertight valve. Check valves that are integral to the pump need not be located in a separate valve chamber if the valve can be removed from the wet well in a convenient and efficient manner.

Separate valve chambers shall be insulated and heated to prevent freezing.

4.6 Alarm and Monitoring Systems

Pumping station alarms and equipment shall comply with the pumping station control philosophy as described in the City SCADA Standards.

Integration into the SCADA system is to be complete by City forces. This includes PLC programming and operator interface all as per the current applicable charge-out rates.

4.7 Emergency Operation

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. Pumping stations shall be designed to provide temporary pumping around the station and enable isolation of the forcemain and pumping station, by means of isolation valves inside and outside the pumping station.

4.7.1 Emergency Power

Emergency power is required for all pumping stations. There shall be sufficient capacity of emergency power to start up and maintain the total confirmed pumping station capacity of the station, the SCADA system and all other electrical equipment for 24 hours, unless otherwise approved by the City Engineer.

All pumping stations shall be equipped with an onsite generator. A genset plug compatible with existing City generators may be installed as directed by the City Engineer.

Generators shall be capable of running full station load powered by natural gas or diesel as directed by the City Engineer. The design of generators shall meet all applicable regulations.

4.7.2 By-pass Overflows

By-pass overflow shall be provided by gravity to existing storm sewer system or allow for emergency pumping to other gravity outlet. Emergency sanitary sewer overflow (SSO) outletting upstream of the SWM facility or directly to a SWM facility is not permitted.

By-pass and overflow monitoring and totalization is required and shall comply with City SCADA Standards.

4.7.3 Instructions and Equipment

Wastewater pumping stations and portable equipment shall be supplied with a minimum of five complete sets of operational instructions, including emergency procedures, maintenance schedules (1 Consultant, 2 Operations, 1 pumping station, 1 Wastewater Division), and such tools and spare parts as may be necessary. The consultant will ensure that this documentation will be provided along with the necessary training for operation and maintenance of the equipment prior to commissioning.

4.8 Forcemains

At design pumping rates, a desired cleansing velocity of at least 0.90 m/s shall be maintained. The minimum force main diameter for raw wastewater shall not be less than 100 mm.

An air relief valve shall be 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. Fittings and isolation valves shall be stainless steel.

Forcemain design shall include transient analysis and consider the provision of water hammer relief.

Force mains should enter the gravity sewer system at a point not more than 200 mm above the flow line of the receiving maintenance hole.

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 need for surge protection chambers shall be evaluated. Forcemain pipe materials shall be approved by the City Engineer.

Force main construction near streams or water works structures and at water main crossings shall meet applicable requirements.

Friction losses through force mains shall be based on the Hazen and Williams's formula or other acceptable methods. When the Hazen and Williams formula is used, the following value for "C" shall be used regardless of pipe material:

Pipe Diameter	C-Factor
100-150mm	100
200-250mm	110
300-600mm	120
Over 600mm	130

When initially installed, force mains may have a significantly higher "C" factor.

The force main shall be appropriately identified when they are constructed of material that may cause the force main to be confused with potable water mains.

Force main shall be tested to ensure there is no leakage. Specify method of testing.

4.9 Safety

The design of the pumping station shall give due regard to safety for the protection of maintenance personnel and visitors from hazards:

- a. Enclose the station site with 1.8m chain link fence, lockable gates, designed to discourage entry by unauthorized persons and animals; provide safety, unauthorized entry and municipal address signage, as per City standards;
- b. Handrails and guards are to be installed around tanks, trenches, pits, stairwells, and other hazardous areas;
- c. Gratings are to be installed over areas where access for maintenance is required;
- d. Confined space entry shall comply with the Pollution Control Operation and OSHA regulations. Facility design and layout shall have due regard to make confined space entry user friendly, optimizing sight and retrieval lines;
- e. All personnel must be trained to operate and maintain pumping station equipment and facilities to the satisfaction of the Pollution Control Operation;
- f. Gas detection and monitoring equipment where required. Where gas alarms are provided, install an indicator light outside the building so that the operator can check gas levels before entering the building
- g. Portable ventilation and blower equipment, intrinsically safe, with sufficient hose, where required;
- h. Portable lighting equipment intrinsically safe, where required;
- i. Appropriately placed warning signs for slippery areas, non-potable water fixtures, low head clearance, open service maintenance holes, hazardous material storage areas, flammable fuel storage areas, etc.;

- j. Adequate ventilation in pumping chambers;
- k. Provisions for lockout and tag-out of mechanical and electrical equipment;
- l. Eyewash fountains and safety showers were required;
- m. Fire extinguishers and emergency lighting.

4.10 Erosion & Sediment Control Plan

The City of London requires an Erosion and Sediment Control Plan (E&SC Plan) be designed for most Capital Works, Operational and Development Projects. The complexity of the E&SC Plan is determined by the sensitivity of the area that is to be protected.

For reconstruction or resurfacing of existing roads, or for infill sites less than 3.0 ha in land area within existing urbanized areas, that are not in close proximity to an open watercourse, woodlands, ESA's, steep slopes or other natural area; an E&SC Plan is not required, unless otherwise directed by the City Engineer. Where an E&SC Plan is not required, all reasonable protective measures must be taken during construction to control sediment and prevent erosion from occurring.

For further information on the requirements of the E&SC Plan, please refer to Section 10 – Erosion & Sediment Control, within this manual.