DESIGN AND CONSTRUCTION SPECIFICATIONS

(WATER, WASTEWATER & STORMWATER SYSTEMS)

2016 Edition

Halifax Water

Halifax Regional Water Commission

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To All Readers:

The Halifax Water Design and Construction Specifications document has been revised. Please refer to our website at www.halifaxwater.ca to download the current 2016 edition.

The Halifax Regional Water Commission (HRWC) merged in 2007 with the wastewater and stormwater operational groups of Halifax Regional Municipality (HRM) forming Halifax Water. Our mandate provides for ownership, operation and maintenance of public water, wastewater and stormwater infrastructure within the boundaries of HRM. In order to establish, as far as practicable, uniformity of practice within the HRM, these Design Standards have been developed by staff of Halifax Water. They are to be used as a guideline of minimum standards to be met in the design and construction of municipal water, wastewater and stormwater services systems within the HRM and to list and suggest limiting values for items upon which an evaluation of such designs will be made by the reviewing authority.

It is the intention of the HRWC to conform to the advancements and improvements in the practice of municipal engineering, and we look forward to a successful utilization of this document.

These specifications are developed to provide consistency in design and construction among developers, consultants and contractors all across this region. Any comments or suggested changes to the document are appreciated and encouraged from all interested parties. All comments received will be reviewed and considered for the 2017 update. Comments should be forwarded to Josh DeYoung, P.Eng., joshd@halifaxwater.ca or (902) 830-6540.

It shall be the responsibility of the specifications holder to access our website on an annual basis to ensure that the most current version is utilized.

Yours very truly,

Kenda MacKenzie, P.Eng.
Director, Regulatory Services

1.0 INTRODUCTION

The Halifax Regional Water Commission (HRWC) was formed as an amalgamation of three separate water utilities (Halifax Water Commission, City of Dartmouth Water Utility, and Halifax County Water Utility) in 1996 and a merger with the former Environmental Services Department of Halifax Regional Municipality (HRM) in 2007 forming Halifax Water. In order to establish, as far as practicable, uniformity of practice within the HRM, these design standards and guidelines have been developed by staff of the HRWC. They are to be used as a guideline of minimum standards to be met in the design and construction of municipal services systems within the HRM, and to list and suggest limiting values for items upon which an evaluation of such designs will be made by the reviewing authority. A complete documentation of all parameters relating to the design and construction of municipal services is beyond the scope of this document, however, an attempt has been made to touch upon the parameters of greatest importance and to present the policies and accepted procedures of the HRWC.

The purpose of this document is to provide guidance for designers in the provision of municipal services systems, offering acceptable service which is consistent with the lowest possible installation, operation and maintenance costs. The design of these services, when submitted to the HRWC, must be over the seal of a Professional Engineer in accordance with the Nova Scotia Engineering Profession Act.

This document is not intended to eliminate the necessity for detailed design; rather it is intended to standardize the materials, design criteria and method of construction to be utilized in the installation of municipal services systems. Further, it is not the intention of the HRWC to stifle innovation. Where, in the judgment of the design engineer, variations from this document are justified or required, and where the designer can show that alternate approaches can produce the desired results, such approaches will be considered for approval. In considering requests for variations from these design criteria, the Engineer shall take into consideration such factors as safety, nuisance, system maintenance, operational costs, life cycle costs, environmental issues, natural topography, configuration of the bulk land, etc. Where the designer uses standards other than those outlined in this document, all appropriate documents and plans shall clearly indicate those areas of difference. The acceptance by the HRWC of the design of proposed municipal service systems does not relieve the design engineer of the responsibility of proper design nor does it imply that HRWC has checked the design exhaustively for compliance with this document. Where the HRWC has accepted a design which does not comply with this guideline and where the design engineer has not brought variations from this document to the attention of the Engineer, the provisions of this document still stand.

The Engineer’s decision shall be final and binding in matters of design and construction.

In any case where this document requires expansion or clarification, the latest revisions of the following documents may be used for reference:

- "Standard Specification for Municipal Services", prepared by the Nova Scotia Road Builders Association and the Nova Scotia Consulting Engineers Association.

- American Water Works Association Standards.

- "Nova Scotia Standards and Guidelines Manual for the Collection, Treatment, and Disposal of Sanitary Sewage", prepared by Nova Scotia Environment.

All contract documents prepared for municipal service systems works within the HRM shall contain a clause requiring the contractor to carry out all work in compliance with all applicable Municipal, Provincial and Federal Regulations, including, but not limited to, the Occupational Health and Safety Act for the Province of Nova Scotia.

Design criteria, guidelines and specifications contained in this document will be revised periodically to conform to advances and improvement in the practice of Municipal Engineering. These changes shall be noted in a revision record and will be available to users of this document. It is the responsibility of the designer to remain current with revisions to this document.

All plans / submissions and calculations shall be in metric units.

The design for municipal service systems shall ensure the safe operations and maintenance of the municipal service systems, in accordance with all applicable Municipal, Provincial and Federal regulations including the Occupational Health and Safety Act and applicable CSA specifications. The designer shall assess the possible change in ground water movement caused by the development (in particular the use of impervious bedding material) and shall be responsible for the design of corrective measures to prevent flooding or lowering of ground water table as a result of this ground water movement. If requested by the Engineer, the designer shall provide a report prepared by a geo-technical engineer on the effectiveness of the proposed corrective measures.

No systems shall be constructed until the design has been approved by the Engineer, the approval process followed and a permit to construct obtained from NSE and the necessary street opening permits, and related municipal approvals.

2.0 DEFINITIONS

Approval	The approval of the Engineer. The Engineer's decision will be final and binding in matters of design and construction.
Carrier Pipe	A pipe (DR18 PVC) used to provide protection for utility services when required vertical separations from other utility services cannot be achieved.
Casing Pipe	A pipe designed by a Professional Engineer used in horizontal underground drilling or open cut trench to protect utility services from being damaged.
Combined System	A system intended to function simultaneously as a Stormwater and a Wastewater System and vested in or under the control of HRWC.
Commissioning	A process by which equipment, facility or plant is tested to verify if it functions according to its design or specifications prior to acceptance by HRWC.
Development	Includes any erection, construction, addition, alteration, replacement or relocation of or to any building or structure and any change or alteration in the use made of land, buildings or structures.
Ditch	An excavated or constructed open channel, which is vested in or under the control of HRWC.
Diameter	The nominal internal diameter of the pipe – unless otherwise noted.
Engineer	The Director of Regulatory Services of the HRWC, or their designated representative.
Feeder Main	A water main which typically receives flow from transmission mains or from pressure control facilities (i.e. booster pumping stations or pressure reducing valves), and which supplies water to several branch mains (distribution mains). The feeder main provides a significant carrying capacity or flow capability to a large area.
HRM	Halifax Regional Municipality.

HRWC Halifax Regional Water Commission (Halifax Water) is the municipal water, wastewater and stormwater utility for HRM. The HRWC is authorized to own and operate the water supply, wastewater and stormwater facilities for HRM.

Hyetograph A graph showing average rainfall, rainfall intensities or volume over specified areas with respect to time.

ICI Industrial, Commercial or Institutional, includes or pertains to industry, manufacturing, commerce, trade, business, or institutions and includes multi-unit dwellings of four or more units.

Major Drainage System The path which stormwater will follow during a Major Storm, when the capacity of the Minor Drainage System is exceeded.

Major Storm The 1 in 100 year storm, which has a 1% probability of being equaled in any given year, and is the storm used as the basis for the design of the Minor and Major Drainage Systems together.

Minor Drainage System The system which is used for initial stormwater flows, or for flows generated in high-frequency rainfalls.

Minor Storm The 1 in 5 year storm, which has a 20% probability of being equaled in any given year, and is the storm used as the basis for the design of the Minor Drainage System.

Monitoring Access Point An access point, including a chamber, in a Wastewater or Stormwater Service Connection to allow for observation, sampling and flow measurement of the Wastewater, Uncontaminated Water or Stormwater within a Service Connection.

Multi-Unit Dwellings Also known as a MUD is a building which contains four or more residential dwelling units.

NSE Nova Scotia Environment.

NSTIR Nova Scotia Transportation and Infrastructure Renewal.

Overland Flow Also known as Sheet Flow is the natural flow of water over the ground surface before it becomes channelized.

Professional Engineer	A registered and licensed member, in good standing, of Engineers Nova Scotia and is referenced in this document particularly as that person(s) under whose signature the plans are sealed.
Runoff	That part of the precipitation which travels by surface flow.
Service	Water Service, Wastewater Service or Stormwater Service or any combination of each of them.
Service Connection	Water Service Connection, Wastewater Service Connection, or Stormwater Service Connection, or any combination of each of them.
Service Requirement Map	A map forming part of the Regional Subdivision By-Law. This map identifies the type of Municipal Service Systems required when such systems are to be constructed within HRM.
Start-Up	A process where equipment, facility or utility plant is installed and tested by the contractor and certified complete by the designer / consultant that it meets its intended design or specification prior to Commissioning.
Stormwater	Water from precipitation of all kinds, and includes water from the melting of snow and ice, groundwater discharge and surface water.
Stormwater System	A system carrying Stormwater and vested in or under the control of HRWC.
Stormwater Service Connection	A piping system that conveys Stormwater from a property to a Stormwater System.
Stormwater Management Plan	The compilation of data and mapping that delineates watersheds, indicates routes of the Major and Minor Drainage Systems, defines flood plains, and indicates constraints associated with water quality and quantity, outlines erosion and bank stability problems and shows specific flood control in the watershed.
Subdivision	The division of any area of land into two or more parcels, which may include a re-subdivision or a consolidation of two or more parcels.

Uncontaminated Water Potable water or any other water to which no matter has been added as a consequence of its use.

Unshrinkable Fill A low cementitious material consisting of Portland cement, flyash, water, aggregates and admixtures suitable for backfill in underground service, utility trenches and structures.

Wastewater Liquid waste containing animal, vegetable, mineral or chemical matter as well as water from sanitary appliances that contains human fecal matter or human urine in solution or suspension together with groundwater, surface water or Stormwater as may be present.

Wastewater Service Connection A piping system that conveys Wastewater from a property to a Wastewater System.

Wastewater System The structures, pipes, devices, equipment, processes and related equipment used, or intended to be used, for the collection, transportation, pumping or treatment of Wastewater and disposal of effluent, which are vested in or under control of HRWC.

Water System The source, structures, pipes, hydrants, meters, devices and related equipment used, or intended to be used, for the collection, transportation, pumping or treatment of water, and which are vested in or under the control of HRWC.

Watercourse As defined by The Environment Act – Revised Statutes of Nova Scotia.

Water Service Connection A piping system that conveys water from a water main to a property.

3.0 DESIGN REQUIREMENTS – WATER SYSTEM

3.1 SCOPE

A water distribution system is a complete and properly functioning system of water mains, service connections from the water main to the street lines and appurtenances, including pumping stations, pressure control facilities and reservoirs, which is designed to carry and distribute an adequate supply of potable water for domestic, institutional, commercial, industrial, and fire protection purposes. The design will ensure that HRWC personnel are not exposed to hazards when conducting operation and maintenance of the water distribution system.

In addition to these design standards, all applicable and relevant codes and standards shall be used by the designer, including the following:

- "Water Supply for Public Fire Protection" prepared by the Insurers Advisory Organization (IAO).
- National Fire Protection Association (NFPA).
- American Water Works Association (AWWA).
- Hydraulic Institute Standards.
- Canadian Standards Association (CSA).
- National Building Code of Canada (NBC).
- National Plumbing Code of Canada (NPC).
- Underwriters Laboratories of Canada (ULC).
- The Occupational Health and Safety Act of Nova Scotia.
- NSF 61 / ANSI 61.

All water distribution systems shall conform to any requirements established by NSE. No system shall be constructed until the design has been approved by the Engineer and NSE.

Water system extensions must be carried out in conformance with a Master Plan prepared for the Water Service District in which the extension is to take place. The Master Plan shall identify major infrastructure such as transmission and/or large diameter feeder mains, reservoir size and location, system design capacity calculations, pressure and/or flow control facilities, and operational information.

The HRWC may enter into agreements with developers to:

- Ensure the Master Plan will be developed with all infrastructure components detailed which are necessary to provide the long-term, ultimate service requirements for the area under consideration.

- Comply with an implementation plan, approved by the Engineer. Such implementation plan will provide for the installation of key infrastructure components within prescribed time frames.

- Assign the amount of capital cost contribution due from the developers to finance required infrastructure works identified in the Master Plan.

For a specific extension to the water distribution system by a developer, HRWC will require the developer to enter into an HRWC Services Agreement which defines the rights and obligations of HRWC and the developer regarding construction, inspection, record collection, acceptance and warranty of the water distribution system.

3.2 HYDRAULIC CRITERIA

3.2.1 System Capacity

Water Distribution systems shall be designed to accommodate the greater of maximum daily demand plus fire flow demand, or maximum hourly demand.

Fire flow demand shall be established by the Engineer in accordance with the latest requirements contained in the publication "Water Supply for Public Fire Protection, a Guide to Recommended Practice", as prepared by the Insurers Advisory Organization.

Water distribution systems shall be designed to accommodate the following domestic water demands:

- Average daily demand: 410 litres per person per day (108 US Gallons per person per day).
- Maximum daily demand: 680 litres per person per day (180 US Gallons per person per day).
- Maximum hourly demand: 1025 litres per person per day (270 US Gallons per person per day).

For design purposes, refer to the permitted land uses under the Municipal Planning Strategy (MPS) and Land Use Bylaw (LUB), or approved Development Agreement. When determining site specific populations, refer to numbers below:

- Single Unit Dwellings 3.35 people / unit (ppu)
- Townhouse 3.35 people / unit (ppu)
- Multi-Unit Dwellings 2.25 people / unit (ppu)

The design population or assumed domestic demand must be clearly specified in the calculations submitted for review and approval.

3.2.2 Hydraulic Analysis

Water distribution designs shall be supported by a hydraulic analysis of the system which determines flows, pressures and velocities under maximum day plus fire, maximum hour and minimum hour conditions. The analysis shall be of sufficient scope to identify and describe any impact on the existing system. The designer will be required to submit the hydraulic model used to conduct the analysis along with a design report describing the design methodology and results of the analysis.

The limits of the analysis shall begin at a location of known hydraulic grade determined in consultation with the Engineer and include demands on the existing system downstream of the known hydraulic grade line, as well as demands generated by the proposed development. The developer's consultant shall conduct a hydrant flow test to confirm the static hydraulic grade line and determine the system curve and available residual pressure at the boundaries of the analysis.

Maximum day plus fire analysis shall include sufficient scenarios to test all extreme conditions, such as high fire flow requirements, fires at locations of high elevations and fires at a location remote from the source or feeder main.

Subject to the Engineer's review, new water system extensions of 30 single family units or less, may not require a hydraulic analysis if it can be demonstrated that minimal or no impact will be created on the existing system.

3.2.2.1 Preparation of Hydraulic Model

HRWC uses WaterCAD 8.0 or higher by Bentley Systems and use of the same software by developers and consultants is encouraged. Where the designer does not have access to WaterCAD, HRWC will also accept digital submission of hydraulic models created using EPANET by the United States Environmental Protection Agency. EPANET is public domain software that may be freely copied and distributed.

The hydraulic model shall be submitted in digital format and should follow these minimum guidelines:

- The hydraulic model shall be submitted in a format compatible with the latest release of Bentley WaterCAD or EPANET.

- The submission shall include all files required to run the model. Hydraulic networks should be drawn to scale and represented in "real world coordinates" using the ATS77 MTM Nova Scotia Zone 5 projection.

- Background layers shall be submitted in DXF of ESRI shapefile formats.

- Submit only the physical alternatives proposed in the design report.

- The Hazen Williams formula shall be used for the calculation of friction losses.

- For each node, document the demand basis for that node (e.g. 5 residential units plus large format commercial) in that node's comments or unit's demands dialogue box.

3.2.2.2 Hydraulic Model Scenarios

The designer shall, at a minimum prepare hydraulic model scenarios which determine flows, pressures and velocities under maximum day plus fire, maximum hour and minimum hour conditions. Domestic water demands in the existing system may be based on recorded values, where available. For domestic water demands in the proposed system extension, refer to Section 3.2.1.

Fire flow analysis may be undertaken on a node by node automated basis or as individual scenarios for discrete nodes. Fire flows used must be supported by HRWC minimum requirements and/or calculation as prescribed in the document "Water Supply for Public Fire Protection" by the Insurance Advisory Organization, whichever requires the higher flow rate. Fire flows must be checked for all critical locations which include locations of high fire demand, remote from the source of supply or relatively high elevation.

Analysis of further scenarios may be required at the request of the Engineer.

3.2.2.3 Hydraulic Analysis Report

The designer shall prepare a Hydraulic Analysis Report for review and approval of the Engineer. The Hydraulic Analysis Report must be prepared by a professional engineer and this report must be approved by the Engineer prior to submitting a final detailed design.

The Hydraulic Analysis Report shall contain, at a minimum:

- A general description/discussion of the existing system in the vicinity of the proposed connection.

- A general description of the proposed system extension including nature of the development (residential, commercial, industrial, mixed use), total area to be developed, total projected population(or population equivalent).

- A description of the site contour information including maximum and minimum elevations to be serviced and how this relates to the HGL in adjacent pressure zones.

- A table showing the ultimate serviced population at full build out of the proposed water system extension including a breakdown of residential, commercial, industrial and institutional.

- If the development is to occur in phases, a similar breakdown showing cumulative population at the completion of each phase.

- Tables showing the serviced population, average day demand, maximum day demand, peak hour demand and peak instantaneous demand cumulatively for each phase.

- Discussion of the required fire flow for the proposed development.

- Discussion of the hydrant flow test results.

- Presentation and discussion of the domestic hydraulic analysis results. The minimum and maximum pressures from each scenario should be identified. A table of the calculated minimum and maximum pressures at each node shall be presented in the appendix.

- Presentation and discussion of the fire flow hydraulic analysis results. The minimum and maximum pressures and minimum residual pressure should be identified. A table of the calculated minimum and maximum pressures at each node shall be presented in the appendix.

- A schematic of the proposed distribution system extension, including the location(s) of connection to the existing system, and land areas of the development. The schematic should also include two (2) metre contours for the proposed development and identify the location of minimum and maximum pressure nodes identified in the hydraulic analysis.

3.2.3 Minimum/Maximum Pressures

Water distribution systems shall be designed and sized such that during a fire flow condition, a minimum residual pressure of 150 kPa (22 psi) is maintained in the distribution system. For any water system extension within the HRM Serviceable Area and/or HRM Water Service District boundaries, a minimum residual water pressure of 275 kPa (40 psi) must be maintained at all points along the distribution mains in the water system during maximum hourly demand conditions unless approved by the Engineer. Maximum water pressure during minimum demand periods is not to exceed 620 kPa (90 psi) unless approved by the Engineer.

3.2.4 Limiting Velocities

The water main shall be sized such that the maximum velocity in the pipe shall not exceed 1.5 m/s (5 ft/s) during maximum hourly domestic flow conditions or 2.4 m/s (8 ft/s) during fire flow conditions.

3.2.5 Looping

Water distribution systems shall be designed to exclude any dead-ended pipe.

3.2.6 Supply Redundancy

Water distribution systems shall be designed such that no group of 30 or more metered customers is supplied by a single source of supply.

3.2.7 Minimum Size

The minimum size of pipe shall be 200 mm for local distribution mains.

The size of pipe in a main feeder grid shall be a minimum of 300 mm or such other size that may be required to properly serve the development with domestic water and fire protection to the approval of the HRWC.

3.2.8 Pumped Systems

3.2.8.1 General Requirements

As a result of difference in ground elevations or distance from the source of supply, isolated areas may require pressure boosting of the water system to provide adequate pressure and flows to meet either domestic or fire flow requirements.

To accomplish this, a pumping station shall be required to service a specific area of a water distribution system based on defined limits. These areas are generally isolated from the remainder of the system.

Discharge pressure from the pumping station must be adequate to ensure that the pressure in the water mains in the area being serviced is within the range of 275 kPa (40 psi) to 620 kPa (90 psi) during peak and minimum domestic demand periods. In the case of fire flows, the pressure in the water main shall be at least 150 kPa (22 psi).

In an in-line booster pumping station, the pressure on the suction side of the fire pump shall not be allowed to drop below 150 kPa (22 psi) when there are service connections on the suction side water main.

Domestic water demand will vary greatly from one area to another. For design purposes, existing records for average, maximum daily and peak rates should be used whenever possible. In the absence of such records, the following demands shall be used:

- Average daily, maximum daily and maximum hourly demands are as specified in this document (Section 3.1.1).

- For instantaneous peak flow demands (i.e. Flow when residential consumption including lawn watering is at its highest) a minimum of 5.45 l/min (1.44 US gallons per minute) per dwelling unit is to be used.

3.2.8.2 Pumps

Domestic booster pumps, fire booster pumps and appurtenances, capacity, system sizing, control facilities, layout, installation, testing, etc. must meet all applicable and relevant standards and codes.

Since a single system head curve cannot be developed due to changing demands within the system, projected points of operating head and flow for at least the following conditions shall be developed:

- Average day.
- Maximum day.
- Maximum hour (p.m.).
- Maximum hour (a.m.).
- Minimum hour.

Pumps must be selected which will operate satisfactorily over the necessary pumping ranges expected at the station, from a minimum total dynamic head to a maximum total dynamic head. In general, the pumps must be capable of meeting the following criteria:

- The rated point corresponding to the maximum day consumption rate.
- The rated point for efficiency evaluation (the point at which the pump would normally run and at which the pump should be selected for best efficiency).
- The possible operating range (the range over which the pump must operate from a minimum total dynamic head to a maximum total dynamic head).
- The available Net Positive Suction Head (NPSH) must be specified.

All four of these criteria must be evaluated when a pump is selected. Typically, the unit will operate at a total dynamic head considerably less than the ultimate rated point. Therefore, the maximum efficiency point should be specified as that point at which the pump will normally run.

The rated point must be selected as the point for which the pump will have to overcome the greatest amount of head with a specified flow rate.

Pumps should be selected to avoid the following conditions:

- Pumps subject to destructive low-head, high–flow cavitation.
- High power consumption while handling low loads.
- Noise levels audible beyond the station.

Pumping equipment shall be selected to perform at maximum efficiencies under normal operating conditions. Provide soft start and variable speed drives under the following conditions:

- Soft start — 7.5 kW and larger (10 HP).
- Variable Speed Drive — 15 kW and larger (20 HP), in consultation with the Engineer.

All pumps with mechanical couplings must be aligned on site by a manufacturer's representative, prior to being placed in service.

Prior to any pump being placed in service, the manufacturer's representative shall certify that the pump was correctly installed.

3.2.8.3 Domestic Booster Pumps

The pumping station shall have at least three (3) domestic pumps (one lead/jockey pump and two lag pumps). The pumps shall be sized such that the capacity of the pumping station with the largest domestic pump out of service and when the area is completely developed shall be as follows:

- 80% of peak demand for pumped systems.
- 100% of maximum day demand for systems with elevated storage.

The pumps shall have the following service capability:

- Lead pumps shall provide a maximum of 25 percent of peak demand and provide an adequate supply during normal periods of domestic demand.
- Lag pumps shall provide a maximum of 55 percent of peak demand, provide an adequate supply to meet maximum hourly or peak demand periods, and provide an adequate supply in the event of failure of the lead pump.

3.2.8.4 Fire Booster Pumps

The fire booster pump shall have adequate capacity to supply the necessary fire flow demand as follows:

- Residential fire flow requirements (Single Unit & Semi-Detached Units) of 55.5 l/s (880 US gallons per minute) and (Townhouse) 75.7 l/s (1200 US gallons per minute).

- Multi-Unit, Industrial, Commercial & Institutional (MICI) fire flow requirements of 227 l/s (3600 US gallons per minute).

Split case horizontal pumps only are to be used for fire pumps.

3.2.8.5 Building

The pump house building shall be of adequate size to accommodate the pumps, pump motors, control panel, auxiliary power supply, fuel supply tank, and other accessories. These items shall be located in the building taking into consideration safety for operators and convenient access for maintenance.

The pump house building design and construction shall meet the requirements of the latest edition of the National Building Code of Canada.

Exterior wall assembly of the building shall be 200 mm split-face concrete block with a minimum of R20 (RSI 3.5) insulation. The door shall be a heavy duty steel door with a minimum 750 mm width, and must be sized to accommodate the removal and maintenance of equipment and shall be insulated with a minimum of R6 (RSI 2.8) insulation. The building shall have a hip roof with a minimum slope of 2:1 (horizontal : vertical) and a minimum of R30 (RSI 5.3) insulation with asphalt shingles (25 year rated). There shall be no windows in any exterior wall. Adequate ventilation for all mechanical equipment shall be provided by vandal resistant, insulated, heavy duty type steel intake and exhaust louvers. Engine emissions shall be directed away from the building so as not to create a ventilation "short circuit". The louver system shall be designed to prevent a negative pressure situation within the building. Provision shall be made to support wall-mounted equipment inside the building. The building is to be designed "secure".

Thermostats are to be located away from the air intakes such that there is no conflict with exterior air. Radiators may be considered for smaller buildings with dual loops.

The building floor shall be a minimum 150 mm above the finished external grade and any potential flood level. Pump house floors shall be poured reinforced concrete and sloped toward the access door.

Interior wall surfaces, doors and trim shall be painted to a color scheme as approved by the Engineer. A non-metallic colored hardener shall be added to the concrete floors during the finishing process to a colors scheme as approved by the Engineer.

Doors shall swing outward to open and panic hardware should be installed for emergency exit. All hinge pins on doors shall be secured to prevent their removal and astragal's (anti-pick plates) be installed with non-removable fasteners, to cover the latch bolt area on the doors. All door locks shall be keyed alike to HRWC standard system.

Lifting devices of a type approved by the Engineer should be incorporated into the design of the structure so that pumps and/or motors can easily be transferred from their location within the station to an access door.

The Engineer may approve an alternate architectural design to better blend in with the surrounding Community.

3.2.8.6 Auxiliary Power & Electrical

An Arc Flash Hazard Analysis study must be performed to determine the available arc fault currents and arc flash hazards for electrical equipment such as switchboards, panel boards, industrial control panels, meter socket enclosures and motor control centres (MCCs). Arc Flash Hazard warning labeling must be provided and shall include system voltage, flash protection boundary distance, hazard risk category, available fault current, incident energy at 460mm and study report issue date.

The pumping station shall be provided with a three-phase power supply. Design and installation of the power supply system shall meet all applicable and relevant standards and codes.

Electrical meter base must be located outside of the building in a stainless steel enclosure with lockable hasp and comply with Nova Scotia Power Inc., Utility Service Requirements. A stand-alone main service disconnect must be available inside the building.

Each pump shall be operated by an energy efficient electric motor capable of operating the pump over the full range of load conditions. Motors should be located such that they cannot be flooded should a pipe failure occur. Each pump shall have a separate lockable disconnect switch for isolation of the motor power supply without affecting the remaining system operation.

Electric motors shall be manufactured by U.S. Motor or equivalent as approved by the Engineer.

All electrical apparatus shall be located in an accessible location above grade with a clear access of 1 m around all pumps and motors. All panels and controls shall have NEMA 4 enclosures.

All floor mounted electrical equipment must be mounted on 100 mm high housekeeping pads.

Pump-house must contain at least the following:

- Electric unit heaters with thermostat control.
- Adequate vapour proof incandescent lighting.
- A single outside vandal proof light adjacent to or over the access door. This light shall be activated by a photo-electric cell.
- A weather proof switch and electrical outlet inside the pump house immediately adjacent to the access door.
- Adequate lightning arresters.
- A fire extinguisher.
- Sufficient ventilation to ensure that heat generated from the electrical equipment is sufficiently dissipated.

Full stand-by power supply shall be provided utilizing a standby diesel generator set. The power generating system shall be capable of providing continuous electric power during any interruption of the normal power supply. The stand-by power unit shall be designed with adequate capacity to operate fire and domestic pumps, control and monitoring systems, and heating and lighting systems within the pump house.

The generating system shall include the following items:

- Diesel engine.
- Alternator.
- Control panel.
- Automatic change over equipment.
- Automatic ventilation system.

Piping systems shall include couplings where required to provide sufficient flexibility to allow removal of equipment and valves. A self-closing check valve must be incorporated in the discharge of each unit in the pumping station. It shall be designed in such a way that if pump flow is lost, the valve will close automatically. The type and arrangement of check valves and discharge valves is dependent on the potential hydraulic transients that might be experienced in the pumping station.

A hydraulic transient analysis shall be undertaken to ensure that transients (water hammer) resulting from pumps starting, stopping, full load rejection during power failure, etc., do not adversely affect either the customers on the water system, or the water distribution system including the booster pumping station. Typical methods of surge protection that can be used to protect the booster station and equipment include the following:

- Surge anticipator systems that dissipate over-pressure from the discharge lines.
- Slow closing and opening control valves on pump discharges.
- Hydro-pneumatic surge tanks on discharge headers.
- Variable speed pumping units.

An adequate number of isolation valves must be provided to allow maintenance of pumps and/or control valves.

3.2.8.7 SCADA and Controls

Pumping station functions shall be monitored by the HRWC supervisory control and data acquisition (SCADA) system to ensure that the station by is performing satisfactorily. Monitoring signals and alarms shall be transmitted to the HRWC SCADA system by a separate communication remote terminal unit (RTU). Programmable logic controller (PLC) shall have eight extra digital points and eight extra analog points and will transmit the following signals and alarms to the HRWC central monitoring system:

- Station flow.
- Suction and discharge pressure.

- Domestic booster pump information (overload, motor current, pump status and phase monitoring).
- Fire pump information (overload, motor current and pump status).
- Power generating system (overload, battery status, fuel tank level, etc.).
- Output control through SCADA system.
- Hand-off-automatic selector switch status.
- Low discharge pressure alarm.
- High discharge pressure alarm.
- Power failure alarm.
- Illegal entry alarm.
- Surge valve alarm.
- Building temperature alarm (high, low).
- Building flood .

Control panel shall include a means of protecting the pump motors from the following potential conditions:

- Under-load.
- Overload.
- Phase loss.
- Current imbalance.
- Overvoltage.
- Undervoltage.

Pump control panel to include the following items:

- PLC based pump controller.
- Minimum 200 mm TFT colour LCD touch screen display panel, 256 colours, 32MB RAM and removable storage media port. Acceptable products: Allen Bradley Panelview, Maple Systems Graphic HMI or approved equivalent.
- Uninterruptible power supply properly sized to maintain PLC in powered state during generator transfer to and from emergency power.
- Status indicator lights to signify the following conditions for each pump:

    - Red - Pump Running.
    - Green - Pump in Standby Mode.
    - Yellow - Pump Alarm Active.

Pump controller shall be PLC based and programmed in a manner that the required I/O (Input / Output) be organized in blocks such that the I/O will transfer the HRWC communication panel in a single read via Modbus RTU protocol. All PLC programming and operator interface screen programming must be coordinated with HRWC. All PLC and OIT programming complete with documentation must be provided to HRWC on electronic storage media to be included in the operation and maintenance manuals.

Acceptable Products: Schneider Electric ScadaPack, Allen Bradley MicroLogix, CompactLogix or approved equivalent

The control system shall be capable of providing:

- Uninterrupted fully automatic operation of the pumping station to meet the various demand requirements of the area being serviced.
- Protection against equipment damage for failure during extreme hydraulic or electrical conditions.

A flow meter providing both local and remote flow indication and as approved by the Engineer, shall be installed in the pumping station. Pressure gauges, complete with isolation ball valves, shall be installed on the suction side and on the discharge side of the pumps.

3.2.8.8 Mechanical

Suction and discharge piping shall be designed and arranged to provide easy access for maintenance. All piping and tubing, 100 mm diameter and smaller, shall be stainless steel, Type 304 or 304L, 11 ga.

All piping within the station larger than 100 mm diameter shall be ductile iron Class 54, cement lined with asphaltic seal coat or stainless steel, Type 304 or 304L, 11 ga. Threaded flanges shall be used for all joints, fittings and connections within the station.

All piping within the pumping station shall be properly supported and shall be designed with appropriate fittings to allow for expansion and contraction, thrust restraint, etc. All exposed surfaces and pipes, other than stainless steel, shall be finished, treated and painted to prevent rusting. Colour scheme and paint types shall be approved by the Engineer.

Piping systems shall include couplings where required to provide sufficient flexibility to allow removal of equipment and valves. A self-closing check valve must be incorporated in the discharge of each unit in the pumping station. It shall be designed in such a way that if pump flow is lost, the valve will close automatically. The type and arrangement of check valves and discharge valves is dependent on the potential hydraulic transients that might be experienced in the pumping station.

A hydraulic transient analysis shall be undertaken to ensure that transients (water hammer) resulting from pumps starting, stopping, full load rejection during power failure, etc., do not adversely affect either the customers on the water system, or the water distribution system including the booster pumping station. Typical methods of surge protection that can be used to protect the booster station and equipment include the following:

- Surge anticipator systems that dissipate over-pressure from the discharge lines.
- Slow closing and opening control valves on pump discharges.
- Hydro-pneumatic surge tanks on discharge headers.
- Variable speed pumping units.

An adequate number of isolation valves must be provided to allow maintenance of pumps and/or control valves.

3.2.8.9 Safety Precautions

The pumping station and appurtenances shall be designed in such a manner as to ensure the safety of operations, in accordance with all applicable current Municipal, Provincial and Federal regulations including the Occupational Health and Safety Act. An adequate hazard assessment of the design should be conducted to ensure that all confined spaces are eliminated. All moving equipment shall be covered with suitable guards to prevent accidental contact.

Equipment that starts automatically shall be suitably designed to ensure that operators are aware of this condition. Individual lock-outs on all equipment shall be supplied to ensure that the equipment is completely out of service when maintenance or servicing is being carried out.

Diesel generator fuel supply lines shall be equipped with fusible link valves. Fuel lines between the generator and the fuel supply shall be located in appropriately sized sleeves cast into the station floor.

3.2.8.10 Site Considerations

All structures and appurtenances associated with the pumping station shall be located off the street right-of-way in an appropriate area specifically designated for that purpose. The ownership of this property shall be deeded to the HRWC. All pumping station land shall be graded such that ponding of water does not occur. All exposed areas shall be sodded. Provision shall be made for the installation of a 2.44 m security fence for the property (refer to Section 39 00 00 for details). HRWC will advise of fencing requirements upon review of the proposed site location. A paved driveway shall be provided for access to the pumping station.

The driveway shall be constructed of surge material as required by the Design Engineer, 150 mm of Type 2 gravel, 150 mm of Type 1 gravel and 75 mm of asphalt to a minimum width of 3.5 meters, and a minimum length of 7.5 meters.

3.2.8.11 Testing

Station Piping

All station process piping (from the pumps to the distribution system connections) shall be hydrostatically tested. Piping must maintain a minimum pressure of 1035 kPa., for two hours in accordance with AWWA C600. No leakage or loss of pressure is permitted. If leakage or loss of pressure occurs, make repairs and re-test. This iterative process should be continued until a successful test is achieved.

3.2.8.12 Facility Start-Up

During the start-up period, the contractor starts, operates and tests all equipment and control and communication systems to ensure proper function in accordance with the project documents. The contractor is responsible for leading and directing the start-up process and calling to the site any subcontractors and suppliers necessary to start, test and certify equipment. The contractor will liaise with the developer's professional engineer and HRWC staff as necessary. The SCADA tag list is to be provided to HRWC at least two weeks prior to facility start-up to allow HRWC technical operations sufficient time to program SCADA.

During the start-up period, all technical issues related to the operation of the facility and all requests for information (RFI's) shall be resolved. Once the start-up period has been completed, the facility should be functioning in accordance with the contract documents. In order to progress to facility commissioning, the contractor shall provide:

- a full itemized list of equipment accompanied by vendor installation verification and certification indicating that the equipment has been started, tested, is functioning within specified parameters and is ready for intended use and;
- a full itemized list of technical difficulties encountered during start-up and their resolutions.

The following personnel shall be present at the facility start-up:

- Contractor (Lead)
- Subcontractors
- Suppliers
- Developers Professional Engineer
- HRWC staff (as necessary)

3.2.8.13 Facility Commissioning

Facility commissioning occurs after successful completion of facility start-up and provision of a full itemized list of equipment, installation verification, certification and a full itemized list of technical difficulties/resolutions. Once the developer's professional engineer has reviewed and accepted this information, they shall provide the Engineer with formal confirmation that the facility is ready for commissioning. The contractor shall then schedule commissioning dates a minimum of two weeks in advance, subject to availability of all parties.

During facility commissioning, the contractor demonstrates to the developer's professional engineer and HRWC that all equipment and systems function properly and in accordance with the project documents. The developer's professional engineer is responsible for providing a commissioning officer to lead the commissioning process, creating the commissioning plan, creating site acceptance testing protocols, and leading and directing the commissioning process. As a minimum the commissioning plan shall cover the following:

- Full Input / Output listing and their function;
- Full list of equipment and system setpoints;
- Test or simulate all Input / Output;
- Test and verify that all equipment and systems function in accordance with the Process Control Narrative (PCN);
- Check, verify and record all parameters of pump performance (including electrical parameters) under all possible operating configurations. These values will be used to check performance throughout pump lifecycle;
- Test (or simulate) and verify functionality of all alarms and ensure that response is in accordance with PCN;
- Check and verify functionality of all mechanical systems (ie. ventilation, pump lifts, heating, hatches and accessories, valving, etc.);
- Demonstrate removal and reinstallation of all removable/serviceable mechanical equipment;
- If an auxiliary power supply system ("generator") is installed, confirm functionality by:
    - simulating a power interruption at full demand, ie. open the line power main disconnect switch;
    - conducting a load bank test - 100% load for 6 hours.

The contractor shall have an appropriate number of staff available on-site to operate all equipment as directed by the commissioning officer and in accordance with the commissioning plan and site acceptance testing protocols. The developer's profession engineer and HRWC facility operator will be present to witness facility commissioning and will liaise with, and call to the site, other HRWC staff as necessary.

It is fully expected that all equipment and systems have been started successfully during facility start-up and operate in accordance with the project documents. This ensures efficient use of resources during commissioning (ie. HRWC staff time and developer's professional engineer time and expenses). If it is determined that all equipment has not been started and does not operate properly during the first attempt at commissioning, the developer's professional engineer may, at their discretion, terminate the commissioning process and instruct the contractor to complete the facility start-up and re-schedule facility commissioning.

The following personnel shall be present at facility commissioning:

- Developer's Professional Engineer (Commissioning officer as lead)
- Contractor
- Subcontractors
- Suppliers
- HRWC Facility Operator
- Other HRWC Staff (as necessary)

3.2.8.14 SCADA Commissioning

SCADA commissioning occurs after successful completion of facility commissioning. During SCADA commissioning, all communications will be verified between the local PLC and RTU and between the local RTU and HRWC's HMI. Under direction from the HRWC technical operations representative, the contractor shall trigger, modulate or simulate all system tags to confirm communications and to ensure consistent nomenclature and units throughout. It is expected that the contractor will have the appropriate technical staff on-site for a full day to complete the SCADA Commissioning.

The following personnel shall be present at SCADA Commissioning:

- HRWC Technical Operations Representative (lead)
- Contractor
- Subcontractors (as necessary)
- Suppliers (as necessary)
- Developer's Professional Engineer

3.2.8.15 Facility Training

After successful commissioning, the contractor or the developer's professional engineer provides training for HRWC staff in the proper operation of the facility. Such training shall include: safety orientation, system description, identification of all individual pieces of equipment and explanation of their purpose; review of control logic, sequencing and setpoints for all equipment and systems; review and demonstration of operator interfaces; identification and demonstration of unique maintenance activities necessary to ensure proper operation of the facility; identification and explanation of equipment and system limitations; identification and explanation of spare parts and special tools.

Following facility training, the contractor is to allow for additional programming adjustments to operator interfaces as directed by HRWC.

The following personnel shall be present at facility training:

- Contractor (may act as lead)
- Developer's Professional Engineer (may act as lead)
- Subcontractors (as necessary)
- Suppliers (as necessary)
- HRWC Facility Operator(s)

3.2.8.16 Facility Commissioning Report

Following successful completion of commissioning and training, the developer's professional engineer shall provide a detailed facility commissioning report complete with certification that the facility has been constructed and operates in accordance with the design intent and project specifications.

- Executive summary, including:
  - Observations
  - Conclusions
  - Outstanding Items
  - Recommendations
- Performance verification checklists (test results and evaluation);
- System deficiencies that were discovered and measures taken to correct them;
- Outstanding deficiencies;
- Plan for resolution of outstanding deficiencies;
- Summary of training process;
- Certification from the Design Engineer that the facility meet design intent, are operating within specified parameters and are ready for intended use;

3.2.8.17 Operations and Maintenance Manual

The developer's professional engineer is to provide three (3) paper copies each bound in a heavy duty "catalog" binder with expanding posts and one (1) digital copy of the facility operation and maintenance manual, in a form acceptable to HRWC. The manual must contain the following items in same general order:

- Title Page including:
    - identification of document as an Operations & Maintenance Manual;
    - facility name;
    - facility Contractor;
    - facility Design Engineer;
    - date of issuance.
- Index
- A quick reference table (spreadsheet to accompany electronic submission) listing the following information for each piece of equipment within the facility:
    - make, model and serial number;
    - name, address and contact details for supplier and installer;
    - lubrication and regular maintenance intervals;
    - an index reference to the full equipment manual contained within the operations and maintenance manual;
    - spare part list, and;
    - expiry date for guarantee / warrantee.
- System Description;
- Narrative on area served inclusive of mapping;
- Facility design intent, parameters and limitations (ie. Design report);
- As constructed civil, mechanical and electrical drawings;
- System hydraulics and design calculations (including system curves);
- Pump literature (including pump curves);
- Manufacturer's operation and maintenance instructions and manuals for all equipment which includes maintenance and lubrication schedules;
- Facility commissioning report;

- Systematic lifecycle upgrade report (if applicable);
- Process Control Narrative;
- Electronic copies of PLC and Operator Interface Terminal (OIT) projects;
- Any original software and interface cables required for programmable equipment installed within the facility with the exception of PLC and OIT programming software, unless specified in the contract document;
- Detailed information on guarantees / warrantees for all equipment;
- Construction and post-construction color digital photos. Post-construction photos shall be taken at various angles showing the main features of the inside and outside of the facility. A plan index shall be provided showing location and angle of each photo in relation to the facility.

3.3 PHYSICAL CRITERIA

3.3.1 Water Main Pipe Material

(refer to SECTION 33 11 00, Part 2 - Products)

The following types of pipe are approved for use as water mains when installed in compliance with the standard specifications and subject to the stated restrictions.

3.3.1.1 Ductile Iron (DI) Pipe

AWWA C151 Special Class 52 cement mortar lined with interior asphaltic seal coat.

.1 All DI pipe and fittings shall be installed with clear polyethylene encasement. Refer to Sections 33 11 00 and 39 00 00.

.2 All valves, hydrants and service laterals shall be installed with an attached zinc anode for cathodic protection.

.3 DI pipe shall not be installed below the salt water tidal zone.

.4 The approved service connection pipe material for Ductile Iron (DI) mains shall be copper (type “k”).

3.3.1.2 Polyvinyl Chloride (PVC) Pipe

AWWA C900 Class 305, DR14, in accordance with CSA 137.3

.1 Subject to the Engineer’s discretion, PVC pipe may be approved for installation in sizes up to and including 300 mm diameter for use in standard residential development.

.2 The approved service connection pipe material for Polyvinyl Chloride (PVC) mains shall be copper (type “k”) and Cross Linked Polyethylene (PEXa) tubing (Municipex).

.3 All valves, hydrants, and service connections shall be installed with an attached zinc anode for cathodic protection. If cross linked polyethylene (PEXa) service pipe is utilized, than an anode is not required.

.4 All fittings for PVC pipe, excluding tapping couplings, shall be to AWWA C110.

.5 All fittings shall be installed with polyethylene encasement.

.6 All PVC & PEXa pipe installations shall include the installation of an approved trace wire system for pipe location purposes, Refer to Sections 33 11 00 and 39 00 00.

.7 All service connection taps shall be completed using an approved saddle or approved tapping coupling. Wet tapping of PVC pipe is not permitted when the pipe and/or trench environment is below 0° Celsius.

3.3.1.3 Consistency of Pipe Material

Consistency of pipe material within a section of the distribution system or within a particular subdivision shall be maintained. The design of a system extension shall identify the type of pipe material previously used in an area and specify the same pipe material for the extension, subject to the above requirements.

Subject to the Engineer’s direction, alternative pipe materials and fittings may be required to address specific site conditions.

3.3.1.4 Meter Chamber

Subject to the Engineer’s direction, a meter chamber shall be installed at the point of connection for leak detection and system monitoring.
Refer to Section 39 00 00.

3.3.2 Cover Over Water Mains

.1 All water mains shall be designed and installed with a **minimum cover of 1.6 m.** The allowable depth of cover shall be a **maximum of 2.0 m**. The depth of cover shall be measured from the finished surface design grade over the pipe to the crown of the water pipe.

3.3.3 Water Main Location

.1 All water mains shall normally be installed at a consistent grade to avoid localized high points in the same trench as the gravity wastewater and stormwater systems. The location of the water mains and service connections relative to wastewater and stormwater systems shall meet the minimum requirements of NSE. The water main shall maintain a minimum 500 mm horizontal and a 300 mm vertical separation in common trench conditions from the wastewater and stormwater systems. If this separation cannot be achieved, the water main shall be installed in a separate trench with a minimum 3.0 m separation from the wastewater and stormwater systems.

Water mains shall maintain a minimum horizontal separation from manholes of 500 mm. Insulation shall be installed on manholes to protect the water main from freezing temperatures for horizontal separations up to 1.2 m from manholes.

.2 When it is not possible to obtain proper horizontal and vertical separation as stipulated, the wastewater and stormwater systems shall be designed and constructed equal to water pipe and shall be pressure-tested to assure water tightness.

.3 Whenever wastewater and stormwater systems must cross under water mains, a separation of at least 450 mm must be maintained between the top of the wastewater and stormwater systems and the bottom of the water main. When the elevation of the wastewater and stormwater systems cannot be varied to meet this requirement, the water main shall be relocated to provide this separation. Catch basin lead inverts shall be shown on the drawings to facilitate checking of clearances.

.4 Where possible the water mains shall be installed in a straight line within the travelled way portion of the street right of way and a minimum of 1.5 m from the face of the curb. On existing streets without curb and gutter the water main may be installed within the gravel shoulder area. Changes in alignment shall be accomplished by the use of pre-manufactured bends. Minor curvature of pipe along its length or at joints may be permitted under certain site conditions at the discretion of the Engineer.

.5 Easements shall only be considered where there are no alternative servicing routes and where the option of locating a street over a servicing corridor has been precluded. Refer to Section 4.4 for easement details. A cross section shall be provided of the easement showing the side slopes in compliance with the safe trench requirements of the Department of Labor and Advanced Education. The water main shall be located as close as possible to the centre-line of the easement. Depending upon the length and location of the easement, a travel way within the easement may be required for maintenance. This travel way shall be a gravel surface for grades up to 6% and asphalt for grades 6% to 8%. Where the water easement is within a walkway, the easement shall be granted to the HRWC prior to the transfer of ownership of the walkway to the HRM.

.6 Water mains shall maintain a minimum 2.0 m horizontal separation from permanent underground and above ground infrastructure / structures. This shall apply / but not be limited to electrical or telephone conduit, steam or hot water piping, transformer pads, utility poles, signs or other utilities.

.7 Water mains shall maintain horizontal and vertical separation from gas lines depending on water main size. Please refer to Section 39 00 00 for standard separations.

.8 Where a need is identified to facilitate continued/future development on adjacent lands, water systems, and easements as required, shall be extended to the limit of the property boundary of the subdivision / development.

3.3.4 Valves

.1 All connections to existing water systems shall be valved so that the system can be isolated from the existing main to facilitate construction and testing while maintaining service in the existing main. Dead end stubs (minimum 1 pipe length) left for future extensions shall be provided with a valve so as to minimize service interruptions. Valves on dead end stubs are to be restrained/tied back to upstream piping as required to protect against the thrust that develops in the water system. If a valve is located in a gravel shoulder or outside of the street R.O.W. then it shall be provided with an asphalt apron as per HRWC requirements (refer to Section 39 00 00).

.2 Valves shall be provided on water mains to satisfy the following requirements:

- Four valves shall be required at each normal four-way street intersection. If there are more or less than four streets meeting at any intersection, the appropriate number of valves shall be installed to allow complete isolation of the system.

- Main line valves shall be located outside of the street intersection in line with the cross street curb locations. Refer to Section 39 00 00 for details.

- On straight runs the maximum spacing for main line valves shall be 150 m for commercial/industrial areas, and 250 m for urban residential areas. This maximum spacing may be increased in residential areas with larger lot sizes as approved by the Engineer.

- For looped systems with close intersection spacing, main line and intersection valve spacing may be adjusted providing that adequate shut down capability is provided on the system without putting more than 30 customers out of service at any time.

- For cul-de-sacs looped through easements a valve shall be provided separating the street and the easement, and located within the asphalt portion of the cu-de-sac bulb.

- Gate valves shall be used for valves 300 mm diameter and smaller.

- Butterfly valves shall be used for valves 350 mm diameter and larger.

3.3.5 Hydrants

3.3.5.1 Location and Spacing

Fire hydrants shall be provided at spacing within the requirements of the latest revision of the IAO publication “Water Supply for Public Fire Protection”. The layout of the hydrants within the water system shall be designed in consideration of the following desirable location criteria:

.1 For residential single family, semi-detached and townhouse developments, the maximum spacing of fire hydrants shall not exceed 150 m.

.2 For ICI developments, the maximum spacing of fire hydrants shall not exceed 90 m.

.3 Locate hydrants at the extension of the boundary line between two lots.

.4 Locate hydrants a minimum 1.8 m from the edge of a driveway flare and minimum 3.0 m from a utility pole, transformer, or utility junction box, refer to Section 39 00 00 for details.

.5 Locate hydrants at high point of water main profile unless automatic air release valves are required at that location.

.6 Locate hydrants mid-block on cul-de-sacs that have a looped connection to the distribution system.

.7 Dead end mains shall terminate at a hydrant to permit flushing of the distribution system.

3.3.5.2 Connection to the Main

The branch pipe to the hydrant shall be 150 mm in diameter and shall include a 150 mm diameter branch valve connected directly to the main with a hydrant anchor tee. For greater thrust protection the hydrant shall be mechanically restrained from the valve to the hydrant. Where the hydrant branch is the extension of a dead end main, the hydrant valve and branch piping shall be mechanically tied to the distribution system.

3.3.5.3 Painting

All hydrants are to be re-painted to HRWC's standards (Section 39 00 00 and Section 33 11 00) prior to acceptance by the Commission.

3.3.5.4 Prior to Commissioning

All hydrants are to have a 300 mm round out of service marker installed on the pumper nozzle until the hydrant is put into service.

3.3.5.5 Product Consistency in Subdivisions

Hydrant models to be installed as part of new subdivision development or system extensions shall be consistent for that approved development phase or system extension limit. Refer to Section 33 11 00 for approved hydrant product list.

3.3.6 Trench Drainage Relief System

The design of the water system shall give consideration to the possible change in ground water movement caused by the use of pervious bedding material. The design shall include corrective measures to prevent flooding as a result of this ground water movement.

.1 Water mains installed in a single pipe trench may require a trench drainage relief system to lower the ground water in the trench. The design of the relief system shall be specific to the situation with consideration for topography, subsurface conditions, ground water conditions and local drainage patterns.

.2 Service connection trenches that have a trench bed sloping down from the main trench may require the installation of an appropriate clay plug, or similar solution, to prevent the flow of ground water from the trench towards the abutting properties.

3.3.7 Thrust Restraint

.1 Any change in direction of the water main, in excess of the pipe joint deflection tolerance, shall be made using an appropriate fitting. Thrust blocks shall be designed and installed in conjunction with these fittings.

.2 The thrust block design shall consider the operating pressure, surge pressure, peak flow velocity and in situ material bearing strength.

.3 Thrust restraints for vertical bends shall be by gravity thrust blocks located below the fitting and shall be connected to the fitting with galvanized tie rods securely embedded in concrete.

.4 The use of mechanical joint restraint is permitted on 11¼°, 22½°, and 45°. horizontal bends on 300 mm diameter pipe and smaller. No pipe joints are allowed within the “minimum pipe length” as denoted in HRWC Standard Drawings located in Section 39 00 00.

.5 Subject to the Engineer’s discretion, mechanical restraint devices shall be used in addition to gradient restraint anchor blocks for pipes installed at grades steeper than 16%.

.6 The use of mechanically restrained joints shall be required where in the opinion of the Engineer, there is a potential for separation of joints as a result of fill settlement (deep fill) or where future excavation may expose the main.

3.3.8 Allowable Joint Deflection (Push-on Type Joints)

When it is necessary to deflect pipe from a straight line in either the horizontal or vertical plane, the amount of joint deflection shall not exceed the allowable joint deflections as shown in the following tables. Refer to Uni-Bell Handbook of PVC Pipe Design and Construction (Table 8.2) and Ductile Iron Pipe Research Association (DIPRA).

Deflection Table – Ductile Iron Push-on Type Joints

Nominal Pipe Size (mm)	Deflection Angle – deg.	Max. Offset 6 m Lengths of pipe (mm)	Max. Allowable Radius (m)
100 mm-300 mm	5	533	70
350 mm-900 mm	3	300	116

Deflection Table – PVC Push-on Type Joints

Nominal Pipe Size (mm)	Deflection Angle – deg.	Max. Offset 6 m Lengths of pipe (mm)	Max. Allowable Radius (m)
100 mm	5.7	600	30
150 mm	4.0	431	44
200 mm	3.0	330	57
250 mm	2.5	254	71
300 mm	2.1	229	84

3.3.9 Air Relief Valve and Vacuum Valves

Air relief and vacuum valves shall be installed, in a manhole, at all significant high points in the distribution system and at such other locations as required for efficient operation of the water system. Refer to section 39 00 00 for details.

3.3.10 Service Connections

As noted in the National Plumbing Code of Canada *(section 2.1.2.4 – Separate Services).* Service connections connected to the public services shall be connected separately from piping of any other building, except that an ancillary building on the same property may be served by the same service.

If a water service connection is to be master metered (ie. Campus / Residential / ICI developments, etc.), than the required meter chamber (which houses the water meter and backflow prevention device(s)) shall be installed on the private side of the street right of way. Please refer to section 39 00 00 for master metering requirements.

3.3.10.1 Water Service Connections - 100 mm and greater

.1 Refer to Section 33 11 00, Part 2 – Products, for water pipe material.

.2 Where a service is connecting to the existing water system and where no means of connection is provided to the water system (stub, cap and valve). A service connection to the water system will be made by cutting in a new tee and valve. This new cut in shall be disinfected with a 1% hypochlorite solution (by swabbing/ spraying) and the connection flushed. Refer to Section 33 11 00, 3.11 and AWWA C651-05.

.3 Utilizing a tapping sleeve for a service connection is permitted only with the approval of the Engineer where the magnitude of a service disruption makes cutting in a new tee impractical. In this situation the use of a tapping sleeve will only be approved when the pipe to be tapped is a minimum of one size increment larger than the connecting pipe. Additionally, all tapping is subject to visual inspection by HRWC operations staff prior to tapping to confirm that the pipe structural condition is acceptable for tapping.

.4 All water service connections connecting to the water system shall be tapped by HRWC's operations department. Please be advised that all parts and materials shall be supplied by the contractor.

.5 All water service connections shall be installed with a **minimum cover of 1.6 m.** The allowable depth of cover shall be a **maximum of 2.0 m**. The water service connection shall maintain a minimum 300 mm separation horizontal above and vertical from the gravity wastewater and stormwater service connections. In cases where a pressure wastewater service connection is to be used, install the water service connection in a separate trench with a 3.0 m horizontal separation.

.6 When water service connections cross wastewater and stormwater system pipes, the water service connection shall cross with a minimum vertical separation of 450 mm.

.7 All water service connections, from the main line to the property line, shall be provided by the developer of the lot. A single service connection shall be installed to each existing lot or potential future lot which could be created under the zoning in effect at the time of the water system installation. There shall be no more than one service connection provided per building.

.8 Water service connections shall be located a minimum 3.0 m from outdoor fuel tanks.

.9 Water service connections shall maintain a minimum horizontal separation of 2.0 m from gas lines, underground electrical / telephone conduit, steam or hot water piping, transformer pads, utility poles or other utilities.

.10 In areas with onsite wastewater disposal, the water service connection must not pass under the wastewater disposal field area. There is to be a minimum of 6.0 m of undisturbed soil between the water service connection and the wastewater disposal field and 3.0 m from a septic tank.

.11 The installation of a domestic service connection off a sprinkler line may be approved by HRWC under the following conditions:

.1 A hydraulic analysis, sealed by a professional engineer, is submitted supporting the proposed design. Such approval will be granted only when, in HRWC's judgment, separate taps and excavations are impractical.

.12 The installation of a private fire hydrant off a sprinkler line may be approved by HRWC under the following conditions:

.1 As noted in the National Building Code of Canada *(Section 3.2.5.15 – Fire Department Connections).* The fire department connection for a standpipe system shall be located so that the distance from the fire department connection to a hydrant is not more than 45 m and is unobstructed.

.2 Private fire hydrants are to be installed such that the hydrant lead is connected to the sprinkler line downstream of a CSA approved detector assembly backflow prevention device (Double Check Detector Assembly or Reduced Pressure Detector Assembly). The detector assembly device must be supplied with a positive displacement type meter. If the meter is not an HRWC approved water meter, HRWC will supply a water meter to be installed on the detector assembly's bypass.

Please refer to Section 39 00 00 and 33 11 00 Part 2, for details of hydrant installation and approved hydrant products.

.3 Private fire hydrants are to be painted safety yellow.

3.3.10.2 Water Service Connections 50 mm and smaller

.1 Refer to Section 33 11 00, Part 2 – Products, for water pipe material.

.2 All water service connections shall be installed with a **minimum cover of 1.6 m.** The allowable depth of cover shall be a **maximum of 2.0 m**. The water service lateral shall maintain a minimum 300 mm separation horizontal above and vertical from the gravity wastewater and stormwater service connections. In cases where a pressure wastewater service connection is to be used, install water service in a separate trench with a 3.0 m horizontal separation.

.3 All water service connections connecting to the water system shall be tapped by HRWC's operations department. Please be advised that all parts and materials shall be supplied by the contractor.

.4 In order to ensure protection from frost penetration, water service connections shall be installed with insulation for the entire length of the water service (main to building). The specific method of frost protection shall be approved by HRWC. Refer to Section 33 11 00 for approved products.

Insulation of service connections (50 mm diameter and smaller) is required in the following situations:

- Sites where service connections are to be installed in trenches that have been excavated in rock.

- Sites where stockpiled or processed rock material is to be used for backfill.

- All applications and situations where the service connection is considered to be at risk of freezing as determined by the HRWC representative.

- Where a water service connection is crossing a ditch with a minimum of 1.2 m of cover.

In the above-noted situations, the requirement for insulation can be addressed through the use of rigid polystyrene trench insulation and pipe sleeve insulation, subject to HRWC approval.

In applications where site conditions prevent the full depth installation of services, pipe sleeve insulation is not to be used as a substitute for rigid polystyrene trench insulation.

.5 When water service connections cross wastewater and stormwater system pipes, the water service connection shall cross with a minimum vertical separation of 450 mm.

.6 All water service connections, from the main line to the property line, shall be provided by the developer of the lot. A single service connection shall be installed to each existing lot or potential future lot which could be created under the zoning in effect at the time of the water system installation. There shall be no more than one service connection provided per building.

.7 The standard minimum domestic water service connection sizing to be as follows:

<u>20 mm (for single residential domestic services):</u>

- 25 mm minimum size if PEXa (Municipex) service pipe is used.

25 mm (for single residential domestic services) where:

- Water system pressure in the municipal system is less than 345 kPa (50 psi) or.
- The set back is greater than 30 m (100 feet).

25 mm (for domestic commercial uses):

- Water service size is to be approved by HRWC dependent on required flow, internal plumbing arrangements, peak domestic demand, service length, and operating pressure. Maximum velocity of water flowing through the water service connection shall not exceed 4.5 m/s (15 ft/s).

.8 New copper water service connections shall not have more than one compression fitting for each 20 m length of pipe.

.9 The public portion of water service connections, including curb stops shall be located 1.5 m from driveways.

.10 Water service connections shall be located a minimum 3.0 m from outdoor fuel tanks.

.11 Water service connections shall maintain a minimum horizontal separation of 1.5 m from gas lines, underground electrical / telephone conduit, steam or hot water piping, transformer pads, utility poles or other utilities.

.12 In areas with onsite wastewater disposal, the water service connection must not pass under the wastewater disposal field area. There is to be a minimum of 6.0 m of undisturbed soil between the water service connection and the wastewater disposal field and 3.0 m from a septic tank.

.13 The installation of a domestic service connection off a sprinkler line may be approved by HRWC under the following conditions:

.1 A hydraulic analysis, sealed by a professional engineer, is submitted supporting the proposed design. Such approval will be granted only when, in HRWC’s judgment, separate taps and excavations are impractical.

3.3.11 Backflow-Prevention Devices

.1 Backflow-prevention devices are required to be installed on all new services where in the opinion of the HRWC there is a risk of contamination of the potable water supply system resulting from back flow or back pressure from the individual premise. Backflow-prevention devices shall be installed, in accordance with the standard specifications, on the following types of services:

.1 Domestic services for Industrial, Commercial and Institutional (ICI) buildings.

.2 Domestic services for residential buildings larger than four (4) units.

.3 Sprinkler service lines.

.2 Backflow-prevention devices shall also be installed when the individual premise is undergoing renovation or alteration. Backflow-prevention devices shall be installed in accordance with the standard specification on the following types of services:

.1 Domestic services for Industrial, Commercial and Institutional (ICI) buildings

.2 Domestic services for residential buildings larger than four (4) units.

.3 Sprinkler service lines where it can be determined that no negative impact on the existing sprinkler system will result from installation of a backflow-prevention device.

3.3.12 Transmission Main Road Crossings

.1 The following procedure shall be employed and specified when an approved new access road is to be constructed over an **existing** transmission main corridor:

.1 Excavate existing backfill material over transmission main to spring line of pipe.

.2 Backfill in accordance with Section 31 20 00 (Refer to Standard Specifications for Municipal Services). Use Type 1 gravel to 450 mm above the top of the pipe. Use Type 2 for remainder.

.3 Maintain a minimum of 1.6 m of ground cover from the top of the existing pipe to finished grade.

.4 Maintain a minimum grade, not to exceed 10%, to transmission main access road.

.5 Provide adequate drainage for new and existing roads.

.6 Provide lockable gates across pipeline road at new street boundaries, and ensure pipeline road is not accessible by vehicular traffic, except via gate structure. (Refer to Section 39 00 00).

.7 Provide “Road Gate Ahead” signs 150 m from gate along both directions of transmission main access road.

.8 Where a ditch crosses an existing transmission main, a depth of cover of 1.6 m shall be provided. The minimum cover over a transmission main at a ditch crossing shall not be less than 1.2 m with insulation. Insulation to be 50 mm HI-40 or equivalent.

.9 Provide asphalt transition 3.0 m on to transmission main access road.

.10 Exact location of existing transmission main to be determined by test pit prior to final approval of road crossing design.

.11 All work at transmission main is to be approved by HRWC representative.

3.3.13 Distribution System Extension Connections to Existing System

.1 Where a new distribution system is connecting to the existing system and where no means of connection is provided (stub, cap and valve) the connection will be made by cutting in a new tee and valve. This new cut in shall be disinfected with a 1% hypochlorite solution (by swabbing/ spraying) and the connection flushed. Refer to Section 33 11 00, 3.11 and AWWA C651-05.

.2 Utilizing a tapping sleeve for a new system connection is permitted only with the approval of the Engineer where the magnitude of a service disruption makes cutting in a new tee impractical. In this situation the use of a tapping sleeve will only be approved when the pipe to be tapped is a minimum of one size increment larger than the connecting pipe. Additionally, all tapping is subject to visual inspection by HRWC Operations staff prior to tapping to confirm that the pipe structural condition is acceptable for tapping.

3.3.14 Water Main Crossings

.1 A water main crossing may be defined as a crossing under a railway, highway, roadway, bridge structure and/or water course. Depending on the type of crossing, the following methods of installation may be required:

.1 When crossing under a roadway and/or water course the water main is to be installed in a carrier pipe. Subject to future accessibility and at the discretion of the Engineer, the carrier pipe may be constructed using DR

18 PVC water class pipe and installed with mechanical fittings to seal the ends.

.2 When crossing under a railway, highway, or bridge structure, the water main is to be installed in a casing pipe. This casing pipe and the method of water main installation are to be designed by a professional engineer for the appropriate situation.

.3 Isolation valves are required to be installed on either side of the water main crossing.

3.3.15 Automatic Flushing Station

Automatic Flushing Stations shall be installed in the distribution system at locations as identified by HRWC for the efficient operation of the water system. Refer to Section 33 11 00 for approved products.

4.0 DESIGN REQUIREMENTS – WASTEWATER AND STORMWATER SYSTEM – COMMON ELEMENTS

Elements exist which are common to both Wastewater and Stormwater systems. This section deals with the requirements for those elements.

4.1 PIPE

Refer to Section 5.0 and Section 6.0 for pipe material. The Engineer will determine the type of pipe to be used in rehabilitation work on a case by case basis.

Earth loads and the effects of concentrated and distributed superimposed (live) loads on the pipe shall be calculated for each installation. The approved method for calculating earth loads on pipes is the Marston Formula. The approved method for calculating the live loads on pipes is the Boussinesq Solution.

The strength of the pipe in place divided by a factor of safety of 1.5 shall be equal to or exceed the loads imposed upon it by the weight of the backfill and any superimposed loads, taking into account the class of pipe bedding and depth and width of trench.

4.2 MAXIMUM / MINIMUM DEPTH

When determining the depth of the pipe, the design shall facilitate gravity connections for future extensions to wastewater and stormwater systems to service adjoining lands by gravity and also to facilitate gravity service connections from buildings on adjoining lots.

The depth of the pipe, measured from the finished surface to the crown of the pipe, shall not exceed 5.0 m. However, under special conditions (e.g. elimination of a pumping station), the maximum depth of the pipe may be increased. However, service connections deeper than 5.0 m at the main are not permitted and shall be addressed by installing a rider wastewater or stormwater system.

The minimum depth, to the crown of the pipe, shall be:

- 1.6 m for the wastewater or stormwater main
- 1.2 m for wastewater or stormwater service connections

At the discretion of the Engineer, if a shallower depth is approved the pipes shall have insulation placed above them.

4.3 PIPE BEDDING

The bedding shall be engineered based on soil condition, depth of bury and type of pipe. Special bedding requirements must be met in certain wastewater situations (see Section 5.0 (WASTEWATER SYSTEM)).

At minimum, bedding material shall be Type 1 gravel compacted to 95% Standard Proctor density. Under some conditions, the Engineer may approve clear stone substituted for Type 1 gravel.

The bedding shall be engineered so as not to affect the ground water adversely.

4.4 LOCATION

All wastewater and stormwater systems shall be constructed within a street traveled way of the HRM and shall be installed closest to the crown or center line of the street. Easements shall only be considered where there are no alternative servicing routes and where the option of locating a street over a servicing corridor has been precluded.

Where a need is identified to facilitate continued / future development on adjacent lands, wastewater and stormwater systems and easements shall be extended to the limit of the property boundary of the subdivision / development.

Easement widths are determined by the depth from the centerline elevation of the road or ground to the inverts of the wastewater, stormwater or water systems. HRWC will determine the placement of the underground infrastructure – on centre or offset – within the easement. The minimum easement widths required for wastewater and stormwater systems and water systems is as follows:

If system size and depth is…	The minimum easement width is…
Single wastewater / stormwater system or water system equal or less than 600 mm diameter and less than 3.7 m deep	6.0 m
Two wastewater / stormwater systems in the same trench	7.5 m
Single wastewater / stormwater system in excess of 3.7 m deep or single water system equal or larger than 750 mm diameter	9.0 m
A combination of two mains, either wastewater / stormwater system or water system, less than 3.7 m deep	9.0 m

A combination of two mains, either wastewater / stormwater systems or water system, in excess of 3.7 m deep and no closer than 3.0 m to easement limit	12.0 m
Major trunk wastewater / stormwater systems or transmission water system	20.0 m
Three or more mains, no closer than 3.0 m to easement limits	Add 3.0 m for each additional wastewater/ stormwater system or water system

A cross section shall be provided of the easement showing the side slopes in compliance with the safe trench requirements of the Department of Labor and Advanced Education.

The wastewater and stormwater systems shall be located as close as possible to the centre-line of the easement.

Depending upon the length and location of the easement, a travel way within the easement may be required for maintenance. This travel way shall be a gravel surface for grades up to 6% and asphalt for grades 6% to 8%.

Where the wastewater and stormwater systems easement is within a walkway, the easement shall be granted to the HRWC prior to the transfer of ownership of the walkway to the HRM.

Where a need is identified to accommodate future upstream lands naturally tributary to the drainage area, a right-of-way or an easement shall be provided from the edge of the street right-of-way to the upstream limit of development.

4.5 MANHOLES

Refer to SECTION 5.2.1.5 for requirements specific to wastewater manholes.

.1 Manholes shall be constructed from precast sections meeting ASTM C-478 with O-ring gaskets, or approved equal. The top of the precast manhole shall be a flat top cover conforming to CS 700 loading requirements of the Canadian Highway Bridge Design Code. The manhole capping section shall be Shaw GC series or equivalent. The grade adjustment section of the manhole, measured from the top of the flat top cover to the bottom of the frame shall be a minimum of 300 mm and a maximum of 600 mm. The wastewater system manhole inclusive of the grade rings, shaft, precast sections and base shall be constructed with a Blueskin waterproofing membrane and gaskets (refer to Section 39 00 00).

Stormwater system manholes are not required to be constructed with a waterproofing membrane.

.2 Manhole frame and covers shall be IMP R10 or equivalent with HRWC logo. Manhole covers shall have one vent hole for air testing and removal of cover. Adjustable manhole frames and R-10 covers shall be used in asphalt and concrete surfaces. Approved products are as follows:

- IMP C-56N.
- Mueller Model AJ600.

All manholes not located in the street right of way are to have an IMP R12 frame and cover (with locking system).

Manholes shall be tested from the concrete cover if an adjustable manhole frame is to be utilized.

.3 Final grade adjustment shall be completed utilizing the following methods.

- Air entrained 35 MPa concrete or an approved non-shrink grout. If final grade adjustment exceeds 150 mm in height then circular 15M rebar must be incorporated in the raised section.
- Pre-cast concrete grade rings (max. 2 rings), with a minimum grade ring size of 150 mm.

.4 Manholes shall be benched. Benching shall start two thirds the height of the pipe and slope upwards at a slope of 4:1 (horizontal : vertical). Benching within manholes shall incorporate half pipe channels to direct the flow from incoming pipes or connections to the outgoing pipe with as long a radius bend as possible. There shall be no void or gap between the pipe and benching.

.5 Manholes shall be provided as follows:

i. at all main intersections.
ii. at any change in:
    - pipe size.
    - pipe material.
    - grade.
    - horizontal alignment.

.6 For connection of mains or service connections to manholes, use "A-LOK" gasket or approved O-ring gasket. "A-LOK" or approved O-ring gaskets shall be thoroughly cleaned then generously covered with lubricant specified by the pipe manufacturer.

For connection of mains or service connections to existing manholes, "Kor-N-Seal" or "INSERTA TEE" fittings may be used in place of "A-LOK" or O-ring gaskets. If "Kor-N-Seal" or "INSERTA TEE" fittings cannot be used, new manhole sections shall be installed incorporating "A-LOK" or O-ring gaskets.

The excavation below the mains or service connections shall be backfilled with unshrinkable fill.

"Kor-N-Seal" or "INSERTA TEE" fittings are to be installed according to manufacturer's specifications.

Epoxy/sand coated stubs grouted into the manhole or main are not permitted. Stubs with a grouted in O-ring are also not permitted.

.7 The maximum spacing between manholes shall be 100 m.

.8 Drops through manholes shall be set so that:

i. the drop through the manhole shall be equal to the head loss through the manhole.

ii. the drop shall be a minimum of:
- Straight run - 50 mm.
- Deflections up to 45° - 60 mm.
- Deflections 46° to 90° - 75 mm.
- In coming legs of tees or cross junctions - 100 mm.
- Pipe deflections through a manhole base greater than 90° are not permitted.

iii. A drop manhole shall be constructed when the vertical drop between any inlet pipe invert and the outlet pipe invert exceeds 1.0 m. External drop manholes shall be used when the inlet pipe exceeds 375 mm in diameter. Internal drop manholes shall be sized to provide a minimum clear width inside the manhole of 1000 mm.

iv. The benching area shall be properly formed and channeled, on a vertical radius, to direct the dropped sewage to the outlet pipe without turbulence. Drop manholes are only to be used when necessary.

.9 The minimum internal diameter of a manhole shall be 1050 mm. Larger diameter manholes shall be provided for larger diameter pipes. Precast units shall also meet the manufacturer's recommendations for manhole sizing.

.10 A connection to an existing manhole, unless driven by servicing considerations and approved by the Engineer, shall be limited to a 3.0 m depth from finished grade to crown of pipe and the internal section shall be constructed with a drop pipe. The excavation below the pipe at the manhole wall shall be backfilled with unshrinkable fill.

.11 Where two manholes are closer together than 300 mm, the space between is to be filled with unshrinkable fill.

.12 Backfill around manholes shall be Type 2 gravel extending a minimum of 300 mm outward from the exterior face of the manhole and vertically from bedding material to the bottom of roadbed gravels.

.13 Where a manhole is located outside of the paved street limits or in a gravel shoulder than it shall be provided with an asphalt apron as per HRWC requirements. Please refer to Section 39 00 00 for details.

4.6 SERVICE CONNECTIONS (WASTEWATER AND STORMWATER)

4.6.1 Residential

In those areas where service connections have already been installed, the connections shall be extended into the lot at the same diameter as those found in the ground.

4.6.1.1 Wastewater Service Connections

- New residential Single Unit Dwelling service connections shall be a minimum of 125 mm in diameter.
- Gravity wastewater service connections of 150 mm diameter or less shall be PVC DR28 (white) from the main to the building foundation.
- Wastewater service connections shall not connect to a dead end manhole. All service connections are to be made directly to the pipe downstream of the dead end manhole.

4.6.1.2 Stormwater Service Connections

- New residential Single Unit Dwelling service connections are to be a minimum of 100 mm in diameter.

- Stormwater service connections are to be PVC DR35 (green) from the main to the building foundation.

4.6.1.3 Pressurized Wastewater Service Connections (Privately Pumped Systems)

- Pressurized wastewater service connections (leading from a private pumped system) shall be a minimum of 50 mm in diameter and shall be PVC DR26 or DR11 (series 160) HDPE from the building to the gravity wastewater service connection. Where a gravity wastewater service connection cannot be installed from the main to the property line, the Engineer may consider a direct connection of the pressurized wastewater service connection to the wastewater system. The pressurized wastewater service connection shall be firmly connected to the gravity wastewater service connection or wastewater system by the use of a watertight prefabricated fitting.
- A shut off valve shall be provided 300 mm inside the street right-of-way for a pressurized wastewater service connection installation if connecting to a forcemain wastewater system (refer to Section 39 00 00).
- A trace wire shall be installed on pressurized wastewater service connections for location purposes (refer to Section 33 11 00 and Section 39 00 00).
- Where private or on-site low head pumps are required, such installations shall be designed by a qualified person and installed as per manufacturers requirements. Indicate on the drawings those locations requiring private pumping installations and private pressurized wastewater service connections.

4.6.2 Industrial / Commercial and Institutional (ICI)

In those areas where service connections have already been installed, the service connections shall be extended into the lot at the same diameter as those found in the ground.

4.6.2.1 Wastewater Service Connections

- New wastewater service connections for ICI projects shall be a minimum of 150 mm in diameter.
- Wastewater service connections shall be sized by an Engineer and submitted for approval by HRWC.
- Gravity wastewater service connections greater than 150 mm shall be PVC DR35 (white).
- Monitoring access point manholes shall be installed for all ICI wastewater service connections. (Refer to Section 39 00 00).

- Wastewater service connections shall not connect to a dead end manhole. All service connections are to be made directly to the pipe downstream of the dead end manhole.

4.6.2.2 Stormwater Service Connections

- New stormwater service connections for ICI projects shall be a minimum of 150 mm in diameter.
- Stormwater service connections shall be sized by a professional engineer and submitted for approval by HRWC.
- Stormwater service connections are to be PVC DR35 (green) from the main to the building foundation.
- Monitoring Access Point manholes shall be installed for all ICI stormwater service connections. (Refer to Section 39 00 00).

4.6.2.3 Pressurized Wastewater Service Connections (Privately Pumped Systems)

- Pressurized wastewater service connections (leading from a private pumped system) shall be a minimum of 50 mm in diameter and shall be PVC DR26 or DR11 (series 160) HDPE from the building to the gravity wastewater service connection. Where a gravity wastewater service connection cannot be installed from the main to the property line, the Engineer may consider a direct connection of the pressurized wastewater service connection to the wastewater system. The pressurized wastewater service connection shall be firmly connected to the gravity wastewater service connection or wastewater system by the use of a watertight prefabricated fitting.
- A shut off valve shall be provided 300 mm inside the street right-of-way for a pressurized wastewater service connection installation if connecting to a forcemain wastewater system (refer to Section 39 00 00).
- A trace wire shall be installed on pressurized wastewater service connections for location purposes (refer to Section 33 11 00 and Section 39 00 00).
- Where private or on-site low head pumps are required, such installations shall be designed by a qualified person and installed as per manufacturers requirements. Indicate on the drawings those locations requiring private pumping installations and private pressurized wastewater service connections.

4.6.3 Installation of Service Connections

Service connections shall be installed according to the following provisions:

.1 Service connections shall be provided to each lot (including duplex and sub-dividable lots) or potential future lot which could be created by the zoning in place at the time of installation of services, by using in-line tees.

The service connections (including the water service connection) shall extend from the main to at least 1.5 m outside the road right-of-way. At the discretion of the Engineer, the service connections may be allowed to terminate at the right-of-way. The service connections shall end in a bell end and be plugged with a PVC cap. The service connection from the 1.5 m at the right of way shall be made to the bell with a full length of pipe.

.2 Residential service connections shall be laid at a minimum grade of 2%.

.3 There shall be no decrease in size of the service connection from the building to the main.

.4 A maximum of two service connections are permitted to connect to a manhole.

.5 ICI service connections may be installed at a grade less than 2%, provided that the service laterals are designed and certified by a professional engineer.

.6 ICI wastewater service connection piping shall be required to be tested. Testing to meet the requirements as outlined in Section 33 31 00 Standard Specifications for Municipal Services.

Stormwater service connection piping shall not be required to be tested, however, it will be required to be certified by the design engineer.

.7 Service connections with a diameter smaller than 200 mm and with an overall length greater than 25 m shall be installed with an access type structure, every 25 m, on private property. A 300 mm x 300 mm x 6 mm steel plate shall be placed above this structure, but 150 mm below the ground surface to allow for detection by a metal detector. (refer to Section 39 00 00).

Service connections with a diameter of 200 mm or larger shall utilize manholes for changes in direction, shall be spaced a maximum of 100 m apart and be located on private property.

.8 Wastewater manholes installed on a private wastewater service connection located outside of the municipal right of way are required to be vacuum tested.

Testing to meet the requirements as outlined in Section 33 39 00 Standard Specifications for Municipal Services.

Stormwater manholes installed on a private stormwater service connection located outside of the municipal right of way are not required to be vacuum tested, however, they will be required to be certified by the design engineer.

.9 Service connections at the main shall be by one vertical long radius bend to a maximum of 45°.

.10 One horizontal, long radius 22½° bend is permitted along the length of a service connection. If a greater bend is required, an access type structure shall be constructed at the bend on private property (refer to Section 39 00 00).

.11 Service connections constructed in rock shall have the rock broken 3.0 m past the plugged end for the full trench width.

.12 Service connection trenches that have a trench bed sloping down from the main trench may require the installation of an appropriate clay plug, or similar solution, to prevent the flow of ground water from the trench towards the abutting properties.

.11 Service connections (up to and including 200 mm in size) to new mains, use prefabricated tee or wye fittings of the same material as the pipe.

Service connections (250mm in size or greater) to new mains, a pre-cast base manhole shall be required to be installed for this connection.

.12 Service connections (up to and including 200 mm in size) to existing mains, use cut in in-line tees coupled with a Unicoupling. "Kor-N-Tee" or "INSERTA TEE" fittings may also be used if installed according to manufacturer's specifications.

Service connections (250 mm in size or greater) to existing mains, a cast in place base manhole will be required to be installed at the main connection.

.13Service connections shall maintain a minimum horizontal separation of 1.5 m from other utility infrastructure.

.14The public portion of a service connection are to be installed a minimum of 1.5 m from driveways. Refer to Section 39 00 00 for details.

.15 Stormwater service connections are not permitted to connect to a catch basin.

4.6.4 Abandonment of Service Connections

An existing service connection shall be abandoned at the main under the following circumstances:

.1 The service connection is undersized for the proposed use of the property. Under this circumstance, a new appropriately sized service connection is to be installed by the developer / property owner; or

.2 The service connection is not going to be re-used due to the demolition of a building; or

.3 The service connection does not meet current pipe material specifications. This would be determined via a CCTV video inspection of the existing service connection by the developer of the property. This CCTV video would be reviewed by HRWC Operations staff, and they would make a determination of the condition of this pipe. If the service connection is deemed to be in disrepair by HRWC Operations staff, a new service connection shall be installed by the developer / property owner.

The developer / property owner shall obtain the appropriate permit (s) from HRM in order to excavate within the street right of way to abandon the service connection.

4.6.5 Re-using of Service Connections

An existing service connection may be re-used under the following circumstances:

.1 The service connection is of adequate size and meets current pipe material specifications; and

.2 At the discretion of HRWC, the service connection may require a CCTV video inspection to be reviewed by HRWC Operations staff, and they will determine if the existing service connection can be re-used.

4.7 UNSHRINKABLE FILL

Unshrinkable fill is approved for use as trench backfill. The specifications governing its manufacture and installation are governed by CSA A23.1 and A23.2.

The Portland Cement content shall be 25 kg/m³. The specified compressive strength at 28 days shall be a maximum of 1.0 MPa.

4.8 PIPE CROSSING

Where any wastewater / stormwater system pipe crosses any other wastewater / stormwater system pipe (including other utilities), the minimum vertical separation must meet NSE requirements and in no case shall the minimum vertical separation be less than 150 mm, measured from outside diameter to outside diameter.

5.0 DESIGN REQUIREMENTS – WASTEWATER SYSTEM

5.1 SCOPE

A wastewater system is a system of pipe lines, conduits, service connections from the pipes or conduits to street lines and appurtenances (including trunk wastewater systems, pumping stations, forcemains and treatment plants), owned, operated and maintained by HRWC. The primary function of the system is to collect and convey wastewater from where it enters the public system to a disposal or treatment location. Wastewater is defined as a combination of liquid and water-carried wastes from residential, institutional, commercial and industrial establishments in a community, together with such incidental stormwater as may be present.

A well designed and properly functioning wastewater system is essential for the environmental health of any community. In the HRM, such systems are to be designed and constructed with a view to minimizing the long term operating and maintenance costs associated with the system. Wastewater systems shall be designed and constructed to minimize infiltration and inflow conditions. The design should also ensure that HRWC personnel are not exposed to hazards when conducting operation and maintenance of the wastewater system.

When installing new wastewater systems, a properly functioning stormwater system is required. The stormwater system shall facilitate gravity flow for on and off street connections where full depth basements exist.

In addition to these design standards, all applicable and relevant codes and standards shall be used by the designer, including the latest editions of the following:

- National Fire Protection Association (NFPA).
- Canadian Electrical Code (CEC).
- Atlantic Canada Wastewater Guidelines Manual.
- Hydraulic Institute Standards.
- Canadian Standards Association (CSA).
- National Building Code of Canada (NBC).
- National Plumbing Code of Canada (NPC).
- Underwriters Laboratories of Canada (ULC).
- The Occupational Health and Safety Act of Nova Scotia

As well, all wastewater systems shall conform to any requirements established by NSE. No system shall be constructed until the design has been approved by the Engineer and NSE.

Wastewater shall be discharged into HRWC's wastewater system in accordance with the HRWC Act, HRWC Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services and applicable bylaws.

5.2 GRAVITY SYSTEMS

5.2.1 Gravity System – Design Requirements

5.2.1.1 Design Loading and Contributory Sewershed

The wastewater system shall be designed for wastewater flows generated from all lands within the sewershed in which the system is situated. Any lands which are, or may be anticipated to be tributary to the sewershed, either by future development, pumping, regrading or flow-through, shall be included in the calculated flows for the system being designed.

The wastewater system shall be designed for a gross population density based on the proposed land use. For deriving wastewater flows, a higher population density, due to the proposed land use or zoning of the tributary area may be required by the Engineer if it is determined that capacity is available in the downstream wastewater system to accommodate the resulting increased flow.

For design purposes, refer to the permitted land uses under the Municipal Planning Strategy (MPS) and Land use Bylaw (LUB), or approved Development Agreement. When determining site specific populations, refer to numbers below:

- Single Unit Dwellings 3.35 people / unit (ppu)
- Townhouse 3.35 people / unit (ppu)
- Multi-Unit Dwellings 2.25 people / unit (ppu)

For site specific flows (Industrial, Commercial & Institutional) refer to the current Atlantic Canada Wastewater Guidelines Manual.

The designer shall analyze the downstream wastewater system for capacity (giving consideration to the tributary upstream flows), septic conditions, and any other adverse effects associated with the proposed wastewater system. The limit of the downstream analysis shall be determined in consultation with the Engineer.

5.2.1.2 Wastewater System Pipe

.1 The minimum wastewater system main diameter shall be 250 mm.

.2 Approved wastewater system pipe materials shall be as follows:

- Reinforced concrete pipe meeting the requirements of the latest CAN/CSA Standard A257.2 and ASTM Standard C76.
- Polyvinyl Chloride (PVC) pipe and fittings meeting the requirements of the latest ASTM Standard D3034, DR35, and CAN /CSA Standard B182.2.
- ADS SaniTite HP - Profile Polypropylene (PP) pipe and fittings, corrugated dual-wall (300 – 750 mm) and corrugated triple wall (750 – 1500 mm) meeting the requirements of the latest ASTM Standard F2736-10, F 2764-10 and CSA Standard B182.13-11.

.3 Pipes shall be tested for leakage using the low pressure air method. Hydrostatic testing is not permitted. Testing of pipes shall be done in accordance with the latest edition of the Standard Specification for Municipal Services as developed by the Nova Scotia Road Builders Association and the Nova Scotia Consulting Engineers Association Joint Committee on Contract Documents. Testing shall not be carried out until the street base course (first lift of gravel) has been placed and compacted. Pipework located outside of the street right of way (R.O.W.) (i.e. easements) shall be at finished grade prior to testing.

.4 There shall be no decrease in pipe size from upstream to downstream.

.5 The minimum pipe grade shall be 0.6 %, (0.8% for cul-de-sacs), provided that a self-cleansing velocity of 0.6 m/s can be achieved based on peak dry weather flow for the area to be serviced in the initial phase of the development.

.6 Gravity flow in wastewater systems shall be calculated using the Manning's Formula or other approved method, with allowances made for energy losses at inlets, manholes, junctions, outlets, etc.

.7 The following Manning Roughness Coefficients shall be used:

PIPE MATERIAL	MANNING ROUGHNESS
Concrete	0.013
PVC	0.010
Polypropylene	0.012
HDPE (Smooth Interior Wall)	0.012

The minimum peak design flow velocity under full development or any phase of development shall be 0.75 m/s and a maximum flow velocity of 4.5 m/s. A higher flow velocity (up to 6.1 m/s) may be approved by the Engineer if adequate energy dissipation and ventilation is achieved

5.2.1.3 Wastewater Hydraulic Design

The flow Q (l/s), in the wastewater sewer system used for pipe sizing shall be as follows:

$Q = [1.25 \times (a \times M)] + b$ *(For sizing gravity wastewater systems)*

$$M = 1 + \frac{14}{4 + P^{0.5}}$$

where:

1.25	is a safety factor.	
$(a \times M) + b$	is the peak design flow.	*(peak design flow is to be utilized for the design of pumping stations and forcemain pipes)*
$a \times M$	is the peak dry weather flow.	
A	identified here as the average dry weather flow. The allowance is 300 litres (0.30 m^3) per person per day for residential development.	
M	is the peaking factor as derived from the Harmon Formula. The minimum permissible peaking factor shall be 2.0.	
b	is the future degradation of pipe long-term infiltration/inflow allowance. The allowable is 0.28 litres / gross hectare / second (24 m^3 per gross hectare/day).	
P	is the design population in thousands.	

5.2.1.4 Special Bedding

A geotechnical investigation must be carried out along the proposed routes prior to the design stage. The subsurface and soils conditions must be made available to the Engineer before approval of the proposed design in order to evaluate and approve the bedding type for the given conditions. The minimum bedding requirement for wastewater systems is 250 mm Type 1 gravel.

5.2.1.5 Wastewater System Manholes

Refer to SECTION 4.5 for general manhole requirements.

.1 Manholes shall be tested for leakage using the air vacuum method. Hydrostatic testing is not permitted. Where service connections are connected to the manhole, the service connections shall be pressure tested separately. Testing of manholes shall be done in accordance with the latest edition of the Standard Specification for Municipal Services as developed by the Nova Scotia Road Builders Association and the Nova Scotia Consulting Engineers Association Joint Committee on Contract Documents.

.2 Wastewater system manholes shall be positioned so as to prevent the infiltration of surface water or ground water. In addition to O-ring gaskets, joints in precast sections below the concrete manhole cover shall be sealed with 25 mm butyl resin cord. The cord shall be placed on the upper inside ledge of the joint prior to placement of the subsequent section. The wastewater system manhole inclusive of the grade rings, shaft, precast sections and base shall be constructed with Blueskin waterproofing membrane (refer to Section 39 00 00). Manholes shall not be located in areas subject to flooding, such as, but not limited to the following locations:

- Drainage ditch or swale.
- Roadway gutters or low points.
- Future roadway gutters or low points.
- Overland flow routes.
- In areas subject to flooding.

.3 Industrial, Commercial and Institutional (ICI) facilities shall be required to provide a Monitoring Access Point manhole into their service connection, located just behind the street line on private property, for inspection and sampling of the wastewater characteristics. The location should be such that the manhole is easily accessible. This location may be adjusted at the discretion of the Engineer.

.4 Cast in place base for precast wastewater manhole: The bell end of the precast section shall be fully embedded in the partially set, cast in place base. Finish the interface with grout or concrete on the inside and outside of the manhole, sloping up at 1:1 to meet the precast section. For clarification, see detail for Cast-in-Place Base for precast manhole. Additionally, all lift holes for pre-cast manhole sections shall be grouted.

5.2.1.6 Hydrogen Sulphide

.1 The wastewater system shall be designed to minimize hydrogen sulphide conditions. This shall include minimizing the use of drop manholes and precautions to reduce turbulence, and a reasonable retention time in pumping stations.

.2 Where hydrogen sulphide conditions are unavoidably high the wastewater system including gravity and forcemain pipes, pumping station, etc. shall be constructed of corrosion resistant materials. Refer to Schedule “A” of HRWC’s Schedule of Rates, Rules & Regulations for Water, Wastewater and Stormwater Services for limits for discharge to wastewater facilities.

.3 Where min./max. wastewater velocities are present and systems with a large number of drop manholes are in place, the system, including gravity and forcemain pipes, pumping station, etc. shall be constructed of corrosion resistant materials.

5.2.1.7 Wastewater Service Connections

As noted in the National Plumbing Code of Canada *(section 2.1.2.4 – Separate Services).* Service connections connected to the public services shall be connected separately from piping of any other building, except that an ancillary building on the same property may be served by the same service.

Refer to SECTION 4.6 for wastewater service connections requirements

5.3 PUMPED SYSTEMS (UP TO 30 L / S)

5.3.1 Design Requirements

5.3.1.1 General

Pumping stations and forcemains represent a long-term financial burden to HRWC in terms of operating and maintenance costs and eventual replacement of system components. Designs are to preclude the need for pumping stations. Pumping stations will be permitted only when a gravity system is not physically possible or when the life cycle costs of a gravity wastewater system are shown to be greater than those of a pumping station.

These guidelines govern smaller or “submersible” type pumping stations with ultimate capacity of 30 l/s or smaller. Larger capacity pumping stations will be evaluated by the Engineer on a site specific basis. An alternative phased pump station design may be considered if practical.

Pumping stations and force mains shall be designed for the peak design flow (Section 5.2.1.3) from the tributary drainage area (Section 5.2.1.1) Present and future conditions shall be considered.

The design shall ensure the safety of operations, in accordance with all applicable Municipal, Provincial and Federal regulations including the Occupational Health and Safety Act and applicable CSA specification.

Pumping stations shall function as an un-manned station.

Equipment that starts automatically shall be suitably signed to ensure that operators are aware of this condition. Lock-outs on all equipment shall be supplied to ensure that the equipment is completely out of service when maintenance or servicing is being carried out. All moving equipment shall be covered with suitable guards to prevent accidental contact.

Where auxiliary power supply buildings are provided, they shall include potable water, on demand supply hot water, toilet facilities, wash-up station facilities and an exterior water supply connection.

The exterior water supply connection shall consist of a 50 mm diameter supply line with a 38 mm water meter, a 38 mm Reduced Pressure Principle backflow prevention device and outfitted with a 38 mm wall hydrant with an internal shut off valve installed in a lockable enclosure suitable for exterior use. The wall hydrant thread shall meet the requirements as outlined in Section 3.0.

5.3.1.2 Submission Requirements

When submitting a proposed pump station design, the following items shall be included in the submission for review by HRWC.

- Civil Drawings.
- Mechanical Drawings.
- Electrical Drawings.
- Pump Information.
- Design Report.
- Sewershed Boundary serviced by pump station.
- System Curves.
- Station Configuration.
- Program Ladder.

5.3.2 Pumping Stations

5.3.2.1 Wet Well Size

Size the wet well to minimize pump cycle time and in accordance with the pump manufacturer's recommendations. Design the wet well and control settings to avoid septic conditions.

Larger stations (exceeding 30 L/s) shall install a dual wet well system to control flows during maintenance activities.

5.3.2.2 Pump Types

Pumps for use in local wastewater pumping stations are approved as follows:

5.3.2.2.1 Submersible Pumps

Guided into place on two guide bars or cables extending from a guide-bar/cable holder at the top of the station to a discharge connection elbow at the bottom; metal to metal pump to discharge connection; pump and motor from the same manufacturer, shall be close-coupled as a single unit, CSA approved and manufacturer certified for Class 1. Div 1 Zone 2, Groups A, B, C or D hazardous locations; air filled, squirrel cage motor with Class F windings rated for 155°C, designed for continuous duty, handling pumped media at 40°C capable of up to 15 starts per hour; service factor not less than 1.10; voltage tolerance ± 10%; protected by thermal switches, located in the windings, calibrated to open at 125°C; float type leakage sensor located in the stator housing. Thermal switches and leakage sensor are to be monitored by a unit in the control panel. Pumps to be cooled with cooling fins; pumps over 10 kW are to be cooled with a water jacket around the stator casing. The motor shall be designed to operate up to 40°C ambient with a temperature rise not to exceed 80°C.

Pumps shall have a retrieval system that allows for the ability of being removed and re-installed in a submerged state.

The pump construction will be cast iron ASTM A-48, Class 35 B with a wastewater resistant coating; exposed nuts and bolts shall be AISI type 304 stainless steel. The impeller shall be cast iron Class 35 B capable of handling solids with up to 75 mm diameter. At the discretion of the Engineer, the volute is to have provision for a Mix Flush Valve. The bearings shall be permanently greased, single roller type for the upper bearing and two row angular contact type for the lower bearing. The pump shall have a tandem mechanical seal system with two independent seals operating in a lubricant reservoir; the seal ring material shall be silicon-carbide.

The power cable to the motor shall be CSA approved, sized for service, sealed at the pump entry by a compressed grommet/washer assembly and shall be continuous from pump to electrical panel.

In order to standardize submersible pumping equipment for HRWC, only pumps from the following manufacturers are permitted:

- Flygt / Xylem.
- ABS.
- KSB.

5.3.2.2.2 Self-Priming Pumps

Horizontal type; casing and volute in contact with wastewater shall be cast iron class 30 or higher grade; two-vane, semi-open, ductile iron impeller with integral pump-out vanes on the back shroud, threaded onto the pump shaft and secured by lock screw; rotating assembly, including bearings, shaft mechanical seal and impeller shall be removable as a unit without removing pump volute or piping; mechanical seal shall have tungsten titanium carbide rotating and stationary faces lubricated by a separate oil-filled reservoir and be covered by at least a four year warranty; replaceable wear plate attached to a removable cover plate which in turn is to allow easy access for inspection. The reprime of a completely empty suction line to full pumping shall take a maximum of 5 minutes operating at the selected speed and impeller diameter with the reprime lift of the installation condition. The reprime lift shall be published data and is to be certified by the pump manufacturer upon request.

Pumps shall be specifically designed for pumping raw, unscreened, domestic wastewater (non-clog, solids handling type). Pumps shall be complete with premium efficiency electric motors, and if applicable be inverter duty and rated for use with variable frequency / speed drive (VFD/VSD) control systems. Pumps installed within the classified space of the wet well shall be CSA approved and manufacturer certified for Class 1, Div 1, Zone 1, Groups A, B, C or D hazardous locations.

All pumps and motors must carry a minimum of 12 months warranty from the date of acceptance of the system.

5.3.2.3 Emergency Overflows

Pumping stations shall be provided with an emergency overflow. The invert of the overflow pipe at the pumping station shall be lower than the lowest invert of any service connection at the property line. The invert of the overflow pipe shall be high enough to prevent back-flow into the pumping station from the high-water of the localized system. If this is not possible the Engineer may approve a check valve on the overflow. The designer shall provide a means to measure emergency overflows within a pumping station.

An auxiliary power supply shall be included in each pumping station unless otherwise required by the engineer. An emergency storage tank may be considered instead of auxiliary power on pumping stations with a maximum peak flow of 30 l/s or less.

5.3.2.4 Auxiliary Power Supply and Building

The auxiliary power supply system (loosely referred to here as "generator") shall be designed with adequate capacity to operate the wastewater pump or pumps required to pump peak wastewater flows, control and monitoring systems, and heating and lighting systems within the pump house. The generator is to run automatically on a power outage and to stop when the power returns; the stopping and starting of the generator is to be activated in co-ordination with an automatic power transfer switch. The generator is to meet all applicable CSA, NEMA, NFPA and IEEE standards. The generator shall include at minimum a governor, battery operated starting system complete with battery charger, exciter, voltage regulator, control panel, generator temperature and oil pressure gauges, alternator output circuit breaker and exhaust system. The generator and exhaust system shall be designed to minimize noise.

For pump stations where auxiliary power is not provided a quick connect feature for a portable generator consistent with existing HRWC portable generator connections is required.

Electrical meter base must be located outside of the building in a stainless steel enclosure with lockable hasp and comply with Nova Scotia Power Inc., Utility Service Requirements. A stand-alone main service disconnect must be available inside of the building.

A building shall be provided to house the auxiliary power supply unit, pumps, pump motors, heat and light, control panel, piping, valves, and any other required accessories. These items shall be located in the building in such a way as to provide safety for workers and convenient access for maintenance.

The fuel storage tank and installation is to be designed to meet the requirements of the National Fire Code of Canada, Section 4 and shall meet the requirements of the Contained Tank Assembly document ULC-S653 and must be either steel meeting CAN/ULC-S603 and S603.1 or FRP (Fiberglass Reinforced Plastic) meeting CAN/ULC-S615. Fuel storage tanks 1500 litres and less are to be installed inside the building and must have a concrete curb containment system sufficient to contain the entire volume of the tank complete with sensors in case of a leak or spill.

Exterior wall assembly of the building shall be 200 mm split-face concrete block with a minimum of R20 (RSI 3.5) insulation. The door shall be a heavy duty steel door with a minimum 750 mm width, and must be sized to accommodate the removal and maintenance of equipment and shall be insulated with a minimum of R6 (RSI 2.8) insulation. The building shall have a hip roof with a minimum slope of 2:1 (horizontal : vertical) and a minimum of R30 (RSI 5.3) insulation with asphalt shingles (25 year rated). There shall be no windows in any exterior wall. Adequate ventilation for all mechanical equipment shall be provided by vandal resistant, insulated, heavy duty type steel intake and exhaust louvers. Engine emissions shall be directed away from the building so as not to create a ventilation "short circuit". The louver system shall be designed to prevent a negative pressure situation within the building. Provision shall be made to support wall-mounted equipment inside the building. The building is to be designed “secure”.

Thermostats are to be located away from the air intakes such that there is no conflict with exterior air. Radiators may be considered for smaller buildings with dual loops.

The building floor shall be a minimum 150 mm above the finished external grade and any potential flood level. Pump house floors shall be poured reinforced concrete and sloped toward the access door.

Interior wall surfaces, doors and trim shall be painted to a color scheme as approved by the Engineer. A non-metallic colored hardener shall be added to the concrete floors during the finishing process to a colors scheme as approved by the Engineer

Doors shall swing outward to open and panic hardware should be installed for emergency exit. All hinge pins on doors shall be secured to prevent their removal and astragal's (anti pick plates) be installed with non-removable fasteners, to cover the latch bolt area on the doors. All door locks shall be keyed alike to HRWC standard system.

The Engineer may approve an alternate architectural design to better blend in with surrounding Community.

5.3.2.5 Emergency Storage Tanks

Emergency storage tanks shall be constructed of precast or cast-in-place concrete. The tank shall be constructed using the following criteria:

- The tank is only to be used during power outages and should remain dry during normal cycling of pumps.
- The tank shall incorporate a wash-down mechanism that can be used each time the storage tank is used.
- The tank floor shall be sloped toward the outlet pipe at a slope of 5:1 (horizontal : vertical) or steeper.
- The tank shall have two access hatches.
- The tank shall be of a size adequate to accommodate peak flow for a time equivalent to the average power outage duration for the area. Refer to NSPI for duration time.

5.3.2.6 Benching and Flush Valve

Wet-wells shall be designed to minimize the deposition of solids. Benching is to be designed to be self-cleansing; no steps, ledges or “dead-spots” are permitted. Install one hydraulically operated flush valve per pumping station. (ITT Flygt / Xylem or approved equal).

5.3.2.7 Phased Developments

In situations of phased development the effects of minimum flow conditions shall be investigated to ensure that the retention time in the wet well will not create an odour or septic problem and that pumping equipment will not operate too infrequently based on manufacturer's recommendations.

5.3.2.8 Pump Selection

Pumping equipment shall be selected to perform at maximum efficiencies under normal operating conditions. Provide soft start and variable speed drives under the following conditions:

- Soft start — 7.5 kW and larger (10 HP).
- Variable Speed Drive — 15 kW and larger (20 HP), in consultation with the Engineer.

Pumping stations, wet well and dry wells shall be designed such that all pumps will operate under a continuous positive prime condition during the entire pump cycle.

System head calculations and pump selection curves shall be provided for the following operating conditions:

(a) C=110 and low water level in the wet well.

(b) C=120 and medium water level over the normal operating range in the wet well.
(c) C=130 and overflow water level in the wet well.

Where C is Hazen-Williams flow coefficient

Curve (b) shall be used to select the pump and motor since this most closely represents normal operating conditions. The extreme operating ranges will be given by the intersections of curves (a) and (c) with the selected pump curve. The pump and motor shall be capable of operating satisfactorily over the full range of operating conditions.

5.3.2.9 Pumping Arrangement

Pumping stations shall have a minimum of two pumps. Each pump will be sized to handle the peak design flow. Where three or more pumps are provided, they shall be of such capacity that, with any one pump out of service, the remaining pumps will have the capacity to handle the peak design flow, taking into account head losses associated with parallel operation.

The pump control circuitry shall be designed to alternate pumps for each pumping cycle automatically and if suitable, to handle cascading operation of multiple pumps based on flow demands.

Pumping arrangements shall be designed to be hydraulically, operationally and energy efficient. Analyses of system hydraulics, pump and pump system operating characteristics, energy consumption and life cycle costs shall be provided to HRWC for review and approval and to confirm the most effective and efficient pumping solution has been selected.

5.3.2.10 Flow Velocities

Suction and header piping shall be sized to carry the anticipated flows. Flow velocities shall be:

- Minimum cleansing velocity of 0.6 m/s.
- Maximum velocity of 2.4 m/s.

Regardless of the above conditions, piping less than 100 mm in diameter is not acceptable.

5.3.2.11 Piping

Pumping station internal piping shall be either ductile iron Class 54 with coal tar epoxy or glass lining, or 11 Gauge stainless steel (Type 316 or 316L). Coloured grey for DI pipe.

Threaded flanges or Victaulic couplings shall be used for ductile iron pipe joints, fittings and connections within the station. Pressed or rolled vanstone neck flanges shall be used for stainless steel pipe joints, fittings and connections. Piping within the station shall be properly supported and shall be designed with appropriate fittings to allow for expansion and contraction, thrust restraint, etc.

5.3.2.12 Inlet Arrangements

A manhole shall be provided outside of the pumping station and only one inlet pipe shall be permitted from this manhole to the pumping station wet well. No service connections shall be connected between the last manhole and the wet-well.

The inlet of the incoming pipe shall be higher than the setting which starts the second pump.

At the invert of the incoming pipe a removable baffle or deflector plate is to be installed on the end of the incoming pipe. The baffle or deflector plate is to be constructed of 12 Gauge stainless steel (Type 316 or 316L). Other designs providing for non-turbulent flow into the station may be considered.

5.3.2.13 Hydraulic Analysis

A hydraulic transient analysis shall be undertaken to ensure that transients (water hammer) resulting from pumps starting, stopping, full load rejection during power failure, etc. do not adversely affect the pipe or valves in the system. The results of the hydraulic analysis shall be provided by the designer in the form of a Design Brief to support the system design.

5.3.2.14 Valves

Hand operated rising stem gate or plug valves shall be provided on discharge piping to allow for proper maintenance. A check valve shall be provided on the discharge lines between the isolation valve and the pump. Check valves shall be accessible for maintenance. All valves, including check valves, shall be located outside of the pumping station and shall be installed in a drained concrete chamber. The minimum number of valves to be installed within the chamber shall be five (5) for a dual forcemain pipe arrangement. The drain shall be directed to the wet well and equipped with backflow protection. Please refer to Section 39 00 00 for details.

5.3.2.15 Wet Well Ventilation

A ventilation system capable of delivering a complete air change to the wet well in ten (10) minutes (6 ACH) or delivering fresh air to the wet well at a minimum rate of 110 litres/sec at 15 mm static pressure is to be provided. The ventilation system must meet the requirements of the Canadian Electrical Code for Class 1, Div 1, Zone 1 hazardous locations. A separate circuit is to be provided for the fan with a ground fault interrupter. The ventilation fan is to be controlled by a switch at the pumping station control panel set to operate when the control panel door is opened. The ventilation fan control shall also provide for automatic operation of the fan at least 4 times during a 24 hour period. The operation duration of each time shall be adjustable and to be 10 minutes minimum. The ventilation fan is to be mounted on the pumping station control panel mounting structure adjacent to the control panel. Above-ground ventilation piping is stainless steel and is to be goose-necked with a birdscreen on the open end.

5.3.2.16 Underground Concrete Structure Water Proofing

Underground concrete structures such as wet-wells, dry-wells, emergency storage tanks, holding tanks, valve and meter chambers, etc., shall incorporate the following water proofing measures:

- Underground concrete structures shall be treated with Xypex or equivalent. This may be applied to the exterior of the structure or pre-mixed with the concrete.
- The joints of precast concrete sections shall be sealed with 32 mm butyl resin flexible gasket (ConSeal CS-202 or equivalent). The outside of the joint shall also be treated with 150 mm wide butyl resin joint wrap (ConSeal CS-213 or equivalent).
- Where cold joints occur in cast in place structures, adequate waterstops shall be installed to prevent the infiltration or exfiltration of water.
- The exterior of underground concrete structures shall be covered in a waterproof membrane, Blueskin or approved alternate.

The Engineer may waive some or all the above requirements if an internal/external waterproof liner is used.

5.3.2.17 Access

Adequate access hatchways shall be provided. Hatchways are to open in a direction which allows access from the driveway. Hatches which are flush with the surrounding grade are to be equipped with a secondary protective grating device to provide fall-through protection.

Pumping stations shall be provided with an acceptable device for the removal of pumps and motors for repair and maintenance.

Pumping station wet wells shall be provided with an approved fall arrest system. Please contact HRWC for specific details on the requirements for this installation.

An accessible hatch must be provided for each pump installed.

Lift hatches shall have gas assisted cylinders and able to be “locked-in” in the upright position. Limit switches are required for the hatches to indicate when they are opened.

Locks shall be keyed alike to HRWC’s standard system.

5.3.2.18 SCADA and Controls

Pumping station control panel is to be a CSA approved NEMA 4X rated lockable stainless steel door-on-door style enclosure measuring 1500 mm (height) x 900 mm (width) x 250 mm (depth). The control panel must incorporate an inside hinged panel to separate the high voltage equipment from the operator interface and controls.

Pumping station utility meter socket base to be housed within the control panel enclosure with a pad lockable access door and ¼ turn closing handle mechanism attached to the main control panel door.

Control panel to include the following items:

- PLC based pump controller.
- Minimum 200 mm TFT colour daylight visible display LCD touch screen display panel, 256 colours, 32MB RAM and removable storage media port. Acceptable products: Allen Bradley Panelview, Maple Systems Graphic HMI or approved equivalent.
- Uninterruptible power supply properly sized to maintain PLC in powered state during generator transfer to and from emergency power.
- Status indicator lights to signify the following conditions for each pump:

  - Red - Pump Running.
  - Green - Pump in Standby Mode.
  - Yellow - Pump Alarm Active.
- Separate mechanical interlocked main breaker for portable generator connection.
- Mechanical run-time meters shall be provided for each pump and an additional meter shall be provided to record run-time for two pumps operating simultaneously.
- Lightning arrestors.
- Intrinsic safety barriers for all float switches.
- Appropriate space allocated in the enclosure to install communication hardware including radio, radio power supply and antenna supplied by HRWC.
- Hand-Off-Auto selector switch for each pump.
- Flow meter transmitters with MODBUS capability.

Magnetic flow meters shall be provided for each pump discharge pipe. Magnetic flow meters shall be located in the valve chamber and installed in accordance with the manufacturer’s specifications allowing for sufficient straight runs of pipe for maximum accuracy.

Flow meters shall be the following approved products:

- ABB
- Siemens
- Keohne

Pump controller shall be PLC based and programmed in a manner that the required I/O (Input / Output) be organized in blocks such that the I/O will transfer to the HRWC communication panel or SCADA system in a single read via modbus RTU protocol. All PLC programming and operator interface screen programming must be coordinated with HRWC. All PLC and OIT programming complete with documentation must be provided to HRWC on electronic storage media to be included in the operations and maintenance manuals.

Acceptable products:

- Schneider Electric SCADAPack
- Allen Bradley MicroLogix
- CompactLogix or approved equivalent.

PLC controller shall have eight extra digital points and eight extra analog points and will transmit the following signals and alarms to the HRWC`s central monitoring system:

- Hand-Off-Auto selector switch status.
- Station voltage.
- Pump motor currents.
- Station level.
- Low level alarm.
- High level alarm.
- Power monitor alarm.
- Pump motor overload.
- Pump motor under-load.
- Pump status.
- Valve chamber flood alarm.
- Flow rate for each pump.
- Pump inlet pressure.
- Pump outlet pressure.
- Overflow rate.
- Entry alarms for well and chamber hatches.
- Totalizer reading for each flow meter.

Where an auxiliary power supply and building exists:

- Entry alarms for building and well hatches.
- Generator status.
- Generator fault alarm.
- Generator fuel tank analog level.
- Generator fuel tank low level alarm.
- Transfer switch status.
- Panic alarm for building.
- Fire alarm for building.
- Gas detection alarm (tied to ventilation control).
- Station thermostat status / control.
- Ventilation system status / control (tied to access control).
- Outdoor air temperature status (tied to ventilation control).

Control panel shall include a means of protecting the pump motors from the following potential conditions:

- Under-load.
- Overload.
- Phase loss.
- Current imbalance.
- Overvoltage.
- Undervoltage

Each pump shall have a separate lockable disconnect switch for isolation of the motor power supply accessible from the dead front panel.

5.3.2.19 Level Controls

Pumping stations shall have an ultrasonic level control with a local display of the station liquid level locally and an analog output into the pump controller to control pump starts and stops. Float switches may be considered in stations where ultrasonic level control is unsuitable.

In conjunction with the ultrasonic level control, the pumping stations shall have two Flygt float switches model # ENM-10 or approved equivalent. One float switch will act as a low level alarm float and lock-out the pumps if the liquid level drops 75 mm below the normal pump shut-off level. This condition is to provide a low level alarm indication but is to be self-resetting. The second float switch shall act as the high level alarm float and start both pumps if the liquid level is above the normal start level and they are not already running. This condition is to provide a high level alarm indication but is to be self-resetting.

5.3.2.20 Electrical

An Arc Flash Hazard Analysis study must be performed to determine the available arc fault currents and arc flash hazards for electrical equipment such as switchboards, panel boards, industrial control panels, meter socket enclosures and motor control centres (MCCs). Arc Flash Hazard warning labeling must be provided and shall include system voltage, flash protection boundary distance, hazard risk category, available fault current, incident energy at 460mm and study report issue date.

Electric motors less than 7.5 kW shall be 208 volt, 3 phase; electric motors 7.5 kW and larger shall be 600 volt, 3 phase. All electric motors shall be premium efficiency motors.

All electrical conduits shall be sized in accordance with the latest edition of the Canadian Electrical Code but being a minimum of 50 mm in diameter. Utility service to the control panel shall be through buried conduit and a spare service conduit shall be provided. Electrical conduit between the control panel and any remote chambers shall be buried. Each pump cable shall be installed in a separate conduit.

There shall be no electrical junction boxes located below the maximum flood level of the pumping station. A NEMA4 corrosion resistant junction box with terminal strips and transit seals must be installed between the EYS seals and the wet well. No splices shall be permitted in power or control cables between the pump and the control panel.

5.3.2.21 Site Considerations

The pumping station, auxiliary power buildings and control panels shall be located off the street right-of-way. The property on which these facilities are located shall be sized to accommodate proper access, maintenance and all features associated with the station; the property shall regardless be a minimum of 150 m^2 and shall be deeded to HRWC. The pumping station shall not be sited in a floodplain and the site shall be evaluated for groundwater conditions. As determined by the Engineer, the site shall be big enough to facilitate a re-build of the station while the current station is operational. HRWC will compensate the developer for land exceeding the required 150 m^2 at full market value.

The site grading and stabilization is to be in accordance with the overall subdivision grading plan for a new development. The elevation of the top of the wet well shall be no less than 100 mm and no more than 150 mm above the finished grade of the pumping station lot.

Non-hard surfaces are to be landscaped. Creative use of low maintenance shrubbery and foliage is to be used to screen the site. The station is to blend in with existing, surrounding and future development.

The driveway to the pumping station shall be designed for commercial level access, egress and turning movements, shall be asphalted and shall have access from the street. The driveway shall be constructed of surge material as required by the Design Engineer, 150 mm Type 2 gravel, 150 mm of Type 1 gravel and 75 mm of asphalt to a minimum width of 3.5 m, and a minimum length of 7.5 m.

Provision shall be made for the installation of a 2.44 m security fence for the property (refer to Section 39 00 00 for details). HRWC will evaluate the fencing requirements upon review of the proposed site.

5.3.2.22 Safety Precautions

The pumping station and appurtenances shall be designed in such a manner as to ensure the safety of operations, in accordance with all applicable Municipal, Provincial and Federal regulations including the Occupational Health and Safety Act. An adequate hazard assessment of the design should be conducted to ensure that all confined spaces are eliminated. All moving equipment shall be covered with suitable guards to prevent accidental contact.

Equipment that starts automatically shall be suitably designed to ensure that operators are aware of this condition. Lock-outs on all equipment shall be supplied to ensure that the equipment is completely out of service when maintenance or servicing is being carried out.

Diesel generator fuel supply lines shall be equipped with fusible link valves. Fuel lines between the generator and the fuel supply shall be located in appropriately sized sleeves cast into the station floor.

5.3.2.23 Testing

Wet Well

Prior to installation of mechanical and electrical equipment, the wet-well shall be tested for leakage. The wet well is to be filled to the top cover level with water and after a 24 hour period, re-filled to the top cover, then monitored for 4 hours. Measured leakage after the 4 hour period must be less than 5 litres/hour/0.8 m^2 surface area/1000 mm of vertical height. If leakage is greater than allowable, make repairs and re-test. This iterative process should be continued until a successful test is achieved. Regardless of test results, repair any visible leaks, seepage or weeping.

Station Piping

All station process piping (from the pumps to the forcemain connections) shall be hydrostatically tested. Piping must maintain a minimum pressure of 1035 kPa for two hours, as indicated in AWWA C600. No leakage or loss of pressure is permitted. If leakage or loss of pressure occurs, make repairs and re-test. This iterative process should be continued until a successful test is achieved.

5.3.2.24 Facility Start-Up

During the start-up period, the contractor starts, operates and tests all equipment and control and communication systems to ensure proper function in accordance with the project documents. The contractor is responsible for leading and directing the start-up process and calling to the site any subcontractors and suppliers necessary to start, test and certify equipment. The contractor will liaise with the developer's professional engineer and HRWC as necessary. The SCADA tag list is to be provided to HRWC at least two weeks prior to facility start-up to allow HRWC technical operations sufficient time to program SCADA.

During the start-up period, all technical issues related to the operation of the facility and all requests for information (RFI's) shall be resolved. Once the start-up period has been completed, the facility should be functioning in accordance with the contract documents. In order to progress to facility commissioning, the contractor shall provide:

- a full itemized list of equipment accompanied by vendor installation verification and certification indicating that the equipment has been started, tested, is functioning within specified parameters and is ready for intended use, and;
- a full itemized list of technical difficulties encountered during start-up and their resolutions.

The following personnel shall be present at the facility start-up:

- **Contractor (lead)**
- Subcontractors
- Suppliers
- Developer's Professional Engineer
- HRWC Staff (as necessary)

5.3.2.25 Facility Commissioning

Facility commissioning occurs after successful completion of facility start-up and provision of a full itemized list of equipment, installation verification, certification and a full itemized list of technical difficulties/resolutions. Once the developer's professional engineer has reviewed and accepted this information, they shall advise that the facility is ready for commissioning. The contractor shall then schedule commissioning dates a minimum of two weeks in advance, subject to availability of all parties.

During facility commissioning, the contractor demonstrates to the developer's professional engineer and HRWC that all equipment and systems function properly and in accordance with the project documents. The developer's professional engineer is responsible for providing a commissioning officer to lead the commissioning process, creating the commissioning plan, creating site acceptance testing protocols, and leading and directing the commissioning process. As a minimum the commissioning plan shall cover the following:

- Full Input/Output listing and their function;
- Full list of equipment and system setpoints;
- Test or simulate all Input/Output;
- Test and verify that all equipment and systems function in accordance with the Process Control Narrative (PCN);
- Check, verify and record all parameters of pump performance (including electrical parameters) under all possible operating configurations. These values will be used to check performance throughout pump lifecycle;
- Test (or simulate) and verify functionality of all alarms and ensure that response is in accordance with PCN;

- Check and verify functionality of all mechanical systems (ie. ventilation, pump lifts, heating, hatches and accessories, valving, etc.);
- Demonstrate removal and reinstallation of all removable/serviceable mechanical equipment (ie. screening baskets, pumps, etc.);
- If an auxiliary power supply system ("generator") is installed, confirm functionality by:
  - simulating a power interruption at full demand, ie. open the line power main disconnect switch;
  - conducting a load bank test - 100% load for 6 hours.

The contractor shall have an appropriate number of staff available on-site to operate all equipment as directed by the commissioning officer and in accordance with the commissioning plan and site acceptance testing protocols. The developer's professional engineer and HRWC facility operator will be present to witness facility commissioning and will liaise with, and call to the site, other HRWC Staff as necessary.

It is fully expected that all equipment and systems have been started successfully during facility start-up and operate in accordance with the project documents. This ensures efficient use of resources during commissioning (ie. HRWC staff time and developer's professional engineer time and expenses). If it is determined that all equipment has not been started and does not operate properly during the first attempt at commissioning, the developer's professional engineer may, at their discretion, terminate the commissioning process and instruct the contractor to complete the facility start-up and re-schedule facility commissioning.

The following personnel shall be present at facility commissioning:

- **Developer's Professional Engineer (Commissioning officer as lead)**
- Contractor
- Subcontractors
- Suppliers
- HRWC Facility Operator
- Other Halifax Water Staff (as necessary)

5.3.2.26 SCADA Commissioning

SCADA commissioning occurs after successful completion of facility commissioning. During SCADA commissioning, all communications will be verified between the local PLC and RTU and between the local RTU and HRWC's HMI. Under direction from the HRWC technical operations representative, the contractor shall trigger, modulate or simulate all system tags to confirm communications and to ensure consistent nomenclature and units throughout. It is expected that the contractor will have the appropriate technical staff on-site for a full day to complete the SCADA commissioning.

The following personnel shall be present at SCADA commissioning:

- **HRWC technical operations representative (Lead)**
- Contractor
- Subcontractors (as necessary)
- Suppliers (as necessary)
- Developer's Professional Engineer

5.3.2.27 Facility Training

After successful commissioning, the contractor or the developer's professional engineer provides training for HRWC Staff in the proper operation of the facility. Such training shall include: safety orientation, system description, identification of all individual pieces of equipment and explanation of their purpose; review of control logic, sequencing and setpoints for all equipment and systems; review and demonstration of operator interfaces; identification and demonstration of unique maintenance activities necessary to ensure proper operation of the facility; identification and explanation of equipment and system limitations; identification and explanation of spare parts and special tools. Facility training shall also identify all transient protection devices on the forcemains, their location, the location of the discharge manhole(s) and any downstream restrictions or interlocks.

Following facility training, the contractor is to allow for additional programming adjustments to operator interfaces as directed by HRWC.

The following personnel shall be present at facility training:

- **Contractor (may act as lead)**
- **Developer's Professional Engineer (may act as lead)**
- Subcontractors (as necessary)
- Suppliers (as necessary)
- HRWC Facility Operator(s)

5.3.2.28 Facility Commissioning Report

Following successful completion of commissioning and training, the developer's professional engineer shall provide a detailed facility commissioning report complete with certification that the facility has been constructed and operates in accordance with the design intent and project specifications.

- Executive summary, including:
  - Observations
  - Conclusions
  - Outstanding Items
  - Recommendations
- Performance verification checklists (test results and evaluation);
- System deficiencies that were discovered and measures taken to correct them;
- Outstanding deficiencies;
- Plan for resolution of outstanding deficiencies;
- Summary of training process;
- Certification from the developer's professional engineer that the facility meet design intent, are operating within specified parameters and are ready for intended use;

5.3.2.29 Operations and Maintenance Manual

The developer's professional engineer is to provide three (3) paper copies each bound in a heavy duty "catalog" binder with expanding posts and one (1) digital copy of the facility operation and maintenance manual, in a form acceptable to the Engineer. The manual must contain the following items in same general order:

- Title Page including:
  - identification of document as an operations & maintenance manual;
  - facility name;
  - facility Contractor;
  - facility Design Engineer;
  - date of issuance.
- Index
- A quick reference table (spreadsheet to accompany electronic submission) listing the following information for each piece of equipment within the facility:
  - make, model and serial number;
  - name, address and contact details for supplier and installer;

  - lubrication and regular maintenance intervals;
  - an index reference to the full equipment manual contained within the operations and maintenance manual;
  - spare part list, and;
  - expiry date for guarantee / warrantee.

- System Description;
- Narrative on area served inclusive of mapping;
- Facility design intent, parameters and limitations (ie. Design report);
- As constructed civil, mechanical and electrical drawings. This is to include forcemain drawings and details of transient devices on the forcemains;
- System hydraulics and design calculations (including system curves);
- Pump literature (including pump curves);
- Manufacturer's operation and maintenance instructions and manuals for all equipment which includes maintenance and lubrication schedules;
- Facility Commissioning Report;
- Systematic lifecycle upgrade report (if applicable);
- Process Control Narrative;
- Electronic copies of PLC and Operator Interface Terminal (OIT) projects;
- Any original software and interface cables required for programmable equipment installed within the facility with the exception of PLC and OIT programming software, unless specified in the contract document;
- Detailed information on guarantees / warrantees for all equipment;
- Construction and post-construction color digital photos. Post-construction photos shall be taken at various angles showing the main features of the inside and outside of the facility. A plan index shall be provided showing location and angle of each photo in relation to the facility.

5.3.3 Forcemain Standards

5.3.3.1 Pipe (Forcemain)

Pumping stations shall be provided with dual forcemains, each capable of handling the peak design flow (Section 5.2.1.3). Following is a list of the types of approved forcemain.

- Ductile Iron pipe, AWWA C151 Special Class 52, cement mortar lined with polyethylene encasement. Anodes shall be installed on this pipe to provide cathodic protection. Anode Spacing requirements are every 30m.

  Fittings are to be wrapped with an approved anti-corrosion tape such as "Denso" or approved equal.

- PVC pipe and fittings, DR18 to CSA B137 as per Standard Specifications for Municipal Services.

  Non PVC Fittings used with PVC pipe installations shall be wrapped with approved anti-corrosion tape such as “Denso” or approved equal.

  All PVC pipe installations shall include the installation of an approved trace wire system for pipe locating purposes. Please refer to Section 33 11 00 and Section 39 00 00 for details.

Notwithstanding the minimum class of pipe, the pipe shall be designed taking into account, pipe pressure, transient pressure, earth pressure, etc.

The Engineer may on development specific basis approve a thinner wall of the above pipe materials if the design engineer presents a comprehensive design, including a complete transient pressure analysis, which has a minimum factor of safety of 2.

The approved method of calculating hydraulic losses in the forcemain is the Hazen-Williams Formula. Variations in the roughness coefficient (C) through the life of the pipe shall be taken into account.

The designer shall assess the forcemain for possible damage from sulfide generation. In sections of the forcemain subject to sulfide generation (sections subject to wet and dry cycle), substitute cement mortar lined ductile iron pipe with “SewperCoat” lined ductile iron pipe or equivalent.

The forcemain shall be identified by placing an underground warning tape at the top of the first backfill layer above the pipe. The warning tape shall be 150 mm wide polyethylene tape with green background and black lettering. The message on the warning tape shall be "Caution, Sewer Line Buried".

The minimum diameter of the forcemain shall be 100 mm.

5.3.3.2 Limiting Velocities

The forcemain shall be designed with a minimum cleansing velocity of 0.6 m/s. The maximum velocity shall not exceed 2.4 m/s.

5.3.3.3 Minimum/ Maximum Depth

Forcemains shall have a minimum cover of 1.5 m and a maximum cover of 2.4 m, measured from the finished surface to the crown of the pipe.

5.3.3.4 Location

Forcemains shall not be located in a common trench with a water system. Horizontal and vertical separations from water systems, etc. shall be as specified by NSE.

Forcemains shall terminate in a well benched manhole such that the flow is directed down the barrel of the receiving gravity wastewater system pipe. The downstream pipe receiving flow from a forcemain must be of sufficient size and grade to prevent surcharging from the forcemain. The forcemain must be mechanically restrained to the manhole and where applicable mechanically restrained within the manhole to prevent movement

5.3.3.5 Valves

Automatic air relief and vacuum valves, suitable for wastewater applications, shall be located in a manhole at high points of the forcemain or as dictated by the design. The manhole is to be drained to the wastewater system. If the venting capacity of the valve exceeds that of the manhole cover vents, provide suitably sized vent pipe ending in an above ground goose-neck at the property line (refer to Section 39 00 00 details).

Drain valves are to be installed at low points. In such instances the drain shall be either to a wastewater system or to a chamber from which controlled pumping to a moveable storage tank can take place.

Valving shall be provided at the pump station to allow dual forcemain arrangements to operate independently.

Gate valves on a forcemain sewer shall close clockwise (right) and open counterclockwise (left). Anodes are to be installed on all valves located outside of a chamber or pumping station where Ductile Iron (DI) pipe is utilized. Anodes are not required if PVC pipe is utilized.

Refer to Section 33 11 00, Part 2 – Products for approved gate valve products.

5.3.3.6 Change in Direction

Changes in direction, in excess of the allowable joint deflection, shall require a bend fitting. Thrust blocks shall be provided at changes of direction and shall be designed considering the operating pressure, surge pressure, peak flow velocity and in-situ material against which the thrust block bears.

Thrust blocks shall be constructed of "ready mix" concrete with a minimum 28 day compressive strength of 20 MPa. In the case of vertical bends, the thrust block shall be located below the fitting and shall be connected to the force main through the use of stainless steel tie rods securely embedded in the concrete. The Engineer may approve the use of restrained joints for its use in conjunction with a thrust block.

Refer to Section 3.0 and Section 39 00 00 of this specification for details on thrust restraint requirements.

5.3.3.7 Hydrostatic and Leakage Testing

Testing shall not be carried out until the street base course (first lift of gravel) has been placed and compacted. Pipework located outside of the street right of way (R.O.W.) (i.e. easements) shall be at finished grade prior to testing.

Refer to Section 33 34 00 for Hydrostatic and Leakage Testing procedures.

6.0 DESIGN REQUIREMENTS – STORMWATER SYSTEM

6.1 GENERAL

Storm drainage design and stormwater management are dynamic areas of engineering design. The purpose of this section is to provide minimum design standards to the designer. However, this guidance should not hinder the application of newer practices or carefully evaluated innovative approaches to stormwater management. Designers are encouraged to present their innovative ideas together with supporting documentation to HRWC for consideration where the design will deviate from the typical specifications.

The design criteria contained in this section are included to illustrate the more common aspects encountered in the design of stormwater systems. Any stormwater system within the core boundary of HRM shall be designed to achieve the following objectives:

- to prevent loss of life and to protect structures and property from damage due to a major storm event.
- to provide safe and convenient use of streets, lot areas and other land during and following rain and snow melt events.
- to adequately convey stormwater flow from upstream sources.
- to mitigate the adverse effects of stormwater flow, such as flooding and erosion, on downstream properties.
- to preserve natural water courses.
- to minimize the long term effect of development on receiving watercourses.
- safe, accessible outlet.

The design should also ensure that HRWC personnel are not exposed to hazards when conducting operation and maintenance of the stormwater system.

Gravity stormwater systems (piped systems and ditch/open channel systems) are to be installed for all new development areas. This system is required to be installed at a depth to facilitate gravity flow for on street and off street connections where a full depth basement is installed. Where a gravity stormwater system is installed, all adjacent lots are required to connect to this system for provision of stormwater service.

The stormwater system may consist of a combination of the following components or features:

Component / Feature	Responsibility/ Owner
Municipal ditch (outside core area *)	NSTIR
Cross culverts (outside core area *)	NSTIR
Driveway culverts – across municipal ditch (outside core area *)	NSTIR
Municipal ditch (within core area *)	HRWC
Cross culverts (within core area *)	HRWC
Driveway culverts – across municipal ditch (within core area *)	HRWC
Driveway culverts (outside municipal right of way)	Property Owner
Rear yard swales	Property Owner
Side yard swales located in an HRWC easement (as part of overall municipal drainage system)	HRWC / Property Owner
Subsurface interceptor drains (within the municipal right of way)	HRM
Subsurface interceptor drains (outside municipal right of way)	Property Owner
Roadways	HRM
Curb and gutter	HRM
Municipal catch basins, ditch inlets/outlets	HRWC
Catch basins on private property (rear, side or front yard **)	HRWC / Property Owner
Manholes (part of municipal system only)	HRWC
Pipes (part of municipal system only)	HRWC
Stormwater management facilities	HRWC
Stormwater service connections (main to street line)	HRWC
Stormwater service connections (street line to building)	Property Owner
Watercourses / Wetlands (as defined by NSE)	NSE
Floodplains (as defined by NSE)	NSE
Ravines (as defined by NSE)	NSE

(* Refer to HRM core area boundary drawing in SECTION 39 00 00)
(Rear, side or front yard catch basins are by variance only)**

All stormwater systems that discharge to a watercourse or wetland shall conform to any requirements established by NSE. No system shall be constructed until the design has been approved by the Engineer and by NSE.

6.2 DESIGN APPROACH

6.2.1 Minor Stormwater Drainage System

The minor stormwater drainage system shall be designed to convey the 1 in 5 year storm without surcharge. The minor system typically consists of lot grades, ditches, back yard/side yard swales, roof leaders, foundation drains, gutters, catch basins (and other inlet structures), manholes, stormwater systems and culverts. Typically, the minor systems are designed to reduce inconvenience to the public related to runoff events. The curb and gutter and cross culverts of the street system generally shall convey the 1 in 10 year storm event unless otherwise approved by HRWC and HRM.

6.2.2 Major Stormwater Drainage System

The major stormwater drainage system (overland flow system) shall be designed to convey the 1 in 100 year storm. The major stormwater system consists of natural streams, valleys, swales, man-made channels, roadways, ponds, and watercourses. The major stormwater system conveys runoff from infrequent events that exceed the minor stormwater system and the street system capacity. Overland flow routes shall follow the natural topography. Realignment of the natural flow path shall be discouraged to avoid future drainage issues. Existing water and drainage courses shall be left in their natural state. Watercourse and wetland alterations are subject to review and approval of the NSE.

The stormwater management report will identify the minor and major flow routes. Notwithstanding the above shall be sized to convey the appropriate storm event.

The capacity of the overland flow routes shall be supported by calculations as part of the overall stormwater management report. When the overland flow is routed along roadways, the designer shall consult with HRM regarding criteria for maximum depth of flow and maximum flow velocity on the roadway.

The stormwater management and overall lot grading plans shall show all watercourses, wetlands, and any other areas subject to flooding under both pre- and post-development conditions.

6.2.3 Downstream Effects of Stormwater Control Facilities

The downstream stormwater system shall have the capacity to convey discharge from its fully developed watershed. Mitigative measures or upgrades may be required to the downstream stormwater system to reduce adverse impacts.

6.2.4 Design Parameters

6.2.4.1 Basis of Design

The stormwater system shall be designed for flows from all lands within the watershed in which the system is situated, and lands anticipated being tributary to the watershed, by future development.

Redirecting of stormwater to another watershed is not favoured, however, may be considered by the Engineer provided the appropriate downstream analysis has been completed and capacity exists.

6.2.4.2 Design Flow

The design is to be based on the larger of winter or annual flow. Submit calculations and size stormwater systems as follows:

- Ordinary residential, commercial, or industrial land uses: annual (year-round) rainfall data.
- Where the duration is greater than 6 hours: winter precipitation and ice/snow melt data.
- Where the design area includes a significant proportion of undeveloped land: annual and winter data.

6.2.4.3 Downstream Effects

The downstream stormwater system shall have the capacity to convey discharge from the fully developed watershed.

6.3 METEOROLOGICAL DATA

Acceptable rainfall data for calculating runoff shall be taken from:

- Intensity – Duration – Frequency (IDF) Curves from Environment Canada's Meteorological Service of Canada using the reporting area closest to the subject development and the most current data.

  $I = a \times T^b$

where:	I	Rainfall rate (mm/hour)
	a	coefficient (published - Environment Canada)
	T	duration/time of storm (hours)
	b	exponent (published - Environment Canada)

- Synthetic design storms using hyetographs of the Chicago type distribution with r = 0.5 hour, 2 hour and 24 hour storm duration, discretization intervals of 5 minutes and 1 hour for the 2 hour and 24 hour storm durations, respectively.

- Historical design storms using historical flood records or runoff simulations of historical storms. These are required to verify the performance of storage facilities and major structures.

6.4 RUNOFF METHODOLOGY

The professional engineer must determine the best runoff calculation method to be used and must also calibrate and verify for local conditions. The professional engineer shall provide for future reference the reason why a certain method is selected. The Engineer may request that a second method be used as verification or checking of the results.

6.5 STORMWATER MANAGEMENT PLAN

A stormwater management plan shall be prepared and included as part of the submission for any land development to deal with stormwater and drainage issues related to the development. At a minimum the stormwater management plan shall be prepared containing the design criteria for the 1 in 5, 1 in 10 and 1 in 100 year events. This design shall also address factors such as watercourse protection, erosion and sediment control, impact on adjacent property, maintenance requirements, public safety, access, liability and nuisance. Storage facilities shall be planned and designed to encompass larger facilities rather than facilities serving individual properties.

Storage facilities shall be designed to control the peak runoff conditions for storm events with different return frequencies including the major storm.

The plan shall include site engineering analysis to a level consistent with the size of the development, its location within the drainage basin, and the sensitivity of the area's drainage system. The plan shall include details of the safety implications of the proposed system, and an examination of erosion should be assessed within the development and downstream receiving streams due to increased peak and total flows and flow velocities as a result of the development.

The stormwater management plan shall also include drainage plans and detailed runoff calculations. The calculations shall include input information showing sub-watersheds, rainfall abstraction, antecedent moisture conditions and schematization of the system for pre and post development and all stormwater management alternatives; and output information which shows the main step of the calculations and the peak discharge at key points in the system. At the points of discharge from the proposed development, the flow route to the major drainage path shall be indicated.

The management plans shall show the location of the proposed development within the topographic drainage area, the drainage area tributary to the proposed and existing storm drainage system(s), boundaries of all drainage sub-areas, contours at intervals not exceeding 2.0 m, site layout including proposed streets and lots, locations of proposed storm drainage system(s) and stormwater management facilities, location of outfalls or connections into existing services, hydrologic and hydraulic data table and any other information required by the Engineer.

6.6 DESIGN REQUIREMENTS

6.6.1 Piped Stormwater Systems

6.6.1.1 Hydraulic Design

Gravity flow in stormwater systems shall be calculated using the Manning's Formula or other approved method, with allowances made for energy losses at inlets, manholes, junctions, outlets, etc.

Table 6.1 – Manning Roughness Coefficients

PIPE MATERIAL	MANNING ROUGHNESS
Concrete	0.013
PVC	0.010
Polypropylene	0.012
HDPE (at discretion of engineer)	0.012

The minimum peak design flow velocity under full development or any place of development shall be 0.75 m/s.

The maximum flow velocity, assuming the pipe to be flowing full, shall be 6.1 m/s. for pipes less than or equal to 750 mm in diameter. A higher flow velocity (up to 7.5 m/s) may be permitted for pipe sizes greater than 750 mm in diameter if adequate energy dissipation and ventilation is provided.

6.6.1.2 Stormwater System Pipe

.1 The minimum stormwater system main diameter shall be 300 mm.

.2 Approved stormwater system pipe materials shall be as follows:

- Reinforced concrete pipe meeting the requirements of the latest CAN/CSA Standard A257.2 and ASTM Standard C76.

- Polyvinyl Chloride (PVC) pipe and fittings meeting the requirements of the latest ASTM Standard D3034, DR35, and CAN /CSA Standard B182.2.

- Dual Wall Corrugated Profile PVC pipe and fittings meeting the requirements of the latest ASTM Standard F794-97 and CAN/CSA Standard B182.4.

- Profile High Density Polyethylene (HDPE) pipe and fittings (up to 900 mm) meeting the requirements of the latest CAN / CSA Standard B182.8, with a minimum pipe stiffness of 320Kpa and Type 1 (Water-tight) joints with integrated bells/welded joints.

- ADS SaniTite HP - Profile Polypropylene (PP) pipe and fittings, corrugated dual-wall (300 -750 mm) and corrugated triple wall (750 – 1500 mm) meeting the requirements of the latest ASTM Standard F 2736-10, F 2764-10 and CSA Standard B182.13-11.

.3 Pipe size shall not decrease in the downstream direction. The exception is an intake pipe being oversized to overcome the effects of inlet control and then, only if the mainline to which the inlet is connected is greater than 600 mm diameter.

.4 Pipe gaskets are to be utilized for all stormwater system main installation.

6.6.1.3 Manholes

.1 When providing in-line storage of stormwater flows as approved by the Engineer, baffles within the manhole base will not be permitted.

Refer to SECTION 4.0 – COMMON ELEMENTS

6.6.1.4 Catch Basins

.1 The capping ring of a catch basin shall be CPC 175 and the frame and grating IMP S-361 (or S-441/411 if mountable curb and gutter approved). Catch basins shall be ASTM C-478 precast concrete complete with “A-LOK” or O-ring gaskets for catch basin leads, 1050 mm diameter with a 450 mm sump. Final grade adjustments shall be in accordance with that for manholes.

.2 Catch basins shall be located in the gutter line of the street with the front edge of the capping ring opening a minimum of 350 mm and a maximum of 500 mm from the face of the curb.

.3 Up to two (2) catch basins can be connected in series, provided, that the downstream (second) catch basin is connected to a manhole.

.4 Catch basins spacing shall minimize ice accumulation and ponding on the street and prevent water from flowing in the travel lanes during the minor system but shall not exceed 120 m.

.5 Area catch basins with pyramid grates shall be installed in off street locations where concentrated flow would otherwise cross a sidewalk or walkway or to collect rear lot drainage from private or publically owned swales.

.6 Catch basins or double catch basins are required at the uphill radius point of curb returns on intersections.

.7 The interception capacity of the catch basins shall be compatible with the capacity of the stormwater system. The stormwater management report shall illustrate the HGL produced during the minor and major storm events.

.8 In areas where there is a potential for contamination of stormwater (e.g. near service stations) the Engineer may require inverted siphons in catch basins or other specialized catch basins (e.g. “Stormceptor CDS Units”).

6.6.1.5 Catch Basin Leads

Catch basin leads shall meet the following criteria:

.1 Be 200 mm diameter or larger manufactured from concrete or PVC DR35.

.2 Be connected to manholes and catch basins using “A-LOK” or O-ring gaskets. (For connection to an existing manhole, use “Kor-N-Seal” or “INSERTA TEE” fittings.).

.3 Have a minimum cover of 1.3 m at construction completion.

.4 Have a minimum slope of 1%.

.5 Be included in the CCTV report.

.6 Be connected to the manhole with an invert no higher than the obvert of the outgoing pipe or 1.0 m above the invert of the outgoing pipe whichever is higher.

.7 Shall protrude not more than 75 mm into the catch basin or manhole

.8 Incorporate a flexible joint within 450 mm of the O.D of the manhole.

6.6.1.6 Service Connections

Refer to SECTION 4.6 for stormwater service connection requirements

6.6.1.7 Inlets, Outfalls and Grates

Refer to SECTION 6.6.4 - CULVERTS

6.6.2 Streets

During minor storms, the depth of flow in gutters shall not exceed 50 mm. During major storms, the depth of flow shall not exceed 50 mm above the crown in areas with curb and gutter. In no circumstances shall the flow of stormwater overtop the curb, escape ditches or travel into driveways. The flow of water shall travel through the major overland flow route.

6.6.3 Ditches/Open Channels

The design shall include safety, nuisance and maintenance implications of ditches and open channels. Statements dealing with these factors shall be included in submitted documentation.

6.6.3.1 Design

Ditches and open channels (if approved) shall meet the following requirements:

.1 Have a minimum grade of 2.0%.

.2 Roadway ditches shall conform to the typical cross section as per HRWC specifications (refer to Section 39 00 00).

.3 Hydraulic capacity is based on the minor storm, unless the ditch functions as the major overland flow route.

.4 Under maximum flow conditions not more than 90% of ditch capacity is utilized.

.5 The invert should be a minimum of 0.2 m below the extension of the subgrade line.

.6 Side slopes shall be no steeper than 2:1 (horizontal:vertical).

.7 Where a ditch or open channels grade exceeds 4%, the bottom of the ditch (wetted perimeter) shall be further stabilized to prevent erosion. Stabilization measures may include the placement of surge (Rip Rap) and or check dams.

.7 Where asphalt swales are placed on a roadway shoulder, appropriate erosion protection shall be installed on the downstream side, protecting the side of the ditch.

.8 Except at street intersections, cross culverts, ditches, overland flow routes and channels shall have a maximum deflection angle between 90° & 270°. Where a deflection of 90° or 270° is proposed the ditch shall be piped with the appropriately sized inlet / outlet structure and manhole. Deflections between 0° & 90° and 270° & 360° are not permitted.

.9 In areas where the natural grade does not allow a conventional ditch to be installed, engineered side slopes (back & front) to the ditch shall be provided (refer to Section 39 00 00).

6.6.3.2 Maximum Velocity

Channel velocities shall be minimized to prevent erosion. The maximum channel velocity in the major storm shall not exceed the following - unless the channel is lined, or acceptable energy dissipation measures are provided:

Channel Material	Mean Channel Velocity (m/s)
Fine Sand	0.46
Coarse Sand	0.76
Fine Gravel	1.83
Earth	
Sandy Silt	0.61
Silt Clay	1.07
Clay	1.22
Soft Sandstone	2.44
Soft Shale	1.07
Grass-lined earth	
Bermuda grass	
Sandy Silt	1.83
Silt Clay	2.44
Kentucky Blue Grass	
Sandy Silt	1.52
Silt Clay	2.13
Poor rock (usually sedimentary)	1.83
Good rock (igneous or hard metamorphic)	6.10

The above values assume a straight, uniform channel. More stringent velocity restrictions will be required for differing channel configurations

6.6.4 Culverts

6.6.4.1 Inlets and Outlets

The design shall address such factors as embankment stability, public safety, erosion, energy dissipation, head losses, appearance, or other items as specified by the Engineer.

.1 All culverts shall have inlet / outlet precast concrete headwalls.

.2 Inlet and outlet control methods shall be utilized in determining the hydraulic capacity of culverts in conjunction with the Manning's Formula.

.3 Headwater Depth

Pipe shall be designed to carry peak design flow with a head-water depth not greater than the diameter of the pipe. At pipe inlets, upstream water levels of the major storm shall be shown on the drainage plan in relation to expected elevations of structures and the ground surface at the boundary of the inundation. Buildings should not be located within the area of inundation. Final plans of development shall show watercourses, wetlands and any areas subject to flooding resulting from the proposed development.

.4 Structures and Grates

Culverts and piped systems that are less than 30 m in length will not require grates.

Inlet and outlet pipes of culverts and piped systems that are longer than 30 m in length and are 450 mm in diameter or larger (or equivalent area or larger), shall be constructed with a pre-cast concrete headwall structure.

Inlet & Outlet Pipe, up to 1500 mm Diameter (or equivalent area)

- Refer to Section 39 00 00 for details.

Inlet & Outlet Pipe, >1500 mm Diameter (or equivalent area)

- Refer to Section 39 00 00 for details.
- The handrail on the headwall shall be constructed in two separate, hinged sections.
- The grate system shall be constructed with a lockable personnel door for access to the inlet pipe. The door shall have the same design as the surrounding grate.
- The inlet structure shall include a debris rack/risers and placement of rip rap for scour protection upstream of the concrete apron. The debris rack/risers can be constructed of concrete or galvanized steel.
- Fixed (non-hinged, non-removable) steel grating system designed for anticipated dead and live loads. The maximum slope on the grate shall be 45°.
- The inlet grate shall have a minimum area 6 times the inlet pipe area (this does not negate the designer's responsibility to investigate the possibility that a ratio higher than 6 may be required).

.5 Location

Inlet and outlet pipes shall extend at least 600 mm beyond the toe of slope of the road embankment unless an intake/outlet structure is provided. The inlet and outlet of pipes shall be located inside the street right-of-way with the right-of-way jogged if necessary. In certain locations, the pipe inlet and outlet may be required to be extended to the backs of adjacent lots with the surrounding area being infill and an easement provided to HRWC.

6.6.4.2 Pipe Sizes

Driveway culverts shall not be smaller than 450 mm in diameter nor smaller than any upstream culvert and shall be installed with precast concrete headwalls. Refer to Section 39 00 00.

Roadway culverts shall have a minimum diameter of 525 mm and a minimum cover of 500 mm.

The Stormwater Management Plan or Subdivision Grading Plan shall also show, in tabular form, the required driveway culvert pipe sizes for each lot in the development. The table shall show the required pipe size for all of the approved culvert pipe materials (refer to Section 6.6.4.3).

6.6.4.3 Pipe Materials

Approved culvert pipe materials shall be as follows:

- Reinforced concrete pipe meeting the requirements of the latest CAN/CSA Standard A257.2 and ASTM Standard C76.

- Profile High Density Polyethylene (HDPE) pipe meeting the requirements of the latest CAN / CSA Standard B182.8 and ASTM standard F-667, with a minimum pipe stiffness of 320Kpa.

- ADS SaniTite HP - Profile Polypropylene (PP) pipe, corrugated dual-wall (300-750 mm) and corrugated triple wall (750–1500 mm) meeting the requirements of the latest ASTM Standard F 2736-10, F 2764-10 and CSA Standard B182.13-11.

6.6.4.4 Enclosures of Watercourses, Ditches and Channels

The number of enclosures of an open channel created by roadways or other traffic crossings shall be minimized. For example if a watercourse crosses the road system in two locations in relatively close proximity, the design shall re-align the road system so that the number of crossings is eliminated or limited to one.

6.6.4.5 Ownership of System

Storm drainage from the public system shall not be carried on, through or over private property other than by natural watercourse or a system controlled by HRM, HRWC or NSTIR. Easements will be required to provide for drainage from existing or future upstream development. Watercourses shall be utilized as stormwater conveyances consistent with overall watercourse objectives and subject to provincial approval. (Refer to Section 6.1).

Watercourses and natural drainage routes shall be maintained as open channels unless designated otherwise by a Stormwater Management Plan as approved or required by the Engineer. Watercourses shall not normally be permitted to drain to roadside ditches or piped stormwater systems.

6.7 MINOR STORMWATER DRAINAGE SYSTEM CONNECTIONS

6.7.1 Foundation Drains

Foundation drains shall be connected by gravity to the piped stormwater system. Foundation drains are not permitted to connect to a catch basin. Relative elevations of the stormwater system main and foundation drains shall be such that foundation drains are above the hydraulic grade line of the major storm.

Where the piped stormwater system discharges into a watercourse, ditch or drainage corridor, foundation drains connected to this piped stormwater system shall be above the major storm flood elevation at the point of discharge.

Foundation drains where directed to an HRWC ditch system shall be designed to be above the minor storm elevation **unless** the ditch functions as the major overland storm route. Foundation drains are not permitted to make a direct connection to an HRWC ditch system and must be terminated at the property line. Discharge to the ditch system shall be achieved using clear stone or rock drain.

6.7.2 Roof Drains - Residential

Roof drains are not permitted to be connected to stormwater system mains and shall be managed onsite. Appropriate lot grading measures shall be provided as per HRM requirements.

6.7.3 Roof Drains - Institutional, Commercial and Industrial (ICI)

ICI developments shall manage stormwater on site in order to ensure that the pre and post development flows are balanced. Roof drains may be connected to the internal private stormwater system, provided that the rainwater flows are incorporated into the pre and post development flows for this site.

6.8 DISCHARGE TO ADJACENT PROPERTIES

Stormwater shall be self-contained within the development limits except for natural runoff from undeveloped areas and where it is intercepted and directed to a natural stream, water course or stormwater system owned by NSTIR, HRWC or HRM. Stormwater shall not be directed to adjacent private properties unless private easements are provided.

If necessary, the Engineer may require zero increase in the peak rate of runoff from storms of a specified frequency.

6.9 EROSION AND SEDIMENT CONTROL

Stormwater management systems shall be an integral part of overall site design and development. The professional engineer shall submit an erosion and sediment control plan in conformity with all applicable municipal and provincial regulations and guidelines. The plan shall include both short-term measures applicable during construction and long-term measures after completion of development.

Site design shall make optimum use of existing topography and vegetation and minimize cut and fill operations. During construction, site design shall prevent/ minimize surface water flows across or from the construction site. Development of the site shall be based on exposing a minimum area of the site for the minimum time.

The control plan shall include, to a minimum, the following:

- Interception & diversion ditches to direct clear water around the construction site.
- Stable diversion berms.

- Sediment traps.
- Covering or seeding of topsoil or other soil stockpiles.
- Isolated stripping of land being developed.
- Vegetation screens or buffers.
- Filter bags in catch basins (during construction only).
- Settling ponds.

Long-term environmental protection measures shall include designs to minimize erosion and sediment flow, protect outfall areas, minimize disruption of natural watercourses, utilize wetlands for natural filtration, and provide for ground water recharge when possible.

Protection methods shall be based on but not limited to the "Province of Nova Scotia Erosion and Sediment Control Manual and Guidelines for Use on Construction Sites"

6.10 STORMWATER MANAGEMENT FACILITIES

.1 Stormwater management facilities (including all ponds, drainage channels forming part of the overland flow system, outfalls, etc.) shall be located on separate parcels within the plan of subdivision and shall be conveyed to HRWC as part of the subdivision acceptance process. HRWC may consider easements under special circumstances, at the discretion of the Engineer.

.2 Where stormwater outfalls onto adjacent lands, the professional engineer shall ensure that the discharge volume and velocity will not impact the receiving area and the developer shall obtain written permission from the owner of the adjacent lands to allow for the stormwater to discharge at this location. Where this stormwater forms part of the major overland flow path, the developer shall secure easements to ensure the continued use of the drainage course except where the drainage course is a designated watercourse as per NSE regulations. In the case of a watercourse, the developer shall obtain all necessary permits prior to construction of the stormwater system.

.3 The required storage volume for stormwater quality control shall be based on the 24 hour extended detention of the runoff generated by a short duration (4 hour), 25 mm storm event. The storage volume required for stormwater quality control shall be determined to meet the HRWC's Rules and Regulations, specifically, the discharge shall not exceed the required concentration of parts per million (ppm) suspended solids per HRWC requirements. These same extended detention criteria shall be used for provision of stream bank erosion protection unless otherwise specified by the Engineer or NSE.

.4 The required storage volume for stormwater quantity control will be based on maintaining peak post-development runoff rates to peak pre-development runoff rates for the 1 in 2, 1 in 5, 1 in 10 and 1 in 100 year storm events. Simulation software shall be used to quantify pre- and post-development runoff rates and the necessary storage volumes. A range of design storms shall be analyzed to confirm system operation over a range of flows.

.5 A stormwater management facilities report shall be submitted with the stormwater and subdivision design package. The report shall include:

- Design calculations for both quantity and quality control including runoff rates and storage volumes.
- Proposed landscaping plan.
- Erosion and sedimentation control (both during and after construction).
- Drawings of the stormwater management facilities.

.6 In lieu of constructing stormwater management ponds, HRWC may consider the use of alternate measures to deal with stormwater management as outlined in this section. The professional engineer shall submit all relevant information and supporting documentation to the Engineer in order to allow a thorough review of the proposed design. Any proposed design shall take into account operational and maintenance requirements of the system, life cycle costs and impacts on the surrounding areas.

.7 HRWC **may** consider the use of oversized in-line pipe storage in lieu of constructing stormwater management ponds. If this approach is taken a rider stormwater system will be required to be installed for stormwater service connections for adjacent lots. Street drainage would be handled by the oversized stormwater system installed for pipe storage. All requirements as outlined in this section are to be followed for design of this system.

6.11 STORMWATER MANAGEMENT POND REQUIREMENTS

Stormwater management ponds shall include the following minimum design requirements:

6.11.1 Siting

Stormwater management facilities shall be sited with consideration of the following factors:

- Topography.
- Soil type.
- Depth to bedrock.

- Depth to seasonally high water table.
- Drainage area.
- Location outside of floodplain and above the 100 year elevation.
- Off-line from the natural watercourse.
- Minimizes risk to the public and adjacent properties.
- Should complement the proposed or existing land uses.

6.11.2 Access

Maintenance access roads shall be provided to access the pond inlet and outlet structures, by-pass manholes, outfall and overflow locations, and the bottom of the forebay and main cell for maintenance and cleaning. The access roads shall have the following features:

- Minimum 4.0 m in width.
- Maximum longitudinal grade of 8%.
- Maximum crossfall of 2%.
- Minimum offset from edge of access road to embankment of 1.0 m.
- Sufficient to carry heavy equipment for the purpose of removing sediment
- Gravel surface using Type 1 gravel (no crusher dust permitted) – where HRWC has permitted grades between 6% & 8%, the surface shall be paved with asphalt.
- Fencing around entire pond and access route with access gates for authorized personnel as approved by HRWC.
- Positive drainage shall be provided along the edge of the access road with an appropriate outlet (cut ditches may be required to ensure water is conveyed to an appropriate outlet and to avoid access road washouts).
- Turnaround areas shall be provided as needed with minimum 12.0 m turning radius.

6.11.3 Forebay

Forebay shall be provided to facilitate maintenance by concentrating sedimentation at the inlet area of the pond. The forebay shall be designed as follows:

- Length to width ratio shall be greater than 2.
- Depth shall be minimum 1.0 m to minimize bottom scouring activity.
- Area shall be less than one-third (1/3) the total pond area.
- Volume shall be less than 20% of the total permanent pool volume required for the facility.
- Volume shall be sufficient to accommodate 10 years of sediment accumulation.

- Forebay berm elevation shall be set at the normal water level (permanent pool elevation) of the pond.
- Forebay berm shall be minimum 2.0 m wide.
- Flow through culverts shall be situated within the forebay berm with inverts set at the predicted 10 year sediment level or 0.6 m from the initial design invert of the forebay (whichever is greater).
- Forebay berm flow through culverts shall have minimum 300 mm of cover to the top of the forebay berm elevation.

6.11.4 Height and Volume

Ponds shall be designed to limit their height and / or volume so that they do not meet the definition of a dam as defined by the Canadian Dam Association. (The definition of a dam is 2.5 m high with 30,000 m^3 of volume).

6.11.5 Inlet Structure

Stormwater system inlets into the pond shall be designed with the following requirements:

- Invert shall be at or above the normal water level (permanent pool elevation). Submerged inlets will not be permitted.
- Inlet pipes shall be minimum 450 mm in diameter and with slopes less than 1%.
- Pre-cast concrete headwalls shall be constructed for the inlet pipe where it discharges into the pond.
- Erosion protection shall be provided where the inlet pipe discharges into the pond, shall extend a minimum 1.5 m beyond the discharge point and headwall, and shall consist of rip rap or river stone underlain with geotextile material.

6.11.6 Outlet Structure

The outlet structure shall be designed as bottom draw outlet structures with the following requirements:

- A reverse sloped pipe that will allow for extended detention is used to drain to an outlet chamber located in the pond embankment.
- The invert of the reverse sloped pipe shall be minimum 1.0 m above the bottom of pond elevation.

- A gate valve shall be installed at the downstream end of the reverse sloped outlet pipe at the outlet chamber.
- Outlet pipes shall be minimum 450 mm in diameter with slopes less than 1%.
- The outlet chamber shall be a concrete outlet structure with a ditch inlet frame and grate to allow for overflow protection.
- A low flow maintenance (or draw down) pipe shall be provided to allow for gravity draining of the pond to 0.5 m above the bottom pond elevation for routine maintenance and sediment removal purposes.
- The maintenance pipe shall drain to the outlet chamber.
- A gate valve shall be installed at the downstream end of the maintenance pipe at the outlet chamber.
- The maintenance pipe shall be designed to release the pond volume over 6 hours to ensure no downstream impacts on the receiving water.
- Outlet Structures shall be designed to allow for a gravity flow.

6.11.7 Shut Off Valve

The shut off valve shall be provided in the outlet structure to contain the extended detention storage component in the event of a spill within the drainage area.

6.11.8 Maintenance By-Pass

Details shall be provided in the design report and drawings that outline the method of by-passing flows during maintenance activities.

6.11.9 Forebay and Main Cell Pond

The bottom shall be lined with 300 mm of 50 mm clear stone (for stability of equipment during future sediment removal) where the native soils are not capable of supporting the required sediment removal equipment. This component shall be verified by the developer’s geotechnical consultant.

6.11.10 Pond Liner

A geotechnical investigation shall be completed that details the need for liners or other construction related methods resulting from groundwater impacts.

6.11.11 Safety Platform

A 2.0 m wide safety platform with a maximum 5% crossfall into the pond shall be provided above the normal water level (permanent pool elevation).

6.11.12 Slopes

Above the safety platform shall be at 4:1 maximum and below the safety platform shall be 3:1 maximum.

6.11.13 Top of Pond Berm

The top shall be minimum 3.0 m wide where no maintenance access route is proposed.

6.11.14 Overflow Spillway

The overflow spillway shall be incorporated (typically along the pond embankment near the outlet area) to provide relief to the system in the event of a severe storm, a blockage of the system, or failure of the outlet structure. The 100 year storm shall be used in the overflow design assuming the pond is full and all outlets are blocked. The spillway shall be designed to convey the 100 year storm while maintaining a 0.15 m freeboard to the top of the slope around the perimeter of the pond. The spillway invert shall be at or above the 100 year water level. Erosion protection of the spillway shall be provided along the entire length of the spillway (i.e. top of berm, down the pond side slopes on the outside of the berm, and into the outfall channel or to the extent required based on the existing site conditions).

6.11.15 Warning Signage

Shall be installed near pedestrian routes or walkways that are adjacent to the stormwater management pond.

6.11.16 Retaining Walls

Retaining walls within the stormwater management pond property limits are not permitted.

6.11.17 As-Constructed Certification

Prior to acceptance of the subdivision and any associated stormwater infrastructure, the stormwater management pond shall be certified by the professional engineer including but not limited to:

- Storage volumes and elevations.
- Permanent pool and extended detention requirements.
- Control structure sizes and inverts.
- All stormwater pipe sizes and inverts.
- Any hydrologic modeling used in the design of the pond shall be updated to reflect as-built conditions.
- Sediment accumulations shall be removed to the original pond design volume and shall be disposed of off-site to an approved disposal facility.
- A certification report confirming all as-built information related to the stormwater management design.
- Operations and maintenance manual.

7.0 DRAWING STANDARDS

7.1 GENERAL

The purpose of this section is to standardize the preparation and delivery of all hardcopy & digital drawings submitted to the HRWC for approval.

Engineering Drawing Submittal Requirements – Quick Summary

	Final Design Drawings		Final Record Drawings	
	Details	Section	Details	Section
Hardcopy Drawings	20lb Bond Paper	7.2.7.1	Matte Polyester Film	7.3.3.1
CAD Drawings	Plan & Profile	7.2.7.2	Plan & Profile	7.4.4.4
DWF or PDF Sheets	NA	NA	Single Sheet-Files	7.4.4.5

7.2 DESIGN DRAWINGS

The engineering design drawing shall include:

- Plan.
- Profile.
- Details as required (project specific).
- Overall development plan.

7.2.1 Presentation

The presentation of the plan and profile views of the engineering design drawing shall be as follows:

7.2.1.1 Units

All drawings submitted for approval shall be prepared using metric units. Drawings submitted in imperial units will not be accepted.

7.2.1.2 Scale

The plan shall be drawn to a scale of 1:500 (metric). The profile shall be drawn with a horizontal scale of 1:500 and a vertical scale of 1:50. HRWC will permit plans drawn to a scale of 1:250 with the profile drawn to a horizontal scale of 1:250 and a vertical scale of 1:25, provided that the maximum sheet size is not exceeded.

7.2.1.3 Title Block

The title block, located on the right side of the sheet shall include a key plan, legend, notes, revisions, dates, scales, drawing number, approving signatures, drawing title, and company name. The key plan on each sheet will indicate the section of the project covered by the sheet.

7.2.1.4 Sheet Size

The drawing size shall be within the following minimum and maximum sizes:

- Minimum – 580 mm wide x 840 mm long.
- Maximum – 610 mm wide x 915 mm long.

7.2.1.5 North Arrow

Drawing plan view is to include a grid north arrow in the upper right corner. Where possible, the plan view should be orientated so that direction of north points to the top half of the sheet.

7.2.1.6 Stations

The plan and profile view stations shall be aligned vertically at one end of the sheet. Stations should increase from left to right and when possible, from lowest elevation to highest elevation. When it is not possible to achieve both increasing stations and increasing elevation from left to right, then the requirement for increasing stations will take precedence.

7.2.2 Detail Requirements

Details are to be included as necessary or as directed by the Engineer.

7.2.3 Plan

The plan of the engineering design drawing shall include:

.1 The existing and proposed location and horizontal alignment of:

- The water distribution system including all valves, water service connections, hydrants, hydrant branches, tees, bends and appurtenances (i.e. chambers, reducers, couplings), and pipe with the length, size, material and class.
- Sprinkler and large diameter water service pipes (>50 mm) with the length, size, material and class, to the street lines.
- The wastewater system, stormwater system, manholes, catch basins and culverts, with offsets from the water system.
- All other public services and their appurtenances including any underground power, telecommunication system, or gas lines.

.2 All topographic features.

.3 The street and its dimensions and name and also intersecting street names.

.4 Curbs and gutters, sidewalks, and driveways.

.5 The boundary lines of each lot, lot number, and property identification (PID) numbers and civic numbers if available.

.6 The chainage at 10 m intervals with labels every 50 m along the centerline of the street, and the chainage of all intersecting street center lines.

.7 Any control monuments and bench marks that are within the area of the plan.

.8 Limits of the construction.

.9 At least two points of known chainage on the centerline of the street, to be related to the Nova Scotia Coordinate Survey System (ATS77) (SECTION 7.4.2 Electronic Submission – Geo-referencing).

.10 Match Lines: Where a water, wastewater or stormwater system extends over more than one drawing sheet corresponding match lines with labels shall be provided with sufficient overlap on each drawing to include all information on fronting properties.

.11 Hydrologic features: watercourses, ditches, swales, oceans, lakes, rivers, wetlands, direction of flow.

.12 Contours.

7.2.4 Profile

The profile of the engineering design drawing shall include the existing and proposed location and vertical alignment of:

.1 The water, wastewater and stormwater systems, including length, size, material and class of pipe, and the chainage and size of all fittings corresponding directly to the plan. Pipe shall be shown as a two-dimensional figure indicating pipe invert and obvert.

.2 The proposed centerline street grade. Where the water line is offset from the street centre line, the elevation of the water main must maintain the minimum depth of cover with consideration for the street cross slope.

.3 The finished grade above the water, wastewater and / or stormwater main where the pipe(s) are not under a street.

.4 The wastewater and stormwater systems, including pipe inverts at manholes (inlet/outlet), manhole cover elevations and catch basin lead invert information. Show all water, wastewater and stormwater system /culvert crossings in profile.

.5 Any other underground services and appurtenances.

7.2.5 Professional Engineer's Stamp

The engineering design drawing shall be stamped and signed by a professional engineer.

7.2.6 Format

The format of design drawing submission shall be:

.1 Hard copy on 20 lb (minimum) bond paper and a DWF or PDF file for each drawing sheet. The DWF or PDF file for each drawing shall be actual size (1:1) and not scaled to fit a page size.

.2 Digital design drawing files shall be delivered in an electronic format compatible with AutoCAD or Civil 3D. The minimum requirement for

CAD file submission (for final design drawings only) shall include the plan & profile portion of the drawing to facilitate GIS updating. This CAD file shall include the location of proposed water, wastewater and stormwater appurtenances. In addition to the water system, the CAD file shall include any proposed buildings (outline) and property parcels.

7.3 RECORD DRAWINGS

The record drawing shall include all information on the "Design Drawing" as per subsection 7.2, revised to reflect the "as recorded" information. As a minimum the field coordinates of the following shall be obtained for the purpose of producing record drawings:

- Valves.
- Hydrants.
- Fittings.
- Finish Grade.
- Pipe Bells.
- Pipe Elevation (water system).
- Corporation Stops.
- ARV Drain Pipes.
- Curb Stops.
- ARV Vent Pipe.
- Manholes (tops).
- Catch Basins.
- Manholes (inlet / outlet inverts).
- Pipe Elevation (wastewater & stormwater systems).
- Stormwater System Inlet / Outlet Elevations.
- Stormwater System Roadside Ditch Profile Elevations

7.3.1 Additional Information

Additional information which must be included on the record drawings includes:

.1 Swing ties from permanent above ground fixtures (i.e. buildings, power poles, hydrants) to locate main line valves, manholes, catch basins, large service and sprinkler valves, and other servicing appurtenances.

.2 The location of all service connections from main to property boundary.

.3 Dimensions to locate tees, bends, and other below ground fixtures.

.4 Hydrant leads to include measurement from:

- Centre of hydrant valve to center of hydrant.
- Centre of hydrant valve to main.

.5 Start and end of rock profile (feature codes Section 7.5).

.6 Start and end of insulation (feature codes Section 7.5).

.7 Start and end of water, wastewater and stormwater system encasement pipes.

.8 The location of restrained joints / pipe.

7.3.2 Format

The format of the record information submission shall be both:

- Hard copy record drawing on reproducible .075 mm (3 Mil) matte polyester film.
- Electronic format as per Section 7.4.

7.3.3 Sheet Size

The drawing size shall be within the following minimum and maximum sizes:

- Minimum – 580 mm wide x 840 mm long.
- Maximum – 610 mm wide x 915 mm long.

7.4 ELECTRONIC SUBMISSION

7.4.1 General

The purpose of this section is to identify the technical requirements for electronic information supplied to the HRWC.

7.4.2 Geo-Referencing

- All work shall be referenced using the Nova Scotia Coordinate Survey System (ATS77).

- Map projection: the Nova Scotia Modified Transverse Mercator projection and grid system (MTM Zone 4 and Zone 5) shall be used for referencing data.

- Datum: the horizontal datum for all coordinates shall be ATS77 adjustment.

- Units: all coordinates and dimensions shall be supplied in metric units.

7.4.3 Coordinate Accuracy

- Measurements and distances shall be collected to an accuracy of ± 50 mm.

- Real world coordinates shall be shown correctly with no front end truncation of the coordinate values.

7.4.4 Delivery Format

.1 Data and text files shall be delivered in ASCII PNEZDID2 format (comma delimited).

.2 ASCII PNEZDID2 files shall contain fields in the following order: Point #, Northing, Easting, Elevation, Description 1 (feature codes), Description 2 (remarks). Description 1 shall contain Halifax Water designated feature codes – available online through the HRWC website (see Section 7.5). Description 2 shall contain additional information pertinent to the infrastructure being collected; specifically around lifecycle status (abandoned infrastructure must be designated), ownership (private infrastructure must be designated), and anything else the contractor deems useful (i.e. existing versus new, size, material, relative location – civic number, etc.). If there is no additional information, the Description 2 field does not have to be populated and can be left NULL. Please refrain from including commas within the Description 2 data field since it will interfere with the CSV file behavior.

Example:

Point #, Northing, Easting, Elevation, Description 1, Description 2

167, 4940718.18902, 5569268.10332, 94.21780, WCWM400,
168, 4940716.75418, 5569266.91370, 94.33934, WCFTTE, copper
169, 4940716.09661, 5569267.76330, 94.25489, WCWM250,

170, 4940715.74929, 5569268.16287, 94.25133, WCFTRD, 400x300
171, 4940715.68923, 5569268.40306, 94.24447, WCWM150,
172, 4940715.44588, 5569268.66440, 94.64779, WCVLGA, 200mm-closed
173, 4940716.79618, 5569269.21558, 93.87974, WCHA, zinc
174, 4940713.66591, 5569264.33459, 94.54840, WCWM400, abandoned
175, 4940709.31549, 5569261.09200, 94.73379, WCWM400,
176, 4940705.20019, 5569257.55010, 95.23455, WCWM400,
177, 4940709.31549, 5569265.53783, 94.73379, SWPIST, private-abandoned
178, 4940711.25680, 5569262.45345, 94.73379, SWMHSA, full of rock
179, 4940715.68974, 5569225.45388, 95.23455, SWPISA, insulated

.3 Quotation marks shall not be used in the data file.

.4 Digital record drawing files shall be delivered in a format compatible with AutoCAD or Civil 3D. If drawing files contain images and/or externally referenced drawing files (XREFS) the use of AutoCAD's "SHEET SET" or "ETRANSMIT" is desirable for assembling a usable CAD submittal package. Include any plot style files (STB or CTB) for plotting purposes.

.5 In addition to hard copy and digital CAD files, record drawing sheets shall be submitted in TIF and PDF format, TIF and PDF files shall be submitted for each single drawing. Layer information shall be included in the final TIF and PDF files. The TIF and PDF file for each drawing shall be actual size (1:1) and not scaled to fit a page size.

7.4.5 Delivery Media

CD, DVD or USB flash drive media, clearly labeled with the project name, project phase, date, and consultant's name.

7.4.6 Computer Aided Drafting (CAD) Standards

External parties preparing engineering drawings for the HRWC may obtain essential symbology (AutoCAD blocks) from the HRWC. These blocks include HRWC standard sheets & title blocks, logo, north arrow, and standard water, wastewater and stormwater system symbology. For legends including existing and proposed symbology and block names for CAD drawings, Refer to HRWC website (www.halifaxwater.ca).

7.5 FEATURE CODES

.1 A feature code (description) is an alphanumeric identifier assigned to all entities. All entities of the same type (i.e. 250 mm water main) will receive the same feature code (i.e. WCWM250).

.2 Refer to HRWC website (www.halifaxwater.ca) for current feature codes, legends and CAD block names.

8.0 APPROVAL AND ACCEPTANCE SUBMISSION REQUIREMENTS

8.1 APPROVAL SUBMISSION REQUIREMENTS

8.1.1 New Development Projects

8.1.1.1 Procedure

Design water, wastewater and stormwater systems to this specification, the standard specification, and in accordance with the HRM By-laws, ordinances, procedures and specifications where they apply.

Information provided by HRWC (Record Drawings, GIS printouts, Service Connection Cards, etc.) are for information purposes only. The professional engineer shall field check all provided information to ensure its accuracy prior to submission of new water, wastewater and stormwater projects.

8.1.1.2 Information

The following information shall be provided on all review submissions involving an extension to the water, wastewater and stormwater systems, or work impacting existing plant:

.1 An overall plan indicating the existing and proposed water, wastewater and stormwater systems, including but not limited to the location of valves, fire hydrants, manholes and catch basins and the size of pipes. The plan shall clearly indicate the specifications edition (year) to which the project is designed to.

.2 Technical Specifications.

.3 Plan and profile drawings.

.4 Cross-section and detail drawings.

.5 Design calculations including a tabulation of population density, domestic demand, fire flow rate requirements, maximum static pressure and minimum static pressure under normal operating conditions, residual pressure under fire flow conditions, and flow velocity in the water system at each fire hydrant in the proposed system extension.

.6 Design calculations for the wastewater system.

.7 Design calculations for the stormwater system.

.8 For subdivision work, an estimate of the cost of the proposed water, wastewater and stormwater systems extension.

8.1.1.3 Water Pumped Systems

Refer to SECTION 3.2

The following information shall be provided on all review submissions involving water booster pumping stations:

.1 Minimum, average, and peak flow rates.

.2 Curves for selected pumps including curves for head, BHP and NPSH.

.3 Motor horsepower and combined electrical/mechanical efficiency.

.4 Electrical motor power factor.

.5 Details of auxiliary power supply unit and pump house building.

.6 A narrative description of the control methodology and operations for the system describing each alarm, status and control activity in both normal and emergency conditions.

8.1.1.4 Wastewater Pump Stations

Refer to SECTION 5.3

The following information shall be provided on all review submissions involving wastewater pumping stations:

.1 Minimum, average, and peak flow rates.

.2 Curves for selected pumps including curves for head, BHP and NPSH.

.3 Motor horsepower and combined electrical/mechanical efficiency.

.4 Electrical motor power factor.

.5 Details of auxiliary power supply unit and pump house building.

.6 A narrative description of the control methodology and operations for the system describing each alarm, status and control activity in both normal and emergency conditions.

8.1.2 Building Permit Applications

(Industrial, Commercial, and Institutional (ICI))

8.1.2.1 Procedure

Design and construct the water, wastewater and stormwater service connections (public and private) to HRWC's Design and Construction Specifications, the Standard Specification for Municipal Services, and in accordance with HRM By-laws, ordinances, procedures and specifications where they apply.

Information provided by HRWC (Record drawings, GIS printouts, service connection cards, etc.) are for information purposes only and the professional engineer shall field check all provided information to ensure its accuracy prior to submission of projects.

8.1.2.2 Information

The following information shall be provided on all review submissions involving building permit applications for ICI projects:

.1 Two (2) sets of site location drawings conforming to HRWC's Design and Construction Specifications indicating the details of the proposed water, wastewater and stormwater service connections to be installed. All existing municipal systems (water, wastewater and stormwater systems) are to be indicated as well as all additional utilities (natural gas, power and communications), electrical conduits, transformers, fuel tanks, structures, etc. that are located within 3.0 m of the proposed service connections as indicated on the submitted drawings.

.2 Plan and profile drawings will be required for the wastewater and stormwater service connections and where the domestic water service connection is greater than 50 mm, or if requested by HRWC due to site conditions and services layout. The requirements for sizes and content (as detailed in SECTION 7.2) are as follows:

- Minimum – 580 mm wide x 840 mm long.
- Maximum – 610 mm wide x 915 mm long.

.3 Completed Backflow Prevention applications (available at www.halifaxwater.ca) for both the domestic and sprinkler water service connections, complete with a drawing showing the orientation and location of the proposed backflow prevention device. The drawing shall also indicate the size of pipe and devices (PRV, BFP, Meter, etc.) The Backflow Prevention applications must be completed by either a licensed plumber or a professional engineer.

.4 Completed pollution prevention program abbreviated discharger information report (Form 1, available on www.halifaxwater.ca)

.5 Design calculations including peak domestic demand and fire flow rate requirements.

.6 Design calculations for the sizing of wastewater service connections.

.7 Design calculations for the sizing of stormwater service connections.

.8 Calculations confirming that the pre and post stormwater flows for the proposed development are balanced.

.9 The applicant shall provide the proposed sewage generation numbers for the proposed development. The required sewage generation numbers must be provided and certified by a professional engineer. Based on the submission of the sewage generation numbers, a downstream combined/wastewater system analysis **may be required** in order to confirm that capacity exists in the local combined/wastewater system. This capacity analysis must be performed and certified by a professional engineer. If it is determined that capacity does not exist in the local combined/wastewater system, it is the responsibility of the developer to complete the required upgrades to ensure capacity exists in the system.

.10 The plan shall indicate all surface classifications (undisturbed natural areas, building foot print, landscaped, graveled, concrete paved and asphalt paved areas) measured areas (m^2) that are applicable to the proposed project. This information shall be provided for in tabular form and indicated on the plan.

.11 The plan shall indicate the square footage of the proposed building to be constructed for ICI uses. For multi-unit residential buildings the total unit count shall be provided on the plan.

8.2 CONSTRUCTION / INSPECTION REQUIREMENTS

8.2.1 HRWC Capital Projects

.1 Contractor to provide HRWC's representative with access to the work, and to locations where products to be incorporated into the work are being prepared.

.2 Contractor to co-operate with and assist the HRWC's representative in conducting tests.

.3 Contractor to provide assistance, labour, and materials, as are normally required for examining, testing, and measuring the quality, weight, or quantity of any material used and supply samples of material requested before incorporation into the work.

.4 Contractor to include costs for providing assistance and samples for testing and for arranging tests in Contract Price.

.5 The HRWC's representative will visit the site at intervals appropriate to the progress of construction to become familiar with the progress and quality of the work and to record the data necessary to evaluate the pay quantities under the Schedule of Quantities and Unit Prices.

.6 The HRWC's representative has authority to reject work which, in his opinion, does not conform to the requirements of the contract documents. Whenever it is considered necessary or advisable, the HRWC representative has authority to require special inspection or testing of work whether or not such work be then fabricated, installed or completed. However, neither the HRWC's representative authority to act nor any decision made by HRWC either to exercise or not to exercise such authority, shall give rise to any duty or responsibility of HRWC to the contractor, subcontractors, or their agents, employees or other persons performing any of the work.

8.2.2 New Development Projects

.1 Prior to construction and not before HRWC approval of the final detailed design, a pre-construction meeting is to be arranged by the developer with representatives of HRWC, the developer, the developer's consultant and contractor. Provide HRWC with 48 hour's notice of pre-construction meetings.

.2 Prior to construction, the developer shall provide HRWC with 3 hard copy sets and a digital file (PDF) of the "Issued For Construction" drawings.

.3 Developer to provide HRWC's representative with access to the work, and to locations where products to be incorporated into the work are being prepared.

.4 Developer to provide assistance to the HRWC's if required when they are collecting relevant information as part of their inspection.

.5 Developer to provide coordinate control points at appropriate locations within the limits of construction. Control locations are to be related to the Nova Scotia Coordinate Survey System (ATS77) in the metric format. The control is to be established by a licensed surveyor. Control is to be established prior to commencement of excavation for pipe installation.

.6 Developer is to notify HRWC at least twenty-four (24) hours in advance of requirements for tests and inspections. All tests are to be conducted by the developer's professional engineer or their representative, and are to be witnessed by the HRWC representative.

.7 The HRWC's representative will visit the site at intervals appropriate to the progress of construction to become familiar with the progress and quality of the work. The developer shall provide **full-time** inspection, by a professional engineer or their representative, for all aspects of the construction of the water, wastewater and stormwater systems, including all pipe bedding, pipe laying and backfilling of trenches.

.8 The developer's professional engineer or their representative shall be responsible for independently collecting and recording all of the required record drawing information. Use of the construction contractor's survey notes and data by the developer's professional engineer for record drawings is not permitted.

8.2.3 Building Permit Applications

(ICI Projects)

.1 Prior to construction of water, wastewater and stormwater service connections all permit approvals must be in place.

.2 Developer/contractor/consultant to provide HRWC's representative with access to the work, and to locations where products to be incorporated into the work are being prepared.

.3 Developer/contractor/consultant is to notify HRWC operations department at least twenty-four (24) hours in advance of requirements for tests and inspections. All tests are to be conducted by the developer's professional engineer or their representative, and are to be witnessed by the HRWC operations department representative.

.4 The HRWC's representative will visit the site at intervals appropriate to the progress of construction to become familiar with the progress and quality of the work. The developer shall provide **full-time** inspection, by a professional engineer or their representative, for all aspects of the construction (public and private) and testing of the water, wastewater and stormwater systems, including all pipe bedding, pipe laying and backfilling of trenches.

.5 The developer's professional engineer or their representative shall be responsible for independently collecting and recording all of the required record drawing information. Use of the construction contractor's survey notes and data by the developer's professional engineer for record drawings is not permitted.

.6 The developer's professional engineer shall provide written certification that the installed services were installed under their direction and that they are installed in accordance with the approved drawings and specifications.

8.3 ACCEPTANCE SUBMISSION REQUIREMENTS

A check sheet which summarized the requirements of Section 8.3.1 has been created and is available at www.halifaxwater.ca for the applicant to complete and submit as a cover page to the take-over package.

8.3.1 New Development Projects

8.3.1.1 General Requirements

Following completion of the construction of any water, wastewater and stormwater systems and prior to acceptance of ownership of any of those systems by the HRWC the following information and/or documentation shall be provided:

.1 Record Drawings – In reproducible and electronic format, certified by a Professional Engineer and in accordance with Section 7.3, Section 7.4 and Section 7.5 of this specification.

Record drawings shall be provided for all new water, wastewater and stormwater systems including, but not limited to, all underground chambers (PRV's, lift stations, etc.), water booster and wastewater pump stations, and all associated appurtenances for any new system extensions.

.2 Service connection card complete for each lot as per the form provided at www.halifaxwater.ca.

.3 Professional engineer's certificate of compliance stating that the municipal water, wastewater and stormwater systems have been installed in accordance with the approved drawings and specifications.

.4 Nova scotia land surveyor certification stating that all services have been installed within the boundaries of the right-of-way, easements in favour of HRWC or a parcel owned by HRWC; and that the as-constructed centre line of the public street coincides with the final legal subdivision plans of the public street.

.5 Detailed records of all actual construction costs and quantities breakdown for the installed water, wastewater and stormwater systems.

.6 Copy of the certificate to construct from NSE.

.7 Warranty deeds including property descriptions and plans for property which is to be transferred to the HRWC.

.8 Grants of easement including property description and plan for all water, wastewater and stormwater systems installed outside the public right-of-way.

.9 Maintenance bond in the amount of 10% of the actual cost of construction of the water, wastewater and stormwater systems to ensure the proper operation of such systems for a period of 12 months. This maintenance bond may be included within the maintenance bond provided to HRM, in which case a copy shall be provided to HRWC.

.10 Where applicable, payment of a capital cost contribution, in the amount calculated by HRWC and subject to the terms of an HRWC Services Agreement.

8.3.1.2 Water System Requirements

.1 Records of water system hydrostatic tests and certification of compliance.

.2 Acceptable bacteriological examination results.

.3 Water Systems installation costs. The actual cost of the installed water system on each individual street or easement. Itemized as follows:

- Water pipe (including fittings); sizes and lengths.

- Hydrants (including leads, valves and anodes); quantity.
- Valves; sizes, anodes and quantity.
- Water services; sizes, number of fittings, anodes and length of services.
- All other system components.

.4 Complete valve and hydrant records for each valve and hydrant on the forms found at the end of this section.

.5 Operation and maintenance manual for water booster stations as outlined in Section 3.2.8.17.

.6 Special tools and standard spare parts for water booster station equipment.

Note: Service connections will not be inspected, nor will water meters be issued until HRWC have accepted the water, wastewater and stormwater systems and has been advised by HRM that all primary services have been accepted.

8.3.1.3 Wastewater System Requirements

.1 Closed Circuit Television (CCTV) inspection and report (also required four weeks prior to end of warranty security period.) Refer to Section 8.3.2 for CCTV requirements.

.2 Pipe test report including service connections to the property lines.

.3 Manholes test and inspection report.

.4 Operation and maintenance manual for pumping stations as outlined in Section 5.3.2.29.

.5 Special tools and standard spare parts for pumping station equipment.

.6 Completed wastewater pumping station inventory sheet.

8.3.1.4 Stormwater System Requirements

.1 Closed Circuit Television (CCTV) inspection and report (also required four weeks prior to end of warranty period). Refer to Section 8.3.2 for CCTV requirements.

.2 Pipe test report including service connections to the property lines.

.3 Manholes test and inspection report.

.4 Driveway culvert sizing tables.

.5 Requirements as per Section 6.11.17

8.3.2 Closed Circuit Television (CCTV) Inspection Requirements for New Development

CCTV inspection procedures shall meet the requirements of the National Association of Sewer Service Companies (NASSCO).

Deflection testing for plastic pipe shall be in accordance with the requirements as set out in Section 33 31 00, Section 33 40 00 and Section 39 00 00 of the Standard Specifications for Municipa1 Services. The CCTV inspection and report must indicate the size of the deflection gauge (mandrel) being used when performing the pipe test.

The CCTV inspection and report shall be performed by a certified third party service provider who has been accredited through NASSCO's Pipeline Assessment & Certification Program (PACP).

A professional engineer's certificate stating that they have viewed the CCTV inspection and report and can certify that no deficiencies have been found. If deficiencies are found, the designer's engineer shall prepare a report outlining measures for repair to HRWC for consideration.

The Engineer reserves the right to reject any CCTV inspection and report that does not meet the NASSCO.

8.3.2.1 (CCTV) Inspection Procedure – General

1. Inspect the systems interior using a color, CCTV camera and document the inspection on a digital recorder.
2. Code all defects using NASSCO certification programs:
    - System mains - follow PACP
3. Use a video overlay system to clearly display the inspection header information for five (5) seconds at the start of each inspection.

4. At the start of each inspection, record the mandatory information outlined in the NASSCO method (PACP) and the following additional information – all inspections:
   - Time and weather conditions
   - Location details
   - Pipe type (wastewater or stormwater)
   - Inspection number
5. Record all defects and code using the NASSCO methods including but not limited to the following:
   - Any system pipe joint that displays a gap or spread, offset, gasket, or signs of infiltration.
   - Any service connection that displays water infiltrating around service connection, or any service connection exhibiting pronounced protrusion into the system line.
   - Any section of the system that is crushed, broken or displays longitudinal or circumferential cracks (other than hairline cracking) and that displays a gap / spread, offset, or signs of infiltration.
   - Any variance in grade, alignment, or diameter of system line section.
   - Any gravel, roots, or foreign material that may impede flow.
   - Any deformation in pipe shape.
   - Any section of system piping displaying standing water.
   - Any material change or spot repair.
   - Any evidence of clear water flows together with the location.
   - Any other evidence of water infiltration (staining, wetted perimeter of joint, high water marks, dripping).
   - Any other information that may be pertinent to the work.
   - Display pipe and manhole IDs on-screen at all times during the inspection for quick reference.
   - Display the exact location of the camera in metres on-screen.

- Include on-screen text for every observation recorded during the inspection and in the database.
- Convert the defect codes to condition ratings for the pipe segments using the PACP.
- Maintain inspection notes during inspection for use in generating the final inspection report.
- Ensure all equipment used to carry out the inspection, analysis, and reporting services is in a state of good repair and is safe for its intended use.
- Ensure all video and still picture images are clear and sharp.
- Ensure recorded image from the CCTV camera is free of fog or haze in the pipe.
- Remove camera from sewer line if the camera lens becomes obscured with condensation, grease, scum, or debris and clean.

8.3.2.2 (CCTV) Inspection Procedure – System Mains

.1 Provide references for the video that clearly display ‘From’ and ‘To’ manhole IDs and travel distance in metres on the periphery of the screen and arrange the information to minimize interference with the inspection image (defect code and description should appear on the screen while ‘coding’ for at least five (5) seconds).

.2 Provide accuracy for distance measurement in the system to within 0.5% of the above ground measurement.

.3 Perform pipe inspection one (1) system line section at a time from manhole to manhole by moving the camera through the system preferably in direction of flow along the axis of the pipe and record general construction, structural condition, and evidence of inflow, infiltration or surcharging together with the location of the defect.

.4 Inspect continuous defects using the pan and tilt feature at intervals that will provide a representation of and fully display and identify that defect.

.5 Operate camera at steady speeds capable of inspecting each pipe joint, tee connection, structural deterioration, infiltration and inflow source, and material deposits at a maximum speed of 9 m/min.

.6 Record features and defects and stop and pan camera to record specific features including manholes, joints, service connections, and defects. Service connections are to be viewed and recorded at a camera angle of 90 deg. to provide a true depiction of the connections.

.7 Record location of defects and service connections with maximum one (1) m tolerance measured from centerline of reference manhole.

.8 Illuminate approximately two (2) m ahead of the camera to minimize reflective glare.

.9 Adjust lighting as needed according to the size of the pipe to provide a clear picture of the entire periphery of the pipe for all conditions encountered.

.10 Distribute lighting evenly around the perimeter of the pipe to prevent loss of contrast.

.11 At the start of each inspection, record the mandatory information outlined in the NASSCO method (PACP) and the following additional information – pipe inspections:

- Pipe ID (From Manhole ID, To Manhole ID, Direction of travel (upstream, downstream))
- Pipe Segment Reference
- Lining Method
- Length Surveyed
- Purpose of Survey
- Weather

8.3.2.3 Closed Circuit Television (CCTV) Report

.1 Provide a report that includes the location of each fault, defect, and service connection with distance measured from the centerline of reference manhole and clock position referenced to the axis of pipe, and report shall include pictures of significant defects (severely deteriorated pipe, severely protruding service connections, locations of severe inflow and infiltration flows, or any other relevant information), and technical recommendations based on the inspection observations.

.2 Provide an inspection report and video for each system line section inspected.

.3 For each inspected main line system reach (referenced manhole to manhole) provide:

- .MPEG file.
- Digital photographs in.JPG or .JPEG files.

- Inspection reports in searchable PDF files.
- Any handwritten inspection logs or field maps prepared during inspection.
- Associated certification program inspection information (PACP) in a.MDB file format.

.4 Name files according to the file naming convention of:

- "Street_PipeID_YYYY_MM_DD_Incremental Number (1, 2, 3, etc…)" with the corresponding file extension (.MPEG, .JPG/.JPEG, .PDF, .MDB, .SHP).

8.3.3 Building Permit Applications

(ICI)

A check sheet which summarized the requirements of Section 8.3.3 has been created and is available at www.halifaxwater.ca for the applicant to complete and submit as a cover page to the take-over package.

8.3.3.1 General Requirements

Following completion of the construction of ICI building projects the following information and/or documentation shall be provided prior to the issuance of a water meter:

.1 Record Drawings – In reproducible and electronic format, certified by a Professional Engineer and in accordance with Section 7.3, Section 7.4 and Section 7.5 of this specification. This shall include all water, wastewater and stormwater service connections installed for the project.

.2 Records of water system hydrostatic tests and certification of compliance.

(For water services 100mm and larger or as directed by HRWC.)

.3 Acceptable bacteriological examination results.

(For water services 100mm and larger or as directed by HRWC.)

.4 Inspection of the backflow prevention device(s) by HRWC.

.5 Final Inspection of the water, wastewater and stormwater service connections by HRWC.

.6 Submission of the engineer's certificate of compliance for building services (refer to SECTION 8.4)

.7 Submission of the (CCTV) inspection and report of the wastewater and stormwater service connections (refer to Section 8.3.2).

.8 For (CCTV) inspections of wastewater and stormwater service connections that are less than 200mm in diameter, a lateral camera is to be utilized.

.9 Deflection gauge testing is not required to be performed on the wastewater service connection if the diameter is less than 200mm.

.10 Submission of a wastewater manhole and service connection test and inspection report (refer to Section 4.6.5).

8.4 INDEX TO HRWC FORMS

.1 Valve Attribute List
.2 Valve Field Form – Blank
.3 Hydrant Attribute List
.4 Hydrant Field Form – Blank
.5 Engineer's Certificate of Compliance for Building Services – Blank
.6 Engineer's Certificate of Compliance for Municipal Services – Blank
.7 HRWC Subdivision Infrastructure Endorsement Check Sheet – Blank
.8 HRWC Building Permit Endorsement Check Sheet - Blank
.9 Service Connection Card – Blank
.10 Wastewater Pumping Station Inventory Sheet - Blank

All forms are available on www.halifaxwater.ca.