Design Specifications & Supplementary Standard Specifications

for Water, Wastewater & Stormwater Systems

Halifax Water

2025 Edition

Feb 24th, 2025

To our readers:

The *Halifax Water Design Specifications* and *Halifax Water Supplementary Standard Specifications* have been updated. In order to provide clarity to building plumbing designers we have published the *Water Meter & Backflow Prevention Device Design & Installation Manual*. All three documents are available for download on the Halifax Water website at www.halifaxwater.ca.

Our mandate provides for ownership, operation and maintenance of municipal water, wastewater and stormwater infrastructure within specific boundaries set by the Municipality. In order to establish, as fair as practical, uniformity of practice within the Municipality, these specifications have been developed by staff of Halifax Water. They are to be used as the minimum standards to be met in the design and installation Water, Wastewater and Stormwater Systems within the Municipality.

These specifications are developed to provide consistency in design and installation of the Halifax Water Systems.

Any comments or suggested changes to the document are welcomed and encouraged from all interested parties. Comments received will be reviewed and considered for the 2026 update. Comments are to be forwarded to EngineeringApprovals@halifaxwater.ca.

It is the responsibility of the users of these specifications to access the Halifax Water website on an annual basis for the most current version of this document. The requirements of these Halifax Water Specifications will take effect **April 1, 2025**, all applications made after this date, must meet the updated Halifax Water Specifications.

Josh DeYoung, P.Eng.
Director, Engineering & Capital Infrastructure

1.0 INTRODUCTION

Halifax Water is the municipal water, wastewater and stormwater utility serving our customers within the Municipality pursuant to the Public Utilities Act. An autonomous, self-financed utility, Halifax Water is a fully metered water utility providing water, fire protection, wastewater and stormwater services as regulated by the Nova Scotia Utility and Review Board.

The *Design Specifications, Halifax Water Supplementary Standard Specifications*, and the *Water Meter & Backflow Prevention Device Design & Installation Manual* are the minimum standards that must be met in the design, installation and testing of water, wastewater and stormwater infrastructure. A complete documentation of all parameters relating to the design, installation and testing of proposed Halifax Water Systems 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 Halifax Water.

The design of Halifax Water Systems, when submitted to the Engineer, must be under the seal of a Professional Engineer in accordance with the Nova Scotia Engineering Profession Act. *R.S., c. 148, s. 1*.

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 Halifax Water to stifle innovation. Where, in the judgment of the Design Engineer, variations from this document are justified or required, and where the Design Engineer 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 will take into consideration such factors as safety, nuisance, system maintenance, operational costs, life cycle costs, environmental issues, natural topography, and configuration of the bulk land. Where the Design Engineer uses standards other than those outlined in this document, all appropriate documents and plans are to indicate the standards referenced. The acceptance by the Engineer of the design proposed Halifax Water Systems does not relieve the Design Engineer of the responsibility of proper design nor does it imply the Engineer has checked the design exhaustively for compliance with this document. Where the Engineer has accepted a design which does not comply with these specifications 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.

All contract documents prepared for the expansion of the Halifax Water Systems 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. Halifax Water Systems are not permitted to be constructed until the design has been approved by the Engineer. In addition to these specifications, all applicable and relevant codes and standards to be used by the Design Engineer, include, but not limited, to the following:

- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- Atlantic Canada Water and Wastewater Association (ACWWA)
- Building Code Act of Nova Scotia
- Canadian Standards Association (CSA)
- Ductile Iron Pipe Research Association (DIPRA)
- Environment Canada
- Fire Safety Act of Nova Scotia
- Hydraulic Institute Standards
- Insurers Advisory Organization
- National Association of Sewer Service Companies (NASSCO)
- National Building Code of Canada
- National Fire Protection Association
- National Plumbing Code of Canada
- National Sanitation Federation (NSF)
- Nova Scotia Environment and Climate Change (NSE)
- Underwriters Laboratories of Canada
- Uni-Bell PVC Pipe Association

The Engineer's decision is final and binding in matters of design, installation and testing. In any case where this document requires expansion or clarification, the latest revisions of the following documents may be used for reference:

- Standard Specifications for Municipal Services, – Nova Scotia Road Builders Association and the Consulting Engineers of Nova Scotia
- Atlantic Canada Water Supply Guidelines – ACWWA & Atlantic Provinces
- Atlantic Canada Wastewater Systems Guidelines – ACWWA & Atlantic Provinces

The Design Engineer is to assess the possible change in ground water movement caused by the development (in particular the use of impervious bedding material) and is responsible for the corrective measures to prevent flooding or lowering of ground water table as a result of this ground water movement. The Design Engineer is to provide a geotechnical engineer's report on the effectiveness of the proposed corrective measures.

The design, installation and testing specifications in this document will be revised periodically to conform to advances and improvement in the practice of engineering. It is the responsibility of the Design Engineer to remain current with revisions.

2.0 DEFINITIONS

Approval — Refers to the approval of the Engineer. The Engineer's decision will be final and binding in matters of design, installation, inspection and acceptance.

Applicant — A person or company that makes application to extend, or connect to, Halifax Water Systems.

Average Day Demand — The total amount of water demand within a certain time period, usually one year, divided by the number of days within that time period.

Carrier Pipe — A pipe designed by the Design 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 Halifax Water.

Commissioning — A process by which equipment, station, facility or plant is tested to verify if it functions according to its design specifications prior to acceptance by the Engineer.

Contractor — Any person who, for another person, carries out work or supplies labour for the alteration, construction, demolition, excavation, or development of land or a structure.

Design Engineer — A person who practices professional engineering and is a registered member, in good standing, of Engineers Nova Scotia. Referenced in this document, as the Professional Engineer under whose signature the engineering design is sealed.

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 Halifax Water.

Diameter	The nominal internal diameter of the pipe – unless otherwise noted.
Domestic	Any residential, industrial, commercial and institutional non-fire water use.
Engineer	The Director of Regulatory Services of the Halifax Water, or designated representative.
Feeder Main	A water main which typically receives flow from transmission mains or from pressure control facilities (i.e. booster 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.
the Municipality	Halifax Regional Municipality, a body corporate, as established under the *Municipal Government Act,* 1998, c. 18, s.1.
Halifax Water	Halifax Regional Water Commission, a body corporate, as established under the *Halifax Regional Water Commission Act*, 2007, c. 55, s. 2; 2012, c. 60, s.1., is the municipal water, wastewater and stormwater utility for the Municipality. Halifax Water is authorized to own and operate the water supply, wastewater and stormwater facilities for the Municipality.
Halifax Water Regulations	Halifax Water's *Schedule of Rates, Rules and Regulations for Water, Wastewater and Stormwater Services*, as amended from time to time by the Nova Scotia Utility and Review Board.
Halifax Water Systems	Halifax Water's collective Water, Wastewater and Stormwater Systems.
Hyetograph	A graph showing average rainfall, rainfall intensities or volume over specified areas with respect to time.
Industrial, Commercial or Institutional	Includes or pertains to industry, manufacturing, commerce, trade, business, or institutions as well as 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 1:100 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.

Maximum Day Demand The average water demand over a 24-hour period (midnight to midnight) of highest water demand day within any one year.

Minimum Hour Demand The smallest short term (1 hour) demand in a 24-hour period (midnight to midnight).

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

Minor Storm The 1:5 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 Residential A building which contains four or more residential dwelling units.

NSE Nova Scotia Department of Environment and Climate Change.

NSDPW Nova Scotia Department of Public Works.

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

Peak Hour Demand The highest short term (1 hour) demand within a system not including fire flow in a 24-hour period (midnight to midnight).

Primary Services	Means those services which must be installed and accepted by the authority having jurisdiction prior to accepting a public street or highway and include park dedication, Water System, Wastewater System and Stormwater System, street construction including all gravel layers and base lift of asphaltic concrete or Portland cement concrete pavement including curb and gutter backfilled, permanent stabilization of all exposed areas, driveways, guiderails, electrical and communication distribution system including underground conduit, street name signs and sign base and standards, and street lighting system.
Professional Engineer	A person who practices professional engineering and is a registered member, in good standing, of Engineers Nova Scotia. Referenced in this document for the purposes of inspection and acceptance of Halifax Water Systems and may, but not necessarily be the Design Engineer whose signature the engineering design 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(s)	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 Municipality Regional Subdivision By-law. This map identifies the type of Halifax Water Systems required when such systems are to be constructed within the Municipality.
Sprinkler Service Connection	A piping system that conveys water from a water main to a property for the sole purpose of providing fire protection.
Start-Up	A process where equipment, facility or utility plant is installed and tested by the contractor and certified complete by the Design Engineer 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	The method or means of carrying stormwater, including ditches, swales, sewers, drains, canals, ravines, gullies, pumping stations, retention ponds, streams, water-courses, floodplains, ponds, springs, creeks, streets or private roads, roadways or driveways, which are vested in or under control of Halifax Water.
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. Designed to the requirements of the Municipality and the Municipality Regional Subdivision By-law.
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, with groundwater, surface water or Stormwater which may be present.
Wastewater Service Connection	A piping system that conveys wastewater from a property to the 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 Halifax Water.

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

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 Halifax Water.

Watercourse (i) the bed and shore of every river, stream, lake, creek, pond, spring, lagoon or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and

(ii) all groundwater.

As defined by the *Environment Act* 1994-95, c. 1, s. 1

3.0 WATER SYSTEM – DESIGN REQUIREMENTS

3.1 SCOPE

A Water System is a complete and properly functioning system of water mains, service connections from the water main to the street lines and appurtenances, including booster 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 Halifax Water personnel are not exposed to hazards when conducting operation and maintenance of the water distribution system.

All water distribution systems are to conform to any requirements established by NSE. No Halifax Water Systems are to be constructed until the design has been approved by the Engineer.

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

For an extension to the Water System, the Engineer requires the Applicant to enter into a Halifax Water Systems Agreement which defines the rights and obligations of Halifax Water and the Applicant regarding construction, inspection, record collection, acceptance and warranty of new Water System.

Halifax Water owns and operates various infrastructure whose operation can be impacted by the tide level of the Atlantic Ocean. These impacts can result from normal tidal fluctuations or from storm surges and wave run-up. Halifax Water infrastructure should also be resilient to adapt to sea level rise as a result of climate change throughout the life cycle of the infrastructure.

As a result, Halifax Water has developed a plausible upper bound flooding scenario of 4.86 metres (CGVD2013). It is recognized that for some infrastructure, the impact of temporary flooding due to storm surge is negligible and therefore low risk. In other instances, the impact of a short duration flood can be catastrophic.

For any infrastructure to be installed below 4.86 meters (CGVD2013), The Design Engineer is to provide a statement for how the infrastructure still provides an acceptable level of service.

High High-Water Level (HHWL):	0.73 metres (CGVD2013)
Sea level rise as a result of climate change:	1.50 metres
Storm surge and wave run-up:	2.63 metres
Total:	4.86 metres (CGVD2013)

3.2 WATER DISTRIBUTION SYSTEM DESIGN

3.2.1 Water Demand

Water distribution systems are to be designed to accommodate the greater of Maximum Day Demand plus fire flow demand, or Peak Hour Demand.

Fire flow demand is to be in accordance with the latest requirements contained within *Water Supply for Public Fire Protection,* by the Insurance Advisory Organization.

Water distribution systems are to be designed to accommodate the following:

- Average Day Demand 375 litres / person / day

Refer to the permitted land uses under the Municipality's Municipal Planning Strategy (MPS), Land Use Bylaw (LUB), or approved Development Agreement for a specific area. When determining site populations, refer to numbers below:

- Single unit dwellings 3.35 people / unit
- Semi-detached & townhouse 3.35 people / unit
- Multi-unit dwellings 2.25 people / unit

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

3.2.2 Hydraulic Model

Water distribution designs are to be supported by a hydraulic analysis of the system which determines flows, pressures and velocities under Maximum Day Demand plus fire flow demand, Peak Hour Demand and Minimum Hour Demand conditions. The analysis is to identify and describe any impact on the existing system. The Design Engineer 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 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 Design Engineer is to 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 Demand plus fire flow demand analysis are to include sufficient scenarios to test all extreme conditions, such as high fire flow demand 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 model if it can be demonstrated that minimal or no impact will be created on the existing system.

3.2.2.1 Hydraulic Model Software

Halifax Water uses the latest version of InfoWater Pro by Innovyze and use of the same software by Design Engineers is encouraged. Where the Design Engineer does not have access to InfoWater Pro, 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, in digital format, is required to follow these minimum requirements:

.1 The hydraulic model is to be in a format compatible with the latest release of Bentley InfoWater Pro or EPANET.

.2 The submission is to include all files required to run the model. Hydraulic networks should be drawn to scale and referenced to horizontal datum NAD83 (CSRS) Epoch 2010.0 and vertical datum Canadian Geodetic Vertical Datum 2013. (Referred to as NAD83 and CGVD2013).

.3 Background layers submitted in shapefile format, ESRI file geodatabase format (.gdb), or OGC geopackage format (.gpkg).

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

.5 The Hazen Williams formula is to 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 Peaking Factors

The peaking factors used to calculate Minimum Hour Demand, Peak Hour Demand and Maximum Day Demand must be based on:

- Historical information
- Nova Scotia Environment guidelines, or
- As directed by the Engineer

Where the proposed development requires a booster station, PRV or storage, peaking factors shall be determined in consultation with the Engineer.

Table 3.1 – Peaking Factors

Land Use	Minimum Hour	Maximum Day	Peak Hour
Low Density Residential	0.70	1.65	2.50
High Density Residential	0.84	1.30	2.50
Industrial	0.84	1.10	0.90
Commercial	0.84	1.10	1.20
Institutional	0.84	1.10	0.90

3.2.2.3 Friction Factors

Hazen Williams 'C' values to be used for the design of water distribution systems, regardless of pipe material, will be:

Table 3.2 – Friction Factors

Diameter of Water Main	'C' factor
150 mm	100
200 mm to 250 mm	110
300 mm to 600 mm	120
larger than 600 mm	130

When evaluating existing systems, the 'C' factor should be determined by actual field tests, whenever possible.

3.2.2.4 Fire Protection

Fire flows used must be supported by Halifax Water's minimum requirements and/or calculation as prescribed in *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.

Estimated fire flow requirements compiled from the Insurance Advisory Organization is shown in the table below.

Table 3.3 – Fire Flow Requirements

Land Use	Fire Flow (litres/minute)	Duration (hours)	Number of Fire Hydrants
Single unit dwellings	3300	1.5	1
Two family dwellings	3300	1.5	1
Townhouse	4542	1.75	1
Multi-unit high rise	13620	3	3
Commercial	13620	3	3
Industrial	13620	3	3
Institutional	13620	3	3

This table is a guideline for the Water System. The Design Engineer of the Sprinkler Service Connection will be required to design the private sprinkler arrangement specific to proposed land use and actual Water System conditions.

3.2.2.5 Fire Hydrant Spacing

The layout of the hydrants within the Water System are to be designed in consideration of the following desirable location criteria:

.1 In residential single family, semi-detached and townhouse developments; the maximum spacing of fire hydrants cannot exceed 150 metres.

.2 In Industrial, Commercial and Institutional developments, the maximum spacing of fire hydrants cannot exceed 90 metres.

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

.4 Dead end mains are to terminate at a hydrant for flushing purposes.

3.2.2.6 Fire Flow Testing

Consult the Engineer to determine the necessity of a fire flow test.

If it is determined a fire flow test is required, call the Halifax Water Customer Care Centre at (902) 420-9287 to schedule a fire flow test.

Fire flow tests will only be scheduled between 10:00 pm and 12:00 am. Halifax Water Operations are required to be present to operate the Water System.

Fire flow tests will not be scheduled during freezing conditions. Halifax Water Operations will determine if the weather conditions permit a test to take place. If there is a risk of freezing, the Applicant is to have salt on hand to offset the paved surface from freezing.

The Applicant requesting the test will provide all gauges and test equipment necessary to carry out the test and perform all necessary calculations. At a minimum this shall include:

- Diffusers
- Pitot Gauge
- 11.25° or 22.5° bends for the hydrant side nozzles to direct water toward the right of way
- Hose to direct water

Halifax Water reserves the right to cancel the test if the applicant does not have proper equipment to safely complete the hydrant test.

The Applicant is responsible to provide traffic control, if required.

All fire flow test results are to be sent to flowtestresults@halifaxwater.ca.Results are reviewed for system performance and are not shared externally.

Fire flow testing is required for all applications to confirm static and residual pressures. If any operational problems are discovered during the fire flow testing, it should be brought to the attention of the Engineer.

Fire flow testing fees can be found in the current version of the Halifax Water Regulations.

3.2.2.7 Maximum Velocity

The maximum velocity in the pipe is not to exceed 1.5 m/s during Peak Hour Demand flow conditions or 2.4 m/s during fire flow conditions.

3.2.2.8 Allowable Pressure Range

The preferred design pressure ranges for:

- Average Day & Maximum Day Demand between 350 kPa (50 Psi) and 550 kPa (80 Psi)
- Minimum Hour & Peak Hour Demand between 275 kPa (40 Psi) and 620 kPa (90 Psi)

Pressures outside of these ranges are acceptable to the limits outlined below but are not desirable.

Non-Fire Scenarios

The minimum residual pressure under any non-fire flow demand scenario will not be less than 275 kPa (40 Psi) at any location in the water distribution system.

Fire Scenarios

The minimum residual pressure during a Maximum Day Demand plus fire flow demand scenarios will not be less than 150 kPa (22 Psi) at any location in the water distribution system.

Maximum Pressure

Maximum water pressure during Minimum Hour Demand is not to exceed 620 kPa (90 Psi) unless approved by the Engineer.

3.2.2.9 Supply Redundancy

Water distribution systems are to be designed such that a group of 30 or more metered customers are not supplied by a single source of supply.

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

3.2.2.10 Water Main Size

.1 Minimum size for local distribution water main is 200 mm.

.2 Minimum size for Feeder Main is 300 mm.

.3 Water main diameter in cul-de-sacs is to be reduced to 100 mm after the last fire hydrant, satisfying fire underwriters requirements, and where the Engineer has indicated supply redundancy is not required.

3.2.2.11 Hydraulic Analysis Report

The Design Engineer is to prepare a Hydraulic Analysis Report for review and approval by the Engineer prior to final detailed design.

The Hydraulic Analysis Report will contain:

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

.2 A description of the site contour information including maximum and minimum elevations to be serviced and how this relates to the hydraulic grade line in adjacent pressure zones.

.3 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.

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

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

.6 A discussion of the required fire flow for the proposed development.

.7 A discussion of the hydrant flow test results.

.8 A 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 will be presented in the appendix.

.9 A 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 will be presented in the appendix.

.10 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 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 Water Main

3.2.3.1 Water Main Material

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.

.1 Ductile Iron (DI) Pipe AWWA C151/A21.51 Special Class 52 cement mortar lined with interior asphaltic seal coat, as well as:

- All DI pipe and fittings will be installed with polyethylene encasement.
- All valves, hydrants and service connections will be installed with an attached zinc anode for cathodic protection.
- DI pipe will not be installed below the salt water tidal zone.
- The approved service connection pipe material for DI mains will be Ductile Iron Special Class 52 cement mortar lined with interior asphaltic seal coat or Type K copper tube.
- Wire bond jumper straps are required on 500mm diameter DI pipe and over, and as directed by the Engineer.

.2 Polyvinyl Chloride (PVC) Pipe AWWA C900 Class 305, DR14, in accordance with CSA 137.3, as well as:

- 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.

- The approved service connection pipe material for PVC mains will be Polyvinyl Chloride (Class 305, DR14) pipe and Cross-Linked Polyethylene (PEX-a) tubing.

- All valves, hydrants, and service connections will be installed with an attached zinc anode for cathodic protection. If cross linked polyethylene (PEX-a) service pipe is utilized, then an anode is not required.

- All fittings for PVC pipe, excluding tapping couplings, to AWWA C153.

- All fittings will be installed with polyethylene encasement.

- All PVC & PEX-a pipe installations are to include a trace wire system for pipe location purposes.

- All service connection taps will 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 Consistency of pipe material within a section of the distribution system or within a particular subdivision will be maintained.

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

3.2.3.2 Water Main Cover

.1 Minimum cover is 1.6 metres.

.2 Maximum cover is 2.0 metres.

The depth of cover is measured from the finished surface design grade over the pipe to the crown of the water main.

3.2.3.3 Water Main Location

.1 Install water mains 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 are to meet the minimum requirements of NSE. Install water mains at least 3.0 metres horizontally from any existing or proposed Wastewater or Stormwater System. If this separation cannot be achieved, water mains are permitted to be installed closer to gravity Wastewater or Stormwater System, provided that:

- The water main is installed in a separate trench; or
- Installed on an undisturbed earth shelf located on one side of the Wastewater or Stormwater Systems and maintains a minimum 500 mm horizontal and a 300 mm vertical separation.

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

.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 is to be relocated to provide this separation. Indicate catch basin lead inverts on the drawings to facilitate checking of clearances.

.4 When it is not possible to obtain proper horizontal and vertical separation as stipulated, the Wastewater and Stormwater Systems are to be water class and pressure tested to 1000 kPa (145 Psi) for water tightness.

.5 Where possible the water mains are to be installed in a straight line within the travelled way portion of the street right of way and a minimum of 1.5 metres 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 may 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.

.6 Easements will 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. A cross section is to 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 is to 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 is to 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 will be granted to Halifax Water prior to the transfer of ownership of the walkway to the Municipality.

.7 Water mains are to maintain a minimum 2.0 metres horizontal separation from permanent underground and above ground infrastructure / structures. This applies to electrical or telephone conduit, steam or hot water piping, transformer pads, utility poles, signs or other utilities.

.8 Water mains are required to maintain horizontal and vertical separation from gas lines depending on water main size.

.9 Where a need is identified to facilitate future development on the adjacent lands, Water Systems, are required to be extended to the midpoint of the frontage of the last lot as per the Municipality Regional Subdivision By-law.

3.2.3.4 Water Main Thrust Restraint

.1 Any change in direction of the water main, in excess of the pipe joint deflection tolerance, are to be made using an appropriate fitting. Thrust block design to consider these fittings.

.2 No unrestrained pipe joints are permitted within the “minimum pipe length”, refer to the Standard Details.

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

.4 Thrust restraints for vertical bends are to be designed and installed using gravity thrust blocks located below the fitting and connected with galvanized tie rods securely embedded in concrete.

.5 Horizontal 11.25° and 22.5° bends up to and including 300 mm require concrete thrust block or mechanical joint thrust restraint devices. At the discretion of the Engineer and system characteristics, both concrete thrust blocks and mechanical joint restraint devices may be required in certain situations.

.6 All tees, caps, 45° and 90° bends require both concrete thrust blocks and mechanical joint thrust restraints.

.7 Thrust restraint to be designed by the Design Engineer for the application of all pipes over 300mm.

.8 Thrust restraint for pipes installed steeper than 16% is to be designed by the Design Engineer. Mechanical restraint devices may be used in addition to gradient restraint anchor blocks for pipes installed at grades steeper than 16%. Mechanical restraint devices on their own are not acceptable.

.9 Mechanically restrained joints are required where there is a potential for separation of joints as a result of fill settlement or where future excavation may expose the main.

3.2.3.5 Water Main Extension Connecting 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. The water main is to be disinfected and flushed as per the Supplementary Standard Specifications.

.2 All work associated with system extensions and connections to the Halifax Water distribution system are to be conducted in temperatures above zero degrees Celsius. The Engineer to approve the schedule.

3.2.3.6 Water Main Crossings

.1 Lay water mains crossing wastewater or stormwater mains with a minimum vertical distance of 450 mm between the outside of the water main and the outside of the wastewater or stormwater main. Preference is given to water main located above the wastewater or stormwater main. One full length of water pipe should be located so both joints will be as far from the wastewater or stormwater main as possible. Structural support of the water, wastewater or stormwater mains may be required.

.2 When it is not possible to obtain proper horizontal and vertical separation as stipulated, the Wastewater and Stormwater Systems are to be water class and pressure tested to 1000 kPa (145 Psi) for water tightness.

.3 When crossing under a railway, highway, bridge structure or water course the water main is to be installed in a carrier pipe. Subject to future accessibility, the carrier pipe and the method of water main installation are to be designed by the Design Engineer and approved by the respective review agency (NSDPW, NSE, CN, etc.).

3.2.3.7 Water Main Automatic Flushing Station

Automatic flushing stations are required in the distribution system at locations as identified by the Engineer for the efficient operation of the Water System.

Automatic flushing stations are required at the end of each phase of a phased development to ensure efficient operation of the Water System prior to full build out. A water meter will be installed on the flushing station and all associated costs will be the responsibility of the developer.

3.2.3.8 Water Main Trench Drainage Relief System

The design of the Water System is to consider possible change in ground water movement caused by the use of pervious bedding materials. The design is to 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 relief system design is to 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.

3.2.4 Valves

Valves installed within the Water System on water mains and Water Service Connections provide the ability to isolate buildings and streets to facilitate construction, maintenance and emergency repair. If a valve is located in a gravel shoulder or outside of the street right-of-way an asphalt apron will be provided.

Refer to *Supplementary Standard Specifications* for Standard Details of valve layout arrangements. Valves requirements on water mains include:

.1 Intersections are isolation points for water mains. For instance, a four-way intersection with bisecting water mains would require four valves. The number of valves required is dictated on the ability to isolate a water main.

.2 Main line valves are to be located outside of the street intersection, offset 1 metre from cross street curb locations as per HWSD-1034.

.3 On straight runs the maximum spacing for main line valves is 150 metres for commercial/industrial areas, and 250 metres for urban residential areas. Based on lot size, the maximum and minimum spacing in residential areas may be adjusted by request of Halifax Water.

.4 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.

.5 For cul-de-sacs looped through easements, a valve is required to separate the street and the easement and is to be located within the asphalt portion of the cu-de-sac bulb.

.6 Use gate valves for 300 mm water mains and smaller.

.7 Use butterfly valves for 350 mm water mains and larger.

.8 Valves will not be permitted at the end of a development phase if the spacing is less than required based on land use. Dead ends will use an end cap on a sacrificial section of pipe. This pipe will be tapped in accordance to Table 3 of AWWA C651 or Section 33 11 00 3.17.7 for flushing. These same taps can be utilized to supply water to the future adjacent phase. A shutdown will be facilitated to remove sacrificial sections of pipe and connect adjoining new phase. Alternatively, a valve may be installed, but it will be removed at the developer's expense during commissioning of the adjoining phase.

3.2.4.1 Pressure Reducing Valves

Pressure reducing valves are to be installed as required to maintain acceptable pressures within pressure zones in the Water System.

3.2.4.2 Air Relief & Vacuum Valves

Air relief and vacuum valves are to be installed, in manholes, at all significant high points in the distribution system and at such other locations as required for efficient operation of the Water System.

3.2.5 Fire Hydrants

The *Supplement Standard Specifications* provides fire hydrant details for urban and rural installations.

3.2.5.1 Fire Hydrant Location

Fire hydrants spacing as per the Section 3.2.2.5 Fire Hydrant Spacing in these specifications. The layout of the hydrants within the Water System must consider the following criteria:

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

.2 Locate hydrants a minimum 1.8 metres from the edge of a driveway flare and minimum 3.0 metres from a utility pole, transformer, or utility junction box, refer to *Supplementary Standard Specifications* for Standard Details.

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

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

.5 Dead end mains require a hydrant to permit flushing of the distribution system.

3.2.5.2 Fire Hydrant Connection to Water Main

Fire hydrant leads are 150 mm in diameter and include a 150 mm hydrant valve connected directly to the main with a hydrant anchor tee. For greater thrust protection, the hydrant is to be mechanically restrained from the valve to the hydrant. Where the hydrant lead is the extension of a dead end main, the Design Engineer must specify the minimum required restrained length to provide thrust restraint. All fire hydrants and valves require a Zinc 24-48 anode

3.2.5.3 Fire Hydrant Product Consistency in Subdivisions

Hydrant models to be installed as part of new subdivision development or system extensions are to be consistent for that approved development phase or system extension limit.

3.2.6 Water Service Connection

3.2.6.1 Water Service Connection General Requirements

The following are the requirements for Water Service Connections:

.1 Every building is required to be connected separately to the mains from any other building, with the exception of an ancillary building on the same property may be serviced by the same Water Service Connection (National Plumbing Code of Canada).

.2 A single Water Service Connection, from the main line to the property line, to each lot is required for all Halifax Water System extensions.

.3 Minimum 1.6 metres cover.

.4 Maximum 2.0 metres cover.

.5 Minimum 300 mm horizontal and vertical separation from gravity Wastewater and Stormwater Service Connections.

.6 Minimum 450 mm vertical separation when crossing above a Wastewater or Stormwater Service Connection.

.7 Minimum 3.0 metres horizontal separation, separate trench, from a pressurized Wastewater Service Connection.

.8 Minimum 3.0 metres horizontal separation from an outdoor fuel tank and septic tank.

.9 Minimum 6.0 metres horizontal separation from septic disposal field.

.10 Minimum 2.0 metres horizontal separation from gas lines, underground electrical / telephone conduit, steam or hot water piping, transformer pads, utility poles or other utilities.

.11 Variance from the requirements outlined above, when it is impossible to obtain the specified separation distances, may be allowed. Where separations of Water Service Connections and Wastewater or Stormwater Service Connections cannot be met, the Wastewater or Stormwater Service Connections materials are to be water class and pressure tested to 1000 kPa (145 Psi) for water tightness. The pressure test is not required on residential service connections.

3.2.6.2 Water Service Connection Pressure

.1 In lower elevation areas of the Municipality, the pressure in the Water System is higher. Where the calculated pressure in the pressure in the Water Service Connection at the building floor elevation exceeds 550 kPa (80 Psi), the Applicant is to provide a pressure reducing valve, at no cost to Halifax Water.

The pressure reducing valve is to be installed prior to the water meter.

For multi-unit, industrial, commercial and institutional uses, it is the responsibility of the Design Engineer to account for the pressure in the Water System in the design water meter and backflow prevention device arrangement.

.2 In higher elevation areas of the Municipality, the pressure in the Water System is lower. Where the calculated pressure in the pressure in the Water Service Connection at the building floor elevation is lower than 275 kPa (40 Psi), the Engineer will recommend a booster pump be installed. The Applicant is responsible to hire a qualified professional to size, specify and install the booster pump at no cost to Halifax Water.

The booster pump, within a bypass arrangement, is to be installed after the water meter and backflow prevention device.

3.2.6.3 Water Service Connection 50 mm & Smaller

In addition to the general requirements, Water Service Connections 50 mm and smaller requires the following:

.1 Shut-off valve (curb stop) to be located within the right-of-way, 300 mm from the boundary. In areas where a public sidewalk exists, locate shut-off valve 1.0 metres from the sidewalk, and provide a minimum 1.0 metre easement, in all directions, around the shut-off valve.

.2 All Water Service Connections to be fitted with Zinc 24-48 anode.

.3 All Water Service Connections are to be installed polyethylene water service connection insulation.

.4 No joints between the shut-off valve and the building. Services greater than 20 metres are permitted one compression fitting every 20 metres.

.5 A Water Service Connection greater than 120 metres (394 feet) in length from the public right of way or public easement boundary requires the water meter and backflow prevention device be installed in a private meter chamber, on private property, adjacent to the right-of-way or easement boundary.

.6 All Water Service Connections connecting to the Water System are to be tapped by Halifax Water Operations. All parts and materials supplied by the Applicant.

.7 Rigid polystyrene insulation of Water Service Connections is required in the following situations:

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

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

   c. All situations where the service connection is considered to be at risk of freezing as determined by Halifax Water Operations.

   d. Where a Water Service Connection is crossing a ditch with a minimum of 1.2 metres of cover.

.8 The standard minimum domestic Water Service Connection sizing to be as follows:

- 19 mm copper Type K
- 25 mm copper Type K where the Water System pressure is less than 345 kPa (50 Psi) or the setback is greater than 30 metres
- 25 mm for all PEX-a installations
- 25 mm copper Type K or PEX-a for all new ICI installations

.9 Maximum velocity is 4.5 m/s in a Water Service Connection.

.10 Locate public portion of Water Service Connections, including curb stops, 1.5 metres from driveways.

3.2.6.4 Water Service Connection 100 mm & Greater

In addition to the general requirements, Water Service Connections 100 mm and greater require the following:

.1 Where a Water Service Connection stub is not available, a new tee and valve is required to be installed. The method of installation (cut in or tapping tee) will be determined by Halifax Water through the permitting process, considering the connection point and impact to the system. The installation requires disinfection as per the *Supplementary Standard Specification*s.

.2 All Water Service Connection valves in the right-of-way require a Zinc 24-48 anode.

.3 All pipe and fittings to be installed with polyethylene encasement.

.4 A Water Service Connection greater than 120 metres (394 feet) in length from the public right of way or public easement boundary requires the water meter and backflow prevention device be installed in a private meter chamber, on private property, adjacent to the right-of-way or easement boundary.

.5 The installation of a private fire hydrant off a Sprinkler Service Connection requires adherence to the National Building Code of Canada. The fire department connection to a hydrant is not more than 45 metres and is unobstructed.

.6 Private fire hydrants are to be installed such that the hydrant lead is connected to the Sprinkler Service Connection 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 a Halifax Water approved water meter, Halifax Water will supply a water meter to be installed on the detector assembly's bypass.

.7 Water Service Connections in a master meter arrangement require a private meter chamber, on private property, adjacent to the right-of-way or easement boundary.

3.2.6.5 Water Service Connection Abandonment

Halifax Water requires Water Service Connections to be abandoned at the main for all Municipality Demolition Permits. The method and extent of abandonment depend on conditions specific to the Water Service Connection and will be determined through the permitting process.

3.2.6.6 Water Service Connection Reutilization

An existing Water Service Connection may be reused subject to all of the following conditions being met:

.1 The proposed land use and building size is known.

.2 The Water Service Connection is of adequate size and meets current pipe material specifications.

.3 Halifax Water confirms the condition of the Water Service Connection warrants reuse.

3.2.7 Water Meter

The Halifax Water Regulations state all Water Service Connections to the Water System are required to be metered. For new connections, the installation of a water meter is triggered by a Municipality Building Permit Application, or a Halifax Water *New Service & Renewal Application* for existing premises. The requirement for a water meter applies to:

- New Water Service Connections for new building construction
- New Water Service Connections for an existing building
- Temporary Water Service Connections for buildings under construction
- Temporary Water Service Connections for events
- Seasonal Water Service Connections

The design requirements for water meter arrangements can be found in the *Water Meter & Backflow Prevention Device Design & Installation Manual*.

A Water Service Connection that is set back 120 metres or greater from the public right of way or public easement boundary requires the water meter and backflow prevention device be installed in a private meter chamber, on private property, adjacent to the right-of-way or easement boundary.

3.2.8 Cross Connection Control Program

The Cross Connection Control Program utilizes premise isolation to minimize the risk of contaminants entering the Water System from the premises through backflow. Backflow can occur if water is siphoned from premises due to a reduction in pressure in the distribution system or as a result of pressurized equipment being used on the premise.

All multi-unit residential, industrial, commercial and institutional uses require a backflow prevention device on the Water Service Connection and Sprinkler Service Connection.

The design requirements for backflow prevention device arrangements can be found in the *Water Meter & Backflow Prevention Device Design & Installation Manual*.

3.3 WATER BOOSTED SYSTEM DESIGN

3.3.1 Booster Station Submission

When proposing a water booster station, include the following in the design submission:

.1 Civil drawings,
.2 Mechanical drawings,
.3 Electrical drawings,
.4 Architectural drawings,
.5 Pump information,
.6 Design report,
.7 Sewershed boundary serviced by pumping station,
.8 System curves,
.9 Station configuration, and;
.10 Program ladder.

3.3.2 Booster Station Design

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 booster station is 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 booster 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 demand periods. In the case of fire flows, the minimum pressure is 150 kPa (22 Psi) in the water main.

In an in-line booster station, the pressure on the suction side of the fire pump is to be designed not to drop below 150 kPa (22 Psi) when there are Water Service Connections on the suction side of the 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 Average Day Demand specified herein is to be used.

3.3.2.1 Booster Station Site Considerations

.1 The booster station is to be on its own property, deeded to Halifax Water prior to commissioning.

.2 Grade the booster station land to prevent ponding of water.

.3 All exposed areas are to be sodded.

.4 Property may require a 2.44 metres security fence depending on site conditions. Confirm with the Engineer.

.5 Driveway subgrade is to be specified by the Design Engineer. The base gravels are to be 150 mm of Type 2 gravel, 150 mm of Type 1 gravel and 75 mm of asphalt to a minimum width of 3.5 metres, and a minimum length of 7.5 metres.

3.3.2.2 Booster Station Safety Precautions

.1 Take into account all applicable Municipal, Provincial and Federal regulations including the Occupational Health and Safety Act when designing the booster station from a safety perspective. Eliminate all confined spaces.

.2 Protect all equipment with guards to prevent accidental contact. Provide all equipment with lock-outs to confirm the equipment is out of service when maintenance is being carried out.

.3 Equip diesel generator fuel supply lines with fusible link valves. Fuel lines between the generator and the fuel supply are to be located in appropriately sized sleeves cast into the station floor.

3.3.2.3 Booster Station Building

.1 The booster station building is to be sized to accommodate the pumps, pump motors, control panel, auxiliary power supply, fuel supply tank, and other accessories. Safety and ease of maintenance are to be considered in the design.

.2 A Booster Station is categorized as a Post-Disaster Building by the National Building Code of Canada and is required to be designed accordingly.

.3 No windows in any exterior wall.

.4 Adequate ventilation for all mechanical equipment provided by vandal resistant, insulated, heavy duty type steel intake and exhaust louvers.

.5 Engine emissions are to be directed away from the building so as not to create a ventilation "short circuit".

.6 Design the louver system to prevent a negative pressure situation within the building. Make provision to support wall-mounted equipment inside the building. The building is to be designed “secure”.

.7 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.

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

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

.10 Doors swing outward to open and panic hardware should be installed for emergency exit. All hinge pins on doors to 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 keyed to Halifax Water standard system.

.11 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.

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

3.3.2.4 Booster Station Electrical & Auxiliary Power

Provide Short Circuit, Protection Coordination and Arc-Flash studies as described below. Reports are to be prepared, signed and stamped by a Professional Engineer (P.Eng.) licensed to practice in Nova Scotia.

.1 Short Circuit Study – Perform a Short Circuit Study to ensure that all electrical equipment has an interrupting capacity that exceeds the calculated short circuit levels throughout the facility.

.2 Protection Coordination Study – Perform a Protection Coordination Study to ensure circuit protective devices such as protective overcurrent trips, starters, relays and fuses are installed to recommended values and settings. The Protection Coordination Study shall include Protection Coordination Sheets for both phase and ground fault overcurrent protective devices and recommended overcurrent settings for all adjustable circuit breaker trip units, motor circuit protector trip units, motor overloads and power distribution fuses. All overcurrent devices are to be properly coordinated.

.3 Arc Flash Hazard Analysis & Study – Perform an Arc Flash Hazard Analysis in accordance with the procedures stated in CSA Z462, “Workplace Electrical Safety” and in conjunction with the short circuit and protective device coordination studies. Provide and install appropriate warning labels to each piece of distribution equipment identified in the Arc Flash Hazard Analysis. Labels to include information in conformance with CSA C22.1 – Canadian Electrical Code Part 1, and CSA Z462 – Workplace Electrical Safety, Section 4.3.5.7 – Equipment Labelling, and Annex Q, Subsection Q4 – Detailed Electrical Hazard Information Label, and including but not limited to the following information:

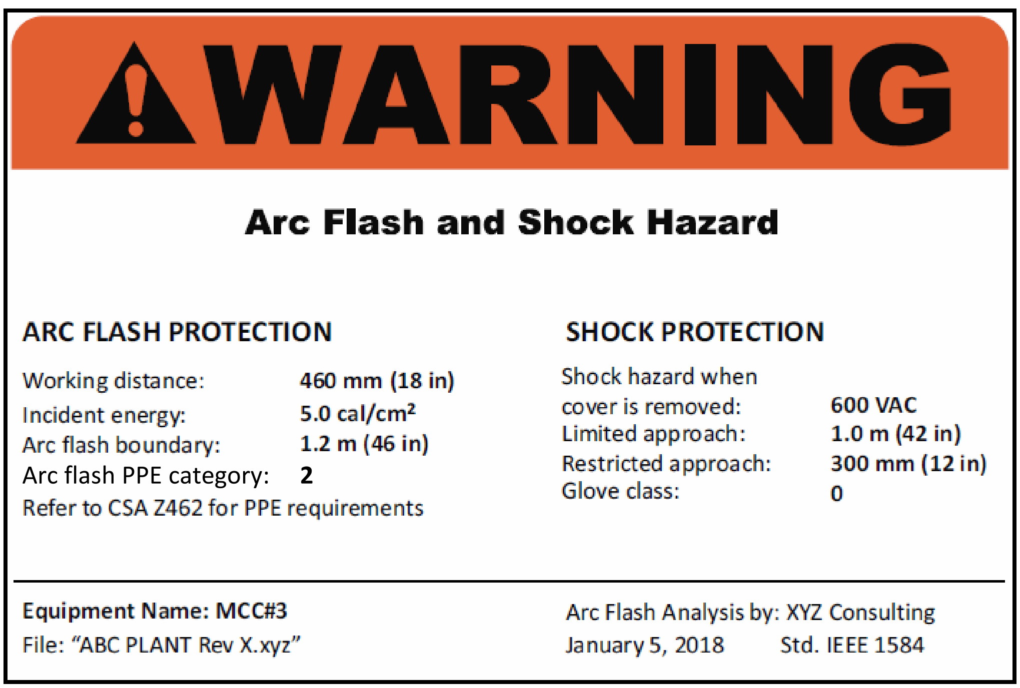
A. Arc Flash Protection
   i. Working Distance
   ii. Incident Energy
   iii. Arc Flash Boundary
   iv. Limited Approach Boundary
   v. Restricted Approach Boundary

B. Shock Protection
   i. Shock hazard when cover is removed
   ii. Arc Flash PPE Category
   iii. Glove Class

C. Project Details
   i. Facility Name
   ii. Equipment Name
   iii. File References
   iv. Arc Flash Analysis by: *Consultant's Name*
   v. Date of Arc Flash Analysis
   vi. Standard Reference (e.g. CSA Z462-18, IEEE 1584)

An example of a combined arc flash and shock warning label and a detailed electrical hazard information label is provided in Figure 3.1.

Figure 3.1 - Example of an Arc Flash and Shock Warning Label



Provide three-phase power supply to the booster station. Design and installation of the power supply system to meet all applicable and relevant standards and codes.

Electrical meter base must be installed in an accessible location 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

For pumping systems, all electric motors shall be premium efficiency motors. Motors intended for use with Variable Frequency Drives (VFDs) shall be "Inverter-Duty" rated motors. All motors shall be 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 is required to have a separate lockable disconnect switch for isolation of the motor power supply without affecting the remaining system operation.

U.S. Motor or equivalent as approved by the Engineer

All electrical apparatus are to be located in an accessible location above grade with a clear access of 1.0 meter around all pumps and motors. All panels and controls are to have NEMA 4 enclosures.

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

Booster Station must contain at least the following:

- Electric unit heater(s) controlled via a separate tamper proof wall mounted thermostat.
- Adequate vapour-proof LED lighting.
- A single outside vandal-proof LED light, with integral photo-electric cell control, adjacent to or over the access door.
- A weather proof lighting 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. Ventilation to be controlled via thermostat and occupancy control via lighting switch, with the lighting switch control overriding the temperature controls. Thermostat to be tamper-proof, suitable for the environment, and set to control the ventilation system to provide a maximum internal temperature of 25 °C (ventilation "ON").

Full stand-by power supply to be provided utilizing a standby diesel generator set. The power generating system is to be capable of providing continuous electric power during any interruption of the normal power supply. The stand-by power unit is to 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 is to include the following items:

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

3.3.2.5 Booster Station 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 is required to be developed:

- Average Day Demand
- Maximum Day Demand
- Peak Hour Demand (p.m.)
- Peak Hour Demand (a.m.)
- Minimum Hour Day

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.

Select pumping equipment 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, have the manufacturer's representative certify the pump was correctly installed.

.1 Booster Station Domestic Pumps

Each booster station will have a minimum of three (3) domestic pumps (one lead/jockey pump and two lag pumps). Size the pumps such that the capacity of the booster station is calculated with the largest domestic pump out of service and full build-out of the development achieved:

- 80% of Peak Hour Demand for pumped systems.
- 100% of Maximum Day Demand for systems with elevated storage.

Pumps are to have the following service capability:

- Lead pumps provide a maximum of 25 percent of peak instantaneous demand and provide an adequate supply during normal periods of domestic demand.
- Lag pumps are to provide a maximum of 55 percent of peak instantaneous demand, provide an adequate supply to meet Peak Hour Demand periods, and provide an adequate supply in the event of failure of the lead pump.

.2 Booster Station Fire Pumps

The fire booster pump are required to have adequate capacity to supply the necessary fire flow demand as indicated in 3.2.2 of these specifications.

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

3.3.2.6 Booster Station Mechanical

Suction and discharge piping are to be designed and arranged to provide easy access for maintenance.

All piping and tubing is to be stainless steel, Type 304 or 304L, 11 gauge. For piping larger than 100 mm diameter, ductile iron, class 54, cement lined with asphaltic seal coat may be used as an alternative. Threaded flanges are to be utilized for all joints, fittings and connections within the station.

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

Piping systems are to 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 booster station and designed 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 booster station.

A hydraulic transient analysis is to 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 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.

3.3.2.7 Booster Station SCADA & Controls

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

The control panel is to 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

- The pump controller is to 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 Halifax Water communication panel in a single read via Modbus RTU protocol. All PLC programming and operator interface screen programming must be coordinated with Technical Services. All PLC and OIT programming complete with documentation must be provided to Technical Services 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 is to be capable of providing:

- Uninterrupted fully automatic operation of the booster 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. Pressure gauges, complete with isolation ball valves, installed on the suction side and on the discharge side of the pumps.

3.3.2.8 Booster Station Pipe Testing

All station process piping (from the pumps to the distribution system connections) is to be hydrostatically tested. Piping must maintain a minimum pressure of 1035 kPa (150 Psi), 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.

3.3.2.9 Booster Station 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 Design Engineer and Technical Services as necessary. The SCADA tag list is to be provided to Technical Services at least two weeks prior to booster station start-up to allow Technical Services sufficient time to program SCADA.

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

.1 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;

.2 a full itemized list of technical difficulties encountered during start-up and their resolutions.

The following personnel are to be present at the booster station start-up:

- Contractor (Lead)
- Subcontractors
- Suppliers
- Design Engineer
- Technical Services
- Water Service (as necessary)

3.3.2.10 Booster Station Commissioning

Booster Station commissioning occurs after successful completion of booster station 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 Design Engineer has reviewed and accepted this information, provide the Engineer with formal confirmation the booster station is ready for commissioning. The Design Engineer is to schedule commissioning dates a minimum of two weeks in advance, subject to availability of all parties.

During booster station commissioning, the contractor demonstrates to the Design Engineer and Technical Services that all equipment and systems function properly and are in accordance with the project documents. The Design 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 is to cover the following:

- Full Input / Output listing and their function
- Full list of equipment and system set points
- 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 (i.e. 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, i.e. open the line power main disconnect switch
  - conducting a load bank test - 100% load for 6 hours

The Contractor is to 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 Applicant's Design Engineer and Technical Services will be present to witness booster station commissioning and will liaise with, and call to the site, other Halifax Water staff as necessary.

It is fully expected that all equipment and systems have been started successfully during booster station start-up and operate in accordance with the project documents. This ensures efficient use of resources during commissioning (i.e. Technical Services and Design 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 Design Engineer may, at their discretion, terminate the commissioning process and instruct the contractor to complete the booster station start-up and re-schedule booster station commissioning.

The following personnel are to be present at booster station commissioning:

- Design Engineer (Commissioning officer as lead)
- Contractor
- Subcontractors
- Suppliers
- Technical Services
- Other Halifax Water Staff (as necessary)

3.3.2.11 Booster Station SCADA Commissioning

SCADA commissioning occurs after successful completion of booster station commissioning. During SCADA commissioning, all communications will be verified between the local PLC and RTU and between the local RTU and Halifax Water's HMI. Under direction from Technical Services, the Contractor is to 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 are to be present at SCADA Commissioning:

- Technical Services (lead)
- Contractor
- Subcontractors (as necessary)
- Suppliers (as necessary)
- Design Engineer

3.3.2.12 Booster Station Training

After successful commissioning, the contractor or the Design Engineer provides training for Halifax Water Operations in the proper operation of the booster station. Training includes: safety orientation, system description, identification of all individual pieces of equipment and explanation of their purpose; review of control logic, sequencing and set points 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 booster station; identification and explanation of equipment and system limitations; identification and explanation of spare parts and special tools.

Following booster station training, the contractor is to allow for additional programming adjustments to operator interfaces as directed by the Engineer.

The following personnel are to be present at booster station training:

- Contractor (may act as lead)
- Design Engineer (may act as lead)
- Subcontractors (as necessary)
- Suppliers (as necessary)
- Halifax Water Operations

3.3.2.13 Booster Station Commissioning Report

Following successful completion of commissioning and training, the Design Engineer is to provide a detailed booster station commissioning report complete with certification that the booster station 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 booster station meet design intent, are operating within specified parameters and are ready for intended use

3.3.2.14 Booster Station Operations & Maintenance Manual

The Design 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 booster station operation and maintenance manual, in a form acceptable to Halifax Water Operations. The manual must contain the following items in same general order:

- Title Page including:
    - identification of document as an operations & maintenance manual
    - booster station name
    - booster station Contractor
    - booster station 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 booster station:

    - 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
- Booster station design intent, parameters and limitations (i.e. 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
- Booster station 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 booster station 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 are to be taken at various angles showing the main features of the inside and outside of the booster station. A plan index is to be provided showing location and angle of each photo in relation to the booster station.

4.0 WASTEWATER SYSTEM – DESIGN REQUIREMENTS

4.1 SCOPE

A Wastewater System is a complete and properly functioning system of wastewater mains, service connections from the wastewater main to the street lines and appurtenances, including pumping stations and force mains. The design will ensure that Wastewater and Stormwater Operations are not exposed to hazards when conducting operation and maintenance of the wastewater collection system.

All Wastewater Systems are to conform to any requirements established by NSE. Wastewater Systems cannot be constructed until the design has been approved by the Engineer.

Wastewater discharged into the Wastewater System must comply with *Halifax Regional Water Commission Act*, Halifax Water Regulations and applicable bylaws.

Wastewater System extensions must be carried out in conformance with a Wastewater Master Plan prepared for the wastewater sewershed in which the extension is to take place. The Wastewater Master Plan is to identify major infrastructure such as trunk sewers, wastewater mains, pumping stations, hydraulic system design calculations and operational information.

For an extension to the Wastewater Systems, the Engineer will require the Applicant to enter into a Halifax Water Systems Agreement which defines the rights and obligations of Halifax Water and the Applicant regarding construction, inspection, record collection, acceptance and warranty of the new Wastewater System.

Halifax Water owns and operates various infrastructure whose operation can be impacted by the tide level of the Atlantic Ocean. These impacts can result from normal tidal fluctuations or from storm surges and wave run-up. Halifax Water infrastructure should also be resilient to adapt to sea level rise as a result of climate change throughout the life cycle of the infrastructure.

As a result, Halifax Water has developed a plausible upper bound flooding scenario of 4.86 meters (CGVD2013). It is recognized that for some infrastructure, the impact of temporary flooding due to storm surge is negligible and therefore low risk. In other instances the impact of a short duration flood can be catastrophic.

For any infrastructure to be installed below 4.86 meters (CGVD2013), The Design Engineer is to provide a statement for how the infrastructure still provides an acceptable level of service.

High High Water Level (HHWL):	0.73 metres (CGVD2013)
Sea level rise as a result of climate change:	1.50 metres
Storm surge and wave run-up:	2.63 metres
Total:	4.86 metres (CGVD2013)

4.2 WASTEWATER COLLECTION SYSTEM DESIGN

4.2.1 Wastewater Demand

Design the Wastewater System 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 are to be included in the design flow calculations.

The Wastewater System is to 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.

Design the Wastewater System to accommodate the Average Dry Weather Flow:

- Average Dry Weather Flow 300 litres / person / day

Refer to the permitted land uses under the Municipality Municipal Planning Strategy (MPS), Land Use Bylaw (LUB), or approved Development Agreement for a specific area. When determining site populations, refer to numbers below:

- Single unit dwellings 3.35 people / unit
- Semi-detached & townhouse 3.35 people / unit
- Multi-unit dwellings 2.25 people / unit

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

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 Engineer will determine the limits of the downstream analysis.

4.2.2 Hydraulic Design

The design flow q (L/s), in the wastewater system is calculated as follows:

$$q = \frac{[1.25 \times (a \times M)] + (b \times area)}{86.4}$$

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

where:

1.25	is the safety factor.
a	identified here as the average dry weather flow. The allowance is 0.30 m^3/person/day for residential development.
M	is the peaking factor as derived from the Harmon Formula. The minimum permissible peaking factor is 2.0.
b	is the future degradation of pipe long-term infiltration/inflow allowance. The allowable is 24 m^3/hectare/day.
area	in hectares.
P	is the design population in thousands.
(a × M)	is the peak dry weather flow.
(a × M) + b	is the peak design flow to be utilized for the design of wastewater pumping stations and their force mains.

4.2.2.1 Minimum Velocity

The minimum peak design flow velocity under full development or any phase of development is 0.75 m/s.

4.2.2.2 Maximum Velocity

The maximum peak design flow velocity is 4.5 m/s. A higher flow velocity (up to 6.0 m/s) may be considered if adequate energy dissipation and ventilation is achieved

4.2.2.3 Friction Factors

.1 The following are Manning Roughness Coefficients:

Table 4.1 - Manning Roughness Coefficients

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

Calculate the gravity flow in Wastewater Systems using the Manning's Formula or other approved method, with allowances made for energy losses at inlets, manholes, junctions, outlets, etc.

4.2.2.4 Wastewater Main Size

- Minimum size for a wastewater main is 250 mm.
- No decrease in wastewater main size from upstream to downstream.

4.2.2.5 Wastewater Main Grade

- Minimum grade 0.6 %
- Minimum grade in cul-de-sacs 0.8%

Minimum grades must provide self-cleansing velocity of 0.6 m/s based on peak dry weather flow for the area to be serviced in the initial phase of the development.

4.2.3 Wastewater Main

4.2.3.1 Hydrogen Sulfide

.1 Design the Wastewater System to minimize hydrogen sulfide conditions. Minimize the use of drop manholes and precautions to reduce turbulence, and a reasonable retention time in pumping stations.

.2 Utilize corrosion resistant materials where hydrogen sulfide conditions are unavoidably high the Wastewater System. Refer to Halifax Water Regulations for limits for discharge to wastewater facilities.

4.2.3.2 Wastewater Main Material

.1 Polyvinyl Chloride (PVC) pipe and fittings type PSM to CSA B1800.

.2 Reinforced concrete pipe to ASTM C76M or CSA A257.2, used only in large diameter applications as approved by the Engineer.

.3 Polyethylene pipe and fittings to AWWA C901 or AWWA C906, used only in special circumstances as approved by the Engineer.

.4 Polypropylene pipe and fittings to AWWA C901 or AWWA C906, used only in special circumstances as approved by the Engineer.

Calculate the earth loads and the effects of concentrated and distributed superimposed (live) loads on the 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.

Take into account the width and depth of trench, backfill, bedding materials and a 1.5 safety factor when calculating the strength/class of pipe to be utilized.

4.2.3.3 Wastewater Main Cover

.1 Minimum cover is 1.6 metres.

.2 Maximum cover is 5.0 metres.

Measure the depth of cover from the finished surface design grade over the pipe to the crown of the wastewater main.

Under special conditions (e.g. elimination of a pumping station), the maximum depth of the pipe may be increased. Wastewater Service Connections deeper than 5.0 metres at the connection to the wastewater main are not permitted. The situations would require a wastewater rider system.

4.2.3.4 Wastewater Main Location

.1 Install wastewater mains at a design grade to avoid localized high points in the same trench as the gravity Water and Stormwater Systems. The location of the wastewater mains and service connections relative to Water and Stormwater Systems are to meet the minimum requirements of NSE. Install wastewater mains at least 3.0 metres horizontally from any existing or proposed Water System and 1.5 metres horizontally from any existing or proposed Stormwater System. If this separation cannot be achieved, wastewater mains are permitted to be installed closer to gravity Water or Stormwater System, provided that:

- The water main is installed in a separate trench;
- Or installed on an undisturbed earth shelf located on one side of the Wastewater or Stormwater Systems and maintains a minimum 500 mm horizontal and a 300 mm vertical separation.

.2 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 is to be relocated to provide this separation. Indicate catch basin lead inverts on the drawings to facilitate checking of clearances.

.3 When it is not possible to obtain proper horizontal and vertical separation as stipulated, the Wastewater and Stormwater Systems are to be water class and pressure tested to 1000 kPa (145 Psi) for water tightness.

.4 The wastewater mains are to be installed in a straight line within the travelled way portion of the street right of way and a minimum of 1.5 metres from the face of the curb. On existing streets without curb and gutter the wastewater main may be installed within the gravel shoulder area.

.5 Wastewater mains are to maintain a minimum 2.0 metres horizontal separation from permanent underground and above ground infrastructure / structures. This applies to electrical or telephone conduit, steam or hot water piping, transformer pads, utility poles, signs or other utilities.

.6 Water mains are required to maintain horizontal and vertical separation from gas lines depending on water main size.

.7 All Wastewater Systems are to be located within the Municipality street right-of-way. Wastewater Systems on private property will be considered at time of design review, and will require an easement agreement jointly signed by the land owner and the Halifax Water Board. Where a need is identified to facilitate future development on the adjacent lands, Wastewater Systems, are required to be extended to the midpoint of the frontage of the last lot as per the Municipality Regional Subdivision By-law. A Halifax Water service easement shall be of sufficient width to allow safe excavation of the Halifax Water Systems in accordance with the requirements Occupational Health and Safety Act of Nova Scotia. Depending upon the length and location of the service easement, the Engineer may require a travel way to be provided within the Halifax Water service easement for access and maintenance purposes.

.8 Where Master Planning indicates a need to accommodate future upstream lands naturally tributary to the sewershed, a service easement is to be provided from the edge of the street right-of-way to the upstream limit of the subdivision. Refer to Section 6.0 for Halifax Water easement requirements.

.9 Where a need is identified to facilitate future development on the adjacent lands, Wastewater Systems, are required to be extended to the midpoint of the frontage of the last lot as per the Municipality Regional Subdivision By-law.

4.2.3.5 Wastewater Main Crossing

Where any Wastewater / Stormwater System pipe crosses any other Wastewater / Stormwater System, the minimum vertical separation is 150 mm, measured from outside diameter to outside diameter.

4.2.3.6 Wastewater Main 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.

4.2.4 Wastewater Manhole

4.2.4.1 Wastewater Manhole Spacing & Location

Generally, the maximum allowable horizontal spacing between wastewater manholes holes is as follows:

Table 4.2 – Wastewater Manhole Spacing

Wastewater Main Size	Maximum Spacing
250 mm to 450 mm	Up to 100 metres
Greater than 525 mm	Up to 150 metres

.1 Locate wastewater manholes at each change in alignment, pipe size, grade or material, and at all junctions with Wastewater Service Connections 250 mm and larger.

.2 Larger diameter wastewater mains may be permitted to utilize a greater spacing.

.3 Do not locate wastewater manholes in areas subject to flooding or roadway low points.

.4 Where wastewater manholes are located outside of the paved street limits, or in a gravel shoulder provide an asphalt apron.

4.2.4.2 Wastewater Manhole Sizing

.1 All sizing of precast wastewater manholes holes are based on inlet and outlet pipe sizes and will be sized as per the Standard Detail. The minimum diameter for wastewater manhole is 1050 mm.

.2 Specify the type and size of wastewater manhole on the profile drawing.

.3 When any dimension of a wastewater manhole hole differs from the specifications, the wastewater manhole will be individually designed and detailed.

4.2.4.3 Wastewater Manhole Frame and Cover

.1 Wastewater manholes require adjustable manhole frames when placed within asphalt and concrete surfaces. Manhole covers, with Halifax Water logo, require one vent hole for air testing and removal of cover.

.2 Wastewater manholes not located within asphalt and concrete surfaces require a cover, with Halifax Water logo, equipped with a locking system.

.3 Wastewater manhole frame and cover will be clear of curb and gutters and clear of bends in the road for new construction.

.4 All wastewater manhole chamber openings will be located on the upstream side of the wastewater manhole.

4.2.4.4 Wastewater Manhole Drop Structure

A drop wastewater manhole is required when the vertical drop between any inlet pipe invert and the outlet pipe invert exceeds 1000 mm. Minimum inside width clearance within internal drop wastewater manholes is 1000 mm. When the inlet pipe exceeds 375 mm use an external drop wastewater manhole. Refer to the *Supplementary Standard Specifications* for the standard details related to both of these arrangements.

4.2.4.5 Wastewater Manhole Benching

Wastewater manholes are required to be benched. Benching starts two thirds the height of the pipe and slope upwards at a slope of 4:1. Benching within wastewater manholes is to incorporate half pipe channels to direct the flow from inlet pipes or connections to the outlet pipe with as long a radius bend as possible.

4.2.4.6 Wastewater Manhole Hydraulic Losses

Suitable drops are to be provided through the wastewater manhole to compensate for the energy losses due to the change in flow velocity and to accommodate the difference in depth of flow in the upstream and downstream pipes. When the pipe size does not change through a wastewater manhole and the upstream flow velocity does not exceed 1.5 m/s, the following allowances will be made to compensate for hydraulic losses.

Table 4.3 – Hydraulic Losses

Wastewater Main Deflection	Inlet / Outlet Invert Difference
0°	50 mm
1° to 45°	60 mm
46° to 90°	75 mm
Junctions and Transitions	Minimum 100 mm
91° and Greater	Not Permitted

Note: For all junctions and transition maintenance holes and when the upstream flow velocity exceeds 1.5 m/s, the drop required will need to be calculated. Calculations for hydraulic losses will be included in the design submission.

4.2.4.7 Wastewater Manhole Connections

.1 Connections to wastewater manholes are permitted to be a maximum depth of 3.0 metres.

.2 A maximum of two (2) Wastewater Service Connections are permitted to connect to a wastewater manhole.

.3 Flexible rubber connectors can be used for connecting pipe to wastewater manholes. Rubber connectors are either cast-in-place during manufacture of the pre-cast product or installed into a cored or preformed hole in the finished wastewater manhole. Wastewater pipe connections are to be grouted within the manhole around the entire outside of the pipe. Pipe connections set in benching are also to be grouted to provide a smooth transition from pipe to manhole.

.4 Pipe connections to wastewater manholes must not protrude more than 25 mm from interior wall.

4.2.5 Wastewater Service Connection

4.2.5.1 Wastewater Service Connection General Requirements

The following are the requirements for Wastewater Service Connections:

.1 Every building is required to be connected separately to the mains from any other building, except that an ancillary building on the same property may be serviced by the same Wastewater Service Connection (National Plumbing Code of Canada).

.2 A single Wastewater Service Connection to each lot is required when extending Halifax Water Systems. Extend the Wastewater Service Connection at least 1.5 metres inside the property line. Cap the bell end of the Wastewater Service Connection with a PVC cap.

.3 Break the rock 3.0 metres beyond the plugged end of the Wastewater Service Connections.

.4 Minimum 2% grade.

.5 Maximum 8% grade.

.6 Minimum 1.2 metres cover.

.7 Wastewater Service Connection 200 mm or smaller are to connect to the wastewater main utilizing a factory tee or wye fittings. Saddle Connections utilizing flexible rubber connectors may also be used. Utilize vertical long radius bend of 45° at the wastewater main.

.8 Wastewater Service Connection 250 mm or greater connect to the wastewater main utilizing a precast wastewater manhole.

.9 Wastewater Service Connections are not permitted to be connected to a dead end wastewater manhole. Make connection into the wastewater main or a wastewater manhole downstream of the dead end wastewater manhole.

.10 One horizontal, long radius 22½° bend is permitted along the length of a Wastewater Service Connection. If more than one bend or a bend greater than 22½° is required, an access type structure is to be installed at each additional bend.

.11 Wastewater Service Connections smaller than 200 mm and an overall length greater than 25.0 metres require an access type structure every 25.0 metres. Place a 300 mm x 300 mm x 6 mm steel plate above the structure 150 mm below the ground surface to allow for detection by a metal detector.

.12 Wastewater Service Connections 200 mm or greater require manholes for changes in direction and maximum spacing of 100 metres.

.13 Wastewater Service Connections are not permitted to decrease in size from the building connection to the main.

.14 Minimum 300 mm horizontal and vertical separation distance from a Water Service Connection.

.15 Minimum 450 mm vertical separation when crossing below a Water Service Connection.

.16 Minimum 3.0 metres horizontal separation from an outdoor fuel tank.

.17 Minimum 2.0 metres horizontal separation from gas lines, underground electrical / telephone conduit, steam or hot water piping, transformer pads, utility poles or other utilities.

.18 One PVC coupling is permitted along the length of the Wastewater Service Connection prior to where it enters the building. Minimum 2 meter length of pipe is required on either side of the coupling for this section.

.19 One additional PVC coupling is permitted between the in-line tee at the main and the long radius bend of the Wastewater Service Connection.

4.2.5.2 Wastewater Service Connection Residential

In addition to the general requirements, Wastewater Service Connection Residential requires the following:

.1 Minimum 125 mm diameter.

.2 Wastewater Service Connections PVC DR28 (white).

.3 Locate the public portion of Wastewater Service Connections 1.5 metres from driveways.

4.2.5.3 Wastewater Service Connection Multi-Unit & ICI

In addition to the general requirements, Wastewater Service Connection Multi-Unit & ICI requires the following:

.1 Minimum 150 mm diameter

.2 Grade less than 2% permitted under the stamp of the Design Engineer.

.3 Wastewater Service Connections PVC DR35 (green).

.4 Locate the public portion of Wastewater Service Connections 1.5 metres from driveways, if possible.

.5 Monitoring Access Point wastewater manhole is required and is to be located on private property, adjacent to the right-of-way.

4.2.5.4 Wastewater Service Connection to a Combined System

For proposed Wastewater Service Connections discharging into a Combined System the Applicant is to provide Combined System capacity analysis to the Engineer.

A meeting between the Engineer, the Applicant and the Design Engineer will take place at which the Design Engineer will provide a development briefing. This meeting will identify the limits of the downstream system that will be part of the Combined System capacity assessment. The downstream system is considered from the site to the nearest regional infrastructure, or a point agreed to by the Engineer.

The Design Engineer is to use the following six times dry weather flow (6DWF) methodology to estimate the theoretical Combined System flow, which will include existing combined flows and the proposed combined development flows, for Combined System being analyzed.

.1 If flow monitoring data is not available:

*Design Flow (q) = 6 * (1.25 * P * a) + I*

where:

1.25 is the safety factor.

P is the Total Population (existing upstream population + proposed development population)

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.

I is the Infiltration (10% of P*a)

.2 If flow monitoring data is available, it is to be used to determine existing Combined System flows and infiltration:

*Design Flow (q) = 6 * (1.25 * (ECSF +* P_d ** a)) + I*

where:

1.25 is the safety factor.

ECSF is the Existing Combined System Flow Recorded, calculated by ADWF – I

P_d is the proposed development population

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.

I is the Infiltration (80% of minimum flows from flow monitoring data)

.3 If the estimated q/Q (Q is the capacity of the main) is ≥ 80% for any main identified, and flow monitoring data was not used (step a), flow monitoring data will be collected and used to re-calculate the total design flows (Step b). The ideal flow monitoring period is April to November.

NB: The 80% trigger represents the confidence associated with an analysis.

.4 If the estimated q/Q is ≥ 80% for any sewer identified in "Step a", and flow monitoring data was used (Step b), the hydraulic model is to be updated with additional infrastructure (as required) and calibrated with new flow monitoring data (as required). The model is then used to assess the design flows for each main identified in "Step a", using a 1:5 year storm.

.5 If the estimated q/Q is ≥ 95% for any main identified with the use of the model, then a capacity deficiency plan of action is required. This study is to be completed by the Design Engineer, and is to consider LID, sewer separation, and main upsizing with respect to feasibility, effectiveness, and cost.

NB: The 95% trigger represents the confidence associated with a modelling analysis.

.6 If the q/Q is sufficient in either "Step c, d, or e", for all sewers identified in "Step a", and the downstream system is not identified as being environmentally sensitive or having existing known constraints (at the discretion of the Engineer), then the application can be accepted.

It should be further clarified that for the application to be accepted, a desktop assessment must yield a q/Q < 80% and a modelling assessment must yield a q/Q < 95%. The difference is due to the more reliable and confident results produced by the model in comparison to the desktop review.

A basic Stormwater System design report must be included with each application to demonstrate that the post-development peak stormwater runoff rate for a 1:5 year storm is less than or equal to that under pre-development conditions, or the existing capacity of the receiving sewer, whichever is less. Pre-development conditions are based on actual pre-development land use, not 'natural' conditions. Any increase in post-development runoff, and how it will be addressed, must be included in the report.

The Design Engineer is required to provide all capacity and flow projection calculations in a form approved by the Engineer. The validity period for building commencement is to be two years from the date of application approval.

4.2.5.5 Wastewater Service Connection Pressurized

.1 Pressurized Wastewater Service Connections minimum of 50 mm PVC DR26 or HDPE DR11 (series 160).

.2 Connect the pressurized Wastewater Service Connection to a wastewater manhole at the property line. This wastewater manhole can also serve as the monitoring access point wastewater manhole. Connect the wastewater manhole to the wastewater main utilizing a gravity connection.

.3 Connection of the pressurized Wastewater Service Connection directly to the wastewater main may be considered by the Engineer. In those cases an isolation valve is to be installed in the right-of-way 300 mm from the property boundary.

.4 Install a trace wire on the pressurized Wastewater Service Connections for location purposes.

4.2.5.6 Wastewater Service Connection Abandonment

Wastewater Service Connections are required to be abandoned at the wastewater main for all Municipality Demolition Permits. The method for abandonment is dependent on the site conditions specific to the Wastewater Service Connection in question. Wastewater Operations will dictate the abandonment method to be used.

4.2.5.7 Wastewater Service Connection Reutilization

An existing Wastewater Service Connection may be reused subject to all of the following conditions being met:

.1 The proposed land use and building size is known.

.2 The Wastewater Service Connection is of adequate size and meets current pipe material specifications.

.3 A Closed Circuit Television video (CCTV) is to be provided to Halifax Water Engineering Approvals confirming the Wastewater Service Connection condition warrants reuse.

4.2.6 Pretreatment Requirements

The Halifax Water Regulations outline the requirements for discharging to Halifax Water's Wastewater and Stormwater Systems. Multi-unit residential, industrial, commercial, and institutional uses may require pretreatment facilities to remove pollutants prior to discharge to the Wastewater or Stormwater Systems.

The design requirements for pretreatment facilities can be found in the *Pretreatment Requirements Manual for Wastewater & Stormwater Systems*.

4.3 PUMPED WASTEWATER SYSTEM DESIGN

Wastewater pump station and force mains represent a long-term financial burden to Halifax Water in terms of operational, maintenance and replacement costs. Where possible, designs are to preclude the need for pump station. Pump station will be permitted only when a gravity system is not physically possible or when the life cycle costs of a gravity wastewater main outweigh those of a wastewater pump station. The design horizon for a new pump station shall be 25 years for mechanical and electrical equipment and 50 years for below grade structures (wetwells, drywells and valve chambers) and 75 years for forcemains and gravity mains.

4.3.1 Pump Station Design

These standards pertain to municipal pump station with a variety of firm capacities; pumping capacity of the station with one (1) of the station's largest pumping units out of service. There are three (3) pump station classifications, based on the firm capacity of the station, as outlined in the following sections: Small, Medium, and Large.

These standards cover the specific requirements for each classification, along with design and operational needs for the pump station. The classifications are defined as follows:

- Small Pump Station (Firm capacity up to 75 L/s).
- Medium Pump Station (Firm capacity between 75 L/s and 220 L/s).
- Large Pump Station (Firm capacity over 220 L/s).

The small pump station is a simple duplex station with single wet well and single valve chamber, as shown in Figure 4.2 in this section.

The medium pump station is made up of two (2) separate wet wells, one (1) shared valve chamber and a slab-on-grade building for electrical components, as shown in Figure 4.3 in this section. The configuration of the medium pump station lends itself well to phased development of pump station capacity.

The large pump station is a wet well / dry well arrangement. Pumps in large stations shall be dry pit - submersible pumps. Typical arrangements for large pump stations are shown in Figure 4.4 in this section.

For special circumstances, a unique pump station configuration may be required due to very large pumping requirements or constraints at an existing site. Any approval for a unique pump station will be at Halifax Water's discretion, and on a case-by-case basis. The design arrangements and specific requirements for the unique station must be fully documented in the Design Report.

These design standards should be read in conjunction with:

- Halifax Water Supplemental Standard Specification Section 33 32 11 – Wastewater Pump Stations; and
- Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment, and Disposal.

4.3.1.1 Design Report

.1 When proposing a wastewater pump station, submit a design report to Halifax Water for review and approval. This design report should provide a high level of information on the background of the proposed pump station project and is to be submitted and approved before proceeding with detailed design. Any changes resulting from the design report review are to be incorporated into a final design report and the subsequent detailed design.

.2 The design report should include, but not be limited to:

   .1 Site location indicated in a lot map of developments.
   .2 All pertinent roads, trails, and paths shall be identified on a surveyed drawing.
   .3 Land use designation.
   .4 Sewer shed details.
   .5 Force main location.
   .6 Site boundaries.
   .7 Topography of surrounding area with notes of drainage paths.
   .8 Location of proposed pump station and manholes with consideration for vehicle access and maneuverability.
   .9 Pump Station general arrangement.
   .10 Main utility secondary voltage (volts), main service size (amps), and total estimated demand (kW).
   .11 Pump selection criteria: Typical pump curves, system curves, operating points, and pump model references shall be identified and provided, where applicable, including but not limited to:

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

.3 Undertake a hydraulic transient analysis to account for water hammer resulting from rapid pressure changes, to support the pump station design. Assess and provide recommendations regarding transient issues. Where required water hammer arrestors shall be included in the design.

.4 NPSH design information, pump curve and system curve for the pumps must be included.

.5 System curves including system head calculations and pump selection curves. Curves shall be provided for the following operating conditions:

.1 C = 100 and low water level in the wet well.

.2 C = 120 and medium water level over the normal operating range in the wet well.

.3 C = 130 and overflow water level in the wet well, where C is the Hazen-Williams flow coefficient.

.3 If flow control or some other control measures are required for proper, efficient operation of the system or downstream systems, provide adequate descriptions of pump control and control philosophy required to meet those requirements.

.4 For each development phase and final development, a description of individual pump capacities, firm pump station capacity, maximum station pumping flow rates (L/s) and force main velocities (m/s).

.5 Force main sizing and hydraulic grade line analysis for each force main (pipe diameter, pipe material, pressure rating, length, elevation difference, and draining flow rate).

.6 Additional storage volume for overflows or other overflow management strategy.

.7 Overflow Data: If the pump station can overflow, provide details of where it would surcharge to e.g. catchment area, manhole(s), or both. If manholes(s) in catchment area are likely to surcharge, provide a map indicating the manhole location(s), local grade level, level to which surcharging may occur, indicate which, if any, sewer laterals are surcharge and indicate the method of overflow measurement.

.8 In situations of phased development, the effects of minimum flow conditions shall be investigated to ensure that the retention time in the wet well(s) will not create an odour or septic problem(s) and that pumping equipment will not operate too infrequently based on manufacturer's recommendations. Phased developments should consider force main size – e.g. 150 mm for initial development levels, 300 mm in 10 years, 600 mm in 25+ years.

.9 Where a gravity wastewater main is possible, but a pump station is provided, show life cycle costs of the wastewater pump station outweighing those of a gravity wastewater main. Life cycle cost shall be based on 50 years for below grade structures, buried pipe work, and conduit and 25 years for all mechanical and electrical equipment.

.10 An assessment of odour potential and a description for odour control systems, if applicable.

.11 Describe temporary (standby/auxiliary) power facilities that will be incorporated into the station.

.12 Furthermore, the report should address all options for servicing the area under consideration and contain a cost/benefit analysis to justify the recommended option. If there are outstanding risks involved with the recommended option, the report should outline how these will be mitigated. The report shall outline any proposed deviations from this standard and the rational for the deviation.

4.3.1.2 Site Considerations

.1 The wastewater pump station is to be on its own property, deeded to Halifax Water prior to commissioning.

.2 Grade the pump station land to prevent ponding of water.

.3 All finished grades of sites and access roads to be safely above 1:100 year flood levels and above tide level of 4.86 metres (CGVD2013) to allow for safe access under all foreseeable conditions.

.4 Areas around the pump station shall have a low maintenance finish, with asphalt provided where possible. Sodded and grassed areas shall be minimized. All non-graveled or asphalt areas are to be sodded.

.5 Pump station site should have a security fence unless site conditions dictate otherwise. Confirm with the Halifax Water Engineer.

.6 Vehicle access and parking space must be provided at the pump station:

   .1 A minimum 4.0m clearance around the station infrastructure is required.

.2 A minimum of two (2) paved parking spaces are required.
.3 Vehicle access road minimum width is 4.0m (13 feet) and road and parking area must be paved.
.4 Pavement structure must be robust enough to handle loads from heavy trucks and shall allow for turn circles, where necessary.
.5 Truck access required around hatches as required.
.6 Allowances shall be made for NSPI truck assess to any pad mounted transformer, in line with their standard conditions.

.7 A turning movement circle to allow site vehicles and sludge trucks maneuver around the site with no difficulty. Sufficient space to be provided to prevent trucks from backing into the site from the road.

.8 Equipment is to be situated to accommodate boom truck access, where required. Allow for surcharged structural loads on foundations if support pads are required for large boom trucks.

4.3.1.3 Safety Precautions

.1 All applicable Municipal, Provincial and Federal regulations, including the Occupational Health and Safety Act, shall be accounted for in the pump station design.

.2 Design pump station to minimize confined spaces, to the extent possible.

.3 Where applicable, sleeves for personnel lifting davits / recovery sets shall be provided at all hatches into confined spaces. Core sleeves, below concrete surfaces, are to be provided for the lifting davit / recovery set. Also refer to subsection 4.3.1.16.

.4 Provide guards on equipment to prevent accidental contact. Provide all electrical equipment with suitable lockouts to ensure the equipment is out of service when maintenance is being carried out.

.5 Equipment which starts automatically is required to be labelled with warning signage to notify operators of this feature.

4.3.1.4 Wet Well Inlet Arrangements

.1 A manhole shall be provided outside of the pump station and only one (1) outlet pipe, equal to or greater than the largest manhole inlet pipe, shall be permitted to connect this manhole to the pump station wet well. No service connections shall be connected between the last manhole and the wet well.

.2 Where applicable, provide a control structure to isolate or direct flows to adjacent wet wells.

.3 The invert of the incoming pipe shall be higher than the level setting which starts the second pump.

.4 A baffle or deflector plate is to be installed at the entrance to a wet well. For “small” and “medium” stations the baffle or deflector plate is to be constructed of stainless steel (Type 316L). Other designs providing non-turbulent flow into the station may be considered, at Halifax Water’s discretion.

.5 The inlet arrangements shall allow for potential, future installation of a screening or influent grinding systems. The screens or grinders need not be provided as part of the design, but the design shall ensure that adding them in the future is possible.

.6 Screening or grinding systems should be avoided where possible. Where such a system is deemed necessary to protect pumping systems, automated screening should be considered. Manual screen should be avoided in particular.

4.3.1.5 Pump Station Building

.1 Safety, ample access to equipment, and ease of maintenance are to be considered in the design of pump station buildings
.

.2 .Do not provide exterior windows.

.3 Adequate ventilation for all mechanical equipment to be provided by vandal resistant, insulated, heavy duty type, hot-dipped galvanized steel intake and exhaust louvers or hoods.

.4 For heated, interior spaces (mechanical galleries, equipment rooms) a nominal design temperature of 12oC shall be assumed. Energy management systems, air-conditioners, dehumidifiers, heat recovery ventilators and other energy recovery systems, can be problematic for ongoing operations and are generally not preferred and should only be considered following discussions with Halifax Water on the relevant merits on a case by case basis.

.5 Minimum insulation values shall be RSI 4.23 (R24) for wall construction and RSI 8.81 (R50) for ceiling/roof construction. Electric heat is preferrable, however other sources of heat may be considered following discussions with Halifax Water on the relevant merits on a case by case basis.

.6 Engine emissions are to be directed away from the building so as not to create a ventilation "short circuit" or potential for exhaust to enter building.

.7 Design the louver system to prevent a negative pressure situation within the building. Thermostats are to be located away from the air intakes such that there is no conflict with exterior air.

.8 Make provision to support wall-mounted equipment inside the building. The building is to be designed "secure". Provide adequate interior space for equipment, cabling, ductwork and equipment. In no cases should the interior floor to ceiling height be less than 3.0m.

.9 The building floor is to be a minimum 150 mm above the finished external grade and any potential flood level. Building floors are to be reinforced concrete. In areas subject to spillage and washdowns, take appropriate measures during design and construction to ensure liquid does not accumulate on floors. Provide positive drainage to trenches and floor drains. Floor mounted equipment are to be mounted on concrete pads.

.10 Interior wall surfaces, doors and trim color to be approved by the Engineer. Provide epoxy paint (colour to be "Light Grey") on interior floors and concrete equipment pads. Exterior trim colour (doors, flashing, facia, weather hoods, etc.) to be dark brown to similar to VicWest "Metro Brown". Hoods and louver colors to match exterior trim color. Ensure proper galvanized primer for painted surface preparation and provided heavy-duty factory coating where possible.

.11 Exterior doors swing outward to open and provide thumb-latch type handle on exterior and panic bar type handle on interior. Doors and frames to be commercial grade, hot-dipped galvanized steel with acid-etched primer applied prior to painting. Doors to be 1.2 mm base thickness, hollow core, vertically stiffened and insulated (thermally broken) with three (3) heavy duty hinges per door. Exterior door hinges to be NRP (non removable pin). All hinge pins on doors to 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 keyed to Halifax Water's standard system.

.12 Where rolling access is required at entrance door, slope entrance and to prevent water entering building.

.13 Building construction to be masonry block with split-face block exterior finish (colours to be similar to Shaw "Tan" block for field and Shaw "Natural" block for accent banding).

.14 Roof to be pitched, standing seam, pre-finished metal roofing (dark brown colour similar to Vic West ("Metro Brown"). Provide ice cleats on roof as required for personnel entrance or areas of regular activity. Provide aluminum facia and soffit. Where practical, orientate roof pitch to be south facing for potential roof mounted solar panels.

.15 Special consideration should be made for large station buildings to fit architecturally with the neighborhood.

.16 Large station building shall incorporate a washroom with toilet, wash-up sink, toilet paper and paper towel dispensers. All fixtures within washroom to be of rugged construction suitable for industrial environment. Provide additional shelves and space for maintenance personnel to store hand cleaning dispensers, drying towels, etc.

.17 Provide underground electrical service entrance.

4.3.1.6 Wet Wells

.1 Buoyant forces for empty wet well are to be considered during the design. The designer will indicate the factor of safety used in the design report. The wet well should be designed to withstand buoyancy of 1:100 year period flood, if applicable.

.2 Wet wells are to be sized such that:

  .1 They can accommodate the peak wet weather flow at full build-out without the pumping flow rate exceeding the firm capacity of the lift station.
  .2 Pump starts do not exceed the pump manufacturer's maximum starts per hour during peak wet weather flow at full build-out.
  .3 Maximum time between pump cycles does not exceed two (2) hours during minimum dry weather flow, at the initial phase of build-out. This criterion may be achieved through pump station controls.

.3 Concrete mix used for wet wells shall take into account potential sulphate exposure as outlined in Table 1 of CSA A23.1. Steel wet wells are not acceptable.

.4 Design the bottom of chamber to prevent the accumulation of settled solids. Consideration to be given to self-cleaning wet wells. Steps, ledges, dead spots and sudden changes in floor elevation are to be avoided.

.5 Corrosion resistant bolts, fasteners and fixtures (316 L stainless steel) will be used within the wet well.

.6 Hatches must be positioned directly above removable equipment in wet wells.

.7 Protrusions into wet wells, which can collect rags and floating material, are to be avoided where possible.

.8 Wet well structures are required to be designed for heavy-duty traffic loading of 7256 kgs plus 30% impact H-20, wheel loads to AASHTO HB.

4.3.1.7 Underground Valve Chambers

.1 For small and medium sized stations, flow meters, isolation vales, check valves and ports for measuring pressure, shall be installed in underground valve chambers.

.2 Provide access to valve chambers by staircase (ship ladder). Use corrosion resistant materials such as FRP, concrete, hot-dipped galvanized steel, aluminum, or 316 Stainless Steel. Access staircase to be provided with handrail. Ensure handrailing and ladder components do not interfere with operation of roof scuttle.

.3 Only in special cases, such as existing sites, where access cannot be facilitated by a staircase (ship ladder) allow for confined space entry but do not provide a fixed ladder.

.4 Underground valve chambers shall be a standard, precast concrete structure (utility vault) as manufactured by “Shaw Precast Solutions” or approved equal. Refer to subsections 4.3.2 and 4.3.3 for standard dimension that pertain to small and medium stations.

.5 Valve chamber to have sumps with minimum internal dimensions of 500 mm x 500 mm x 575 mm deep for drainage collection and sump pump. Valve chamber to be supplied with sump pump for dewatering.

.6 Minimum 1% grade to floor of chamber towards dewatering sump. Provide sloped floor using non-shrink grout with a minimum depth of 50 mm.

.7 Buoyant forces for empty valve chamber are to be considered during the design. The designer will indicate the factor of safety used in the design report. The valve chamber should be designed to withstand buoyancy of 1:100 year period flood, if applicable.

.8 The top of valve chambers shall be flush with finished grade. Roof scuttle access covers to be raised on 150 mm curb, above finished grade. Roof scuttle access hatches are not traffic rated. Consideration shall be given for snow plowing, access requirements and preventing vehicles from driving over valve chambers.

.9 Valve chamber structures to be designed for heavy-duty traffic loading of 7256 kgs plus 30% impact H-20, wheel loads to AASHTO HB.

.10 The underside of valve chamber roof and the top 1.2m (4ft) of buried walls shall be insulated to prevent frost damage.

4.3.1.8 Underground Concrete Structure Water Proofing

.1 Underground concrete structures such as wet wells, dry wells, emergency storage tanks, holding tanks, valve, and meter chambers, etc., shall incorporate external water proofing. All buried surfaces, including bottoms, shall be waterproofed using a fully adhered membrane water proofing system, complete with protection, as required, to prevent damage during construction. Water proofing is required on all buried faces including bottom.

.2 Structures designed for retention of wastewater shall have interiors waterproofed up to 305 mm above the highest liquid level for the structure. The waterproofing must be able to withstand sewage and durable enough to withstand high pressure washing. Coatings applied to concrete surfaces are subject to approval by Halifax Water prior to installation.

.3 A visual hydrostatic test of the wet well must be completed after internal waterproofing is complete and before external waterproofing and backfilling. Testing of the wet well shall be in accordance with Supplementary Standard Specification 33 32 11. In the event of failure, wet well must be re-coated and re-tested to the satisfaction of Halifax Water.

.4 All concrete joints and all penetrations through the concrete will use link seals and will be grouted with non-shrink grout on both sides of the joint or penetration.

4.3.1.9 Emergency Storage Tanks

.1 Where applicable, emergency storage tanks shall be constructed of precast or cast-in-place concrete. The tank shall be constructed using the following criteria:

.1 The tank is only to be used during power outages and should remain dry during normal cycling of pumps.
.2 The tank shall incorporate a wash-down mechanism that can be used each time the storage tank is used.
.3 The tank floor shall be sloped toward the outlet pipe at a slope of 5:1 (horizontal: vertical) or steeper.
.4 The tank shall have, at minimum, two (2) access hatches. Access hatches shall be provided over the tank inlet and outlet, and over the wash-down mechanism. Hatches which are flush with the surrounding grade are to be equipped with a secondary protective grating device to provide fall-through protection. Access hatches shall be provided with gas assist lift mechanism and are to be lockable.
.5 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, in the last ten (10) years. Consult historical power outage data from NSPI for duration time.
.6 Float switch level monitoring to be provided, to indicate when the chamber has started to fill and when it has reached three quarters (¾) of its full capacity.

4.3.1.10 Emergency Overflows

.1 Pump station shall be provided with an emergency overflow. Emergency overflows should only occur after the storage tank has filled. The invert of the overflow pipe shall be high enough to prevent backflow into the pump station discharge point. If this is not possible the Halifax Water Engineer may approve a check valve on the overflow.

.2 All overflow conditions shall be detected and alarmed at the pump controller PLC. Provide a means to measure the overflow volume and record the time of occurrence and duration of the emergency overflows within the pump station.

.3 An auxiliary power supply shall be included in medium and large pump station unless otherwise required by the Halifax Water Engineer. The auxiliary power supply shall provide power to all station equipment. A storage tank may be considered instead of auxiliary power on a pump station where applicable.

4.3.1.11 Wet Well Ventilation

.1 Unless necessary, continuous positive pressure ventilation with fixed ventilation fans for supply and exhaust is not required.

.2 In stations where ventilation is required (eg. odour capture, equipment constraints, or where personnel access is required) then such ventilation shall be in accordance with NFPA 820 and the Canadian Electrical Code.

.3 Where wet well, dry well, or underground valve chamber ventilation is provided for personnel access, include an "on/off" switch at entrance and ventilate at 30 air changes per hour.

4.3.1.12 Pump Selection

.1 Pumping equipment shall be selected to perform at maximum efficiencies under normal operating conditions.

.2 Use pumps designed specifically for wastewater pumping.

.3 Pumps 20 kW (25 HP) and larger must be able to pass solids up to 75 mm (3 inch) sphere through the impeller without damage to the pump.

.4 With the largest pump out of service, the remaining pumps will have capacity to handle 100% of the peak wastewater design flow.

.5 Select pumps with minimum energy consumption and maximum pump efficiency. Pump efficiency to consider both motor efficiency and hydraulic efficiency.

.6 Use identical sewage pumps in multi-pump applications. Provide one (1) spare impeller.

.7 As per section 4.3.1.1, system curves including system head calculations and pump selection curves to be provided for the following operating conditions:

.1 C = 100 and low water level in the wet well.
.2 C = 120 and medium water level over the normal operating range in the wet well.
.3 C = 130 and overflow water level in the wet well, where C is the Hazen-Williams flow coefficient.

.8 Pump curve (2) 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 system curves (1) and (3) with the selected pump curve. The pump and motor shall be capable of operating satisfactorily over the full range of operating conditions.

.9 Where Variable Frequency Drives (VFDs) are used, their operation shall be detailed with relation to the pump and system curves. The Allowable Operating Region (AOR) and Preferred Operating Region (POR) shall be identified.

.10 Net Positive Suction Head (NPSH) shall be considered when selecting a pump. Pump selection and suction configuration shall ensure that a ratio of 1:2 is maintained for available NPSH (NPSHa) divided by required NPSH (NPSHr).

.11 Pump selection and VFD programming to provide a minimum force main velocity of 0.9 m/s (3.0 ft/s) for cleansing forcemains.

.12 Where practical, select a pump with an impeller that is at least one size smaller than the largest impeller for that pump.

4.3.1.13 Mechanical Piping, Valves and Appurtenances

.1 Mechanical piping shall be Ductile Iron or Stainless Steel, as per Supplementary Standard Specification 33 32 11.

.2 Piping within the station shall be properly supported and shall be designed with appropriate fittings to allow for expansion and contraction, thrust restraint, etc. Weight of pipe work shall not be borne by the pump body or its connection flanges.

.3 All pipe supports and miscellaneous assemblies shall be of 316L stainless steel in pump station wet wells. Pipe supports and miscellaneous assemblies in other parts of the pump station may be 316L stainless steel or hot-dipped galvanized steel.

.4 Hand operated plug valves shall be provided on piping to allow for proper isolation for maintenance. Valves on sewer force mains shall be plug valve type. Isolation valves, for pumping systems, shall not be located in the wet well. Slide gates or knife gate valves may be used for isolation between wet well tanks. Knife gate valves may be used, where necessary, for suction piping isolation in wet well – dry well pump stations.

.5 A check valve shall be provided on the discharge lines between the isolation valve and the pump. Check valves shall be readily accessible for maintenance. Check valves shall not be located in the wet well.

.6 Surge anticipation or pressure relief valves may be required for certain circumstances where potentially problematic hydraulic conditions cannot be addressed by other means. Pressure relief valves and surge anticipator valves shall incorporate instrumentation or limits switches to indicate activation. Activation of the valves is to be monitored by the station PLC controller.

.7 Bypass pumping arrangements: A tee piece, fitted with valve and quick connect coupler shall be fitted to the force main arrangement in the valve chamber. In instances where both pumps have failed or during power failure a diesel pump may be set up with flexible hose from wet well to this flanged tee on the force main, for bypass-pumping.

.8 Pressure gauges:

  .1 Pressure gauge mounting arrangements shall be provided on each force main for small and medium size stations, fitted in the valve chamber.
  .2 Pressure gauges mounting arrangements shall be provided on pump suction and discharge pipe work for large stations.
  .3 Gauge pipe work shall be 25 mm diameter stainless steel and equipped with isolation ball valves to allow gauge to be removed.
  .4 Gauge pipe work shall be provided with a method of draining/flushing.
  .5 Pipe work to be fitted with 13 mm NPT female connection for pressure gauge.
  .6 Fit gauge pipe work to the centerline, parallel to floor, of the stations pipe work, and at the location stated above.

4.3.1.14 Flush Valve

.1 For Small and Medium submersible pump stations, install one (1) hydraulically operated flush valve on one (1) of the pumps, for each wet well.

4.3.1.15 Odour Control

.1 All tankage containing wastewater shall be fully covered.

.2 The use of odour control measures is case specific and is to be agreed with the Halifax Water Engineer.

.3 Design odour control for future built out loads and consider potential solids build up and residence time in the tankage and force mains.

4.3.1.16 Lifting Devices

.1 Large pump stations shall be provided with an acceptable device for the removal of pumps for repair and maintenance e.g. lifting davit and chain block, or hoist system. Pumps for small and medium stations are lowered and raised using standard Halifax Water, truck mounted, davit and winch system.

.2 For small, medium, and large stations, wet well access hatches shall be provided with sleeves for Honeywell Miller Durahoist fall arrest davits. The sleeves shall be manufactured by Honeywell Miller and flush mounted. To minimize the number of sleeves, a sleeve can service more than one (1) hatch as long as it is positioned such that the vertical lines from the davit can be generally centered over each hatch.

.3 Provide a hoist system for pump removal in large pump stations (i.e. in the dry well). Hoists rated 1.0 tonne or less may be manually operated. For greater than 1.0 tonne motorized trolleys and motorized lifting hoist are to be provided. Provide rail system to allow pumps to be brought from their operating positions to outside the building's assess door.

.4 Rail, beams and lifting hoists to be rated for present and potential future loads. The capacities of the rail and hoist system to be clearly indicated on the rail or beam.

4.3.1.17 Labelling

.1 Pumps, valves, lifting hoists, and other electromechanical equipment to be fitted with manufacturer's identification nameplates.

.2 Pump name plates shall be fitted to the underside of the pump access hatch or to the inside of the pump control panel.

4.3.1.18 Wet Well

.1 There shall be a dedicated stainless steel 150mm (6") cleaning line installed in all wet wells.

.2 The cleaning line shall have a male end quick release coupler above ground for tanker connection, a cap for the quick release coupler for when the line is not in use, and pipework to base of wet well. Pipe work shall terminate a maximum of 75 mm above the lowest point of the wet well floor i.e. bottom of sloped base. Wash down can then be carried out, using a hose to push sludge to suction pipe at base of the wet well.

4.3.1.19 Electrical & Auxiliary Power Requirements

.1 Provide Short Circuit, Protection Coordination, and Arc-Flash studies as described below. Reports are to be prepared, signed and stamped by a Professional Engineer licensed to practice in Nova Scotia.

1. Short Circuit Study – Perform a Short Circuit Study to ensure that all electrical equipment has an interrupting capacity that exceeds the calculated short circuit levels throughout the facility.

2. Protection Coordination Study – Perform a Protection Coordination Study to ensure circuit protective devices such as protective overcurrent trips, starters, relays, and fuses are installed to recommended values and settings. The Protection Coordination Study shall include Protection Coordination Sheets for both phase and ground fault overcurrent protective devices and recommended overcurrent settings for all adjustable circuit breaker trip units, motor circuit protector trip units, motor overloads and power distribution fuses. All overcurrent devices are to be properly coordinated.

3. Arc Flash Hazard Analysis & Study – Perform an Arc Flash Hazard Analysis in accordance with the procedures stated in CSA Z462, “Workplace Electrical Safety” and in conjunction with the short circuit and protective device coordination studies. Provide and install appropriate warning labels to each piece of distribution equipment identified in the Arc Flash Hazard Analysis. Labels to include information in conformance with CSA C22.1 – Canadian Electrical Code Part 1, and CSA Z462 – Workplace Electrical Safety, Section 4.3.5.7 – Equipment Labelling, and Annex Q, Subsection Q4 – Detailed Electrical Hazard Information Label, and including but not limited to the following information:

    .1 Arc Flash Protection:

        .1 Working Distance.
        .2 Incident Energy.
        .3 Arc Flash Boundary.
        .4 Limited Approach Boundary.
        .5 Restricted Approach Boundary.

    .2 Shock Protection:

        .1 Shock hazard when cover is removed.
        .2 Arc Flash PPE Category.
        .3 Glove Class.

.3 Project Details:

.1 Facility Name.
.2 Equipment Name.
.3 File References.
.4 Arc Flash Analysis by: Consultant's Name.
.5 Date of Arc Flash Analysis.
.6 Standard Reference (e.g. CSA Z462-18, IEEE 1584).

4. An example of a combined arc flash and shock warning label and a detailed electrical hazard information label is provided in Figure 1.

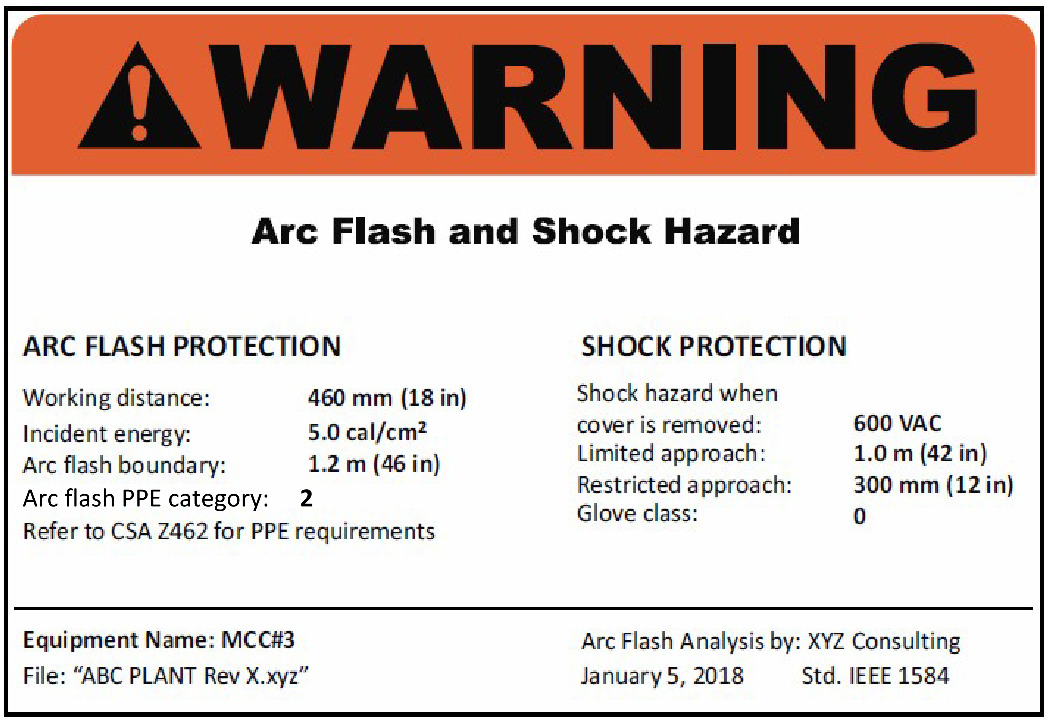


Figure 4.1 - Example of an Arc Flash and Shock Warning Label

.2 Utility power shall be provided to pump stations with a 600v/3Ph/60Hz service unless site conditions dictate otherwise and if acceptable to the Halifax Water Engineer. Design and install the power supply system to meet all applicable and relevant standards and codes.

.3 For pumping systems, all electric motors shall be premium efficiency motors. Motors intended for use with Variable Frequency Drives (VFDs) shall be "Inverter-Duty" rated motors. All motors shall be capable of operating the pump over the full range of load conditions.

.4 Each motor is required to have a separate lockable disconnect switch for isolation of the motor power supply without affecting the remaining system operation.

.5 Equip “small” pump station with a quick connect feature for a portable generator consistent with existing Halifax Water portable generator connections. Confirm with Halifax Water the required regional generator connection arrangements.

.6 Pumps with motors under 7.5 kW (10 HP) may have direct across-the-line starter. Pumps with 7.5 kW (10 HP) and larger motors shall be equipped with a reduced voltage (soft start) starter or variable frequency drive (VFD). Where modulation of pumped flow or control of acceleration and deceleration of flows is required, variable frequency drive (VFD) should be considered.

.7 Pumps to be protected by built-in motor temperature and leakage sensors.

.8 Pumps with motors 112kW (150HP) or larger shall be provided with:

  .1 Vibration monitoring.
  .2 Thermal monitoring on each phase of the motor windings.
  .3 Thermal measurement on upper and lower bearings.

4.3.1.20 Instrumentation, SCADA and Controls

.1 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).

.2 The control panel must incorporate an inside hinged panel to separate the high voltage equipment from the operator interface and controls.

.3 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:

1. PLC based pump controller.
2. Ethernet router (rail mount). Redline RAM-6021 or equivalent.
3. HMI Touch screen Panel PC, Windows 10 IoT Enterprise, 375 mm, Intel Atom E3845 Processor, 4GB RAM, 128 GB SSD, Windows 10 IoT software, P-CAP touch, 2 x LAN, 1 x serial

RS232/RS485. Acceptable products: Winmate M-Series - R15IBWS-MHC3 or approved equal.

4. Uninterruptible power supply properly sized to maintain PLC in powered state during generator transfer to and from emergency power.
5. Status indicator lights to signify the following conditions for each pump:

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

6. Separate mechanical interlocked main breaker for portable generator connection.
7. Mechanical run-time meters shall be provided for each pump and an additional meter shall be provided to record run-time for two (2) pumps operating simultaneously.
8. Lightning arrestors.
9. Intrinsic safety barriers for all float switches.
10. Appropriate space allocated in the enclosure to install communication hardware including radio, radio power supply and antenna supplied by Technical Services.
11. Hand-Off-Auto selector switch for each pump.
12. Flow meter transmitters with MODBUS capability.
13. Temperature sensor (thermostat to detect low temperature within panel).
14. Task light.

.4 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 Halifax Water 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 Technical Services. All PLC and OIT programming complete with documentation must be provided to Technical Services on electronic storage media to be included in the operations and maintenance manuals. Acceptable products:

   .1 Schneider Electric SCADAPack 474.
   .2 Allen Bradley MicroLogix.
   .3 CompactLogix or approved equivalent.

.5 PLC controller shall have eight (8) extra digital points and eight (8) extra analog points and will transmit the following signals and alarms to Halifax Water`s central monitoring system:

.1 Hand-Off-Auto selector switch status.
.2 Station voltage.
.3 Pump motor currents.
.4 Station level.
.5 Low level alarm.
.6 High level alarm.
.7 Power monitor alarm.
.8 Pump motor overload.
.9 Pump motor under-load.
.10 Pump status.
.11 Valve chamber flood alarm.
.12 Flow rate for each pump.
.13 Pump inlet pressure.
.14 Pump outlet pressure.
.15 Overflow rate.
.16 Entry alarms for well and chamber hatches.
.17 Totalizer reading for each flow meter.
.18 Temperature alarm (detecting low temperature within panel).

.6 Where an auxiliary power supply and building exists:

.1 Intrusion alarms on entry doors.
.2 Generator status.
.3 Generator fault alarm.
.4 Generator fuel tank analog level.
.5 Generator fuel tank low level alarm.
.6 Transfer switch status.
.7 Panic alarm for building.
.8 Smoke and heat detectors for building fire protection.
.9 Gas detection alarm (tied to ventilation control).
.10 Station thermostat status / control.
.11 Ventilation system status / control (tied to access control).
.12 Outdoor air temperature status (tied to ventilation control).

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

1. Under-load.
2. Overload.
3. Phase loss.
4. Current imbalance.
5. Overvoltage.
6. Undervoltage.

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

.9 Level Control:

.1 Pump station shall have a laser level measurement device, accessible from the surface, with a display for the station liquid level locally and an analog output into the pumping station's PLC for pump control. Where laser level control is not possible radar or ultrasonic level measurement may be used.

.2 In conjunction with the laser level measurement, the pump station shall have two (2) float switches. One (1) float switch will act as a LOW-LOW level alarm float, activated if the liquid level drops 75 mm below the normal pump shut-off level and shall shut off both pumps. This condition is to provide a low-level alarm indication but is to be self-resetting. The second float switch shall act as a HIGH-HIGH level alarm float and shall 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 not to be self-resetting. In the case of laser level failure or PLC failure the pump station should continue to operate between the above floats. These floats are to be hard wired to relays and not the pumping station's PLC controller, to facilitate this feature.

.10 Overflow Measurement:

.1 Provide programming to calculate (estimate) instantaneous overflow based on continuous level measurement reading and the appropriate hydraulic formula.

.11 Pump Discharge Flow Measurement:

1. Flow measurement shall be by electromagnetic flow meter.
2. Each force main shall be fitted with a flow meter.
3. Flow meters shall be installed in line with manufacturer's recommendations with regards to required approach conditions before and after the meter.
4. Remote flow display shall be provided showing instantaneous and totalized flows, in units as agreed with Halifax Water's Engineer. These readings shall be duplicated on the pumping station's HMI.
5. For submersible pump station the flow meter shall be located in the valve chamber. Where the flow meter is located in the valve chamber its flow tube and electrical connection shall be rated for immersion service with transmitters located above grade at electrical control panels.

4.3.2 Small Pump Stations

.1 Pump Stations with firm capacity up to 75 L/s shall be considered “Small” pump stations.

.2 Small pump stations shall be simple duplex stations with a single wet well, two (2) submersible pumps, a below grade valve chamber, and electrical controls mounted on a pedestal structure as shown in Figure 4.2 General Arrangements – Small Pumping Station.

.3 Pump stations shall have a minimum of two (2) pumps. Each pump will be sized to handle the peak design flow.

.4 The pump control circuitry shall be designed to alternate pumps for each pumping cycle automatically.

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

.6 Minimum hatch size must accommodate removal of equipment (pumps) but in no case be less than 750 mm by 750 mm (30” by 30”). Use corrosion resistant materials such as FRP, aluminum, or 316 stainless steel. Hatch frames must be poured in place or if mechanically fastened, shall be surface mounted on the slab.

.7 Electrical equipment shall be mounted in outdoor enclosures on a standard, precast concrete structure (Halifax Water Standard) that is available from Shaw Precast Solutions or approved equal. Refer to Appendix A of Halifax Water *Supplementary Standard Specification Wastewater Pump Stations* for electrical panel layout for small stations.

.8 Valve chamber shall be a 3,048 mm Wide x 3,658 mm Long x 2,134 mm High (internal dimensions) precast utility vault complete with roof scuttle, ship ladder and integral, precast sump and sump pump.

.9 Valve chamber to be supplied with a sump pump for dewatering. The use of P-traps to the wet well, are not acceptable.

.10 The following control philosophy is to be provided for small pump stations:

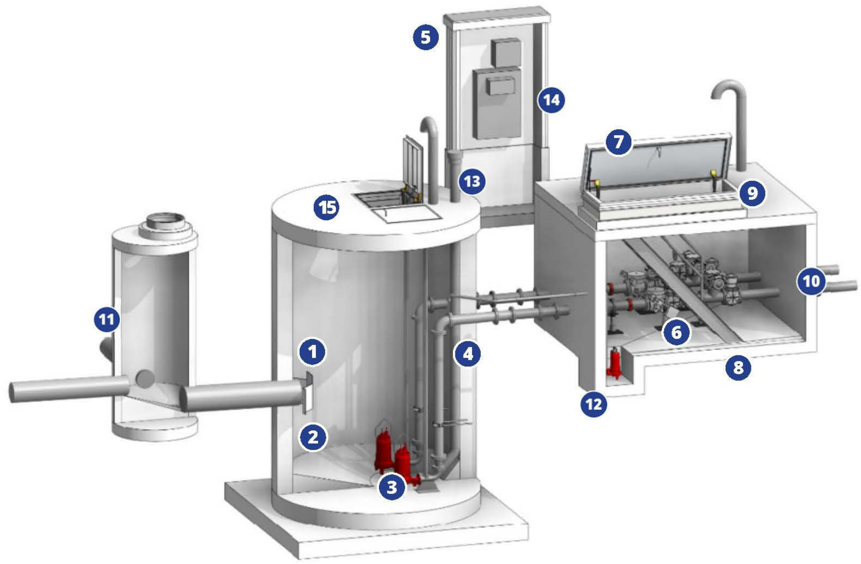
.1 Two (2) systems are to be installed to provide redundancy for level monitoring and pump control. The primary level system will be laser sensor and the backup system will be two (2) float switches. The float switches are to override the laser system. Floats are to be LOW-LOW and HIGH-HIGH, and shall provide an alarm at the control panel and HMI and start or stop the pumps, as described below. The floats shall be hard wired to relays and operate independently of PLC control arrangements.

.2 There will be a gap between the pre-programmed levels of the laser level transmitter and installed elevations of the float switches. The HIGH-HIGH level float switch will start both pumps at a higher elevation than laser programmed LAG PUMP level. The LOW-LOW level float shall stop both pumps at lower elevation than laser programmed STOP level.

.3 The HIGH-HIGH float is to activate an alarm, which is to be manually acknowledged.

.4 The LOW-LOW float shall activate an alarm but is to be self-re-setting when wet well liquid level raises above the float.

.5 If laser level or PLC fails (e.g. loss of echo, cable fault), the pumping station will switch entirely to float switch control mode.



1. Baffle at incoming sewer
2. Benching
3. Flush valve on one pump
4. Flexible couplings on all exiting pipes
5. Standard precast pedestal (electrical)
6. Slope floor to chamber sump
7. Scuttle hatch and ship's ladder
8. Waterproof all buried surfaces
9. Standard precast chamber
10. Dual force mains
11. Multiple sewers in separate manhole
12. Sump pump in pre-cast sump
13. 150mm diameter cam-lock for vacuum truck
14. Connection for emergency generator
15. Fall arrest sleeve in cover

Figure 4.2: General Arrangements - Small Pumping Station

4.3.3 Medium Pump Stations

.1 Pump Stations with firm capacity between 75 and 220 L/s shall be considered "Medium" pump stations.

.2 Medium pump stations shall include two (2), separate, below grade, wet wells, with a shared below grade valve chamber. Medium stations are configured for three or four submersible pumps. The electrical controls for the station shall be housed in a slab on grade building separated from the wet wells. Many features for a medium pumping station are common to the previously described small station, therefore, the details provided for the small station shall be included for medium stations. Additional requirements for the medium stations are laid out below.

.3 Refer to Figure 4.3: for the General Arrangement of a Medium Pumping Station.

.4 Wet wells shall be interconnected at a low level at an elevation below the LOW-LOW level override float. A downwards closing 300 mm diameter slide gate valve shall be placed on the interconnecting pipe between the wet wells.

.5 A separate flow splitting chamber shall be provided upstream of the wet wells, but downstream of the final sewer shed collection manhole. The outlet pipe size from the splitting chamber shall be equal or greater than the inlet pipe size. Downwards closing slide gate valves shall be placed on each tank penetration to isolate flows as required.

.6 Where three (3) or more pumps are provided, they shall be of such capacity that, with the largest 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.

.7 The pump control circuitry shall be designed to alternate pumps for each pumping cycle automatically and handle cascading operations of the multiple pumps based on flow demands.

.8 A permanent, fixed position, generator shall be located outside and in a suitable weatherproof, fully self-contained enclosure with fuel tank and acoustic hood. Enclosure shall be mounted on a reinforced concrete base. Generator shall operate automatically on power failure or disruption e.g. Automatic Transfer Switch (ATS).

.9 The valve chamber shall be a 4,039 mm Wide x 3,048 mm Long x 2,134 mm High (internal dimensions) precast utility vault complete with roof scuttle, ships ladder, integral precast sump and sump pump.

.10 The same control philosophy for a small station will apply, with the following additions:

- .1 During normal operation the station shall run on an alternating Duty/Lag/Standby basis.
- .2 Provision shall be made to allow one (1) combined set of laser level and float switches to be the master level control, while the second set is to be the slave. The two (2) wet wells shall be able to operate automatically, independently, or together as one (1).
- .3 There will be a gap between the pre-programmed levels of the laser level transmitter and installed elevations of the float switches. The HIGH-HIGH level float switch will start at least two (2) pumps at a higher elevation than laser programmed LAG level. The LOW-LOW level float shall stop all pumps at a lower elevation than laser programmed STOP level.

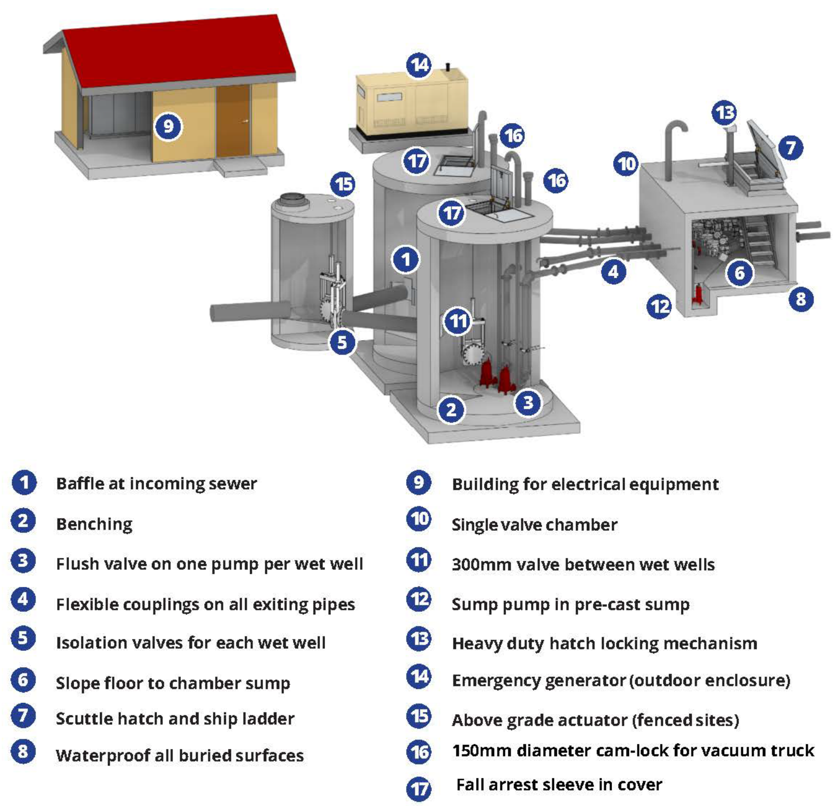


Figure 4.3: General Arrangements - Medium Pumping Station

4.3.4 Large Pump Stations

.1 Pump Stations with firm capacity over 220 L/s shall be considered "Large" pump stations.

.2 Large pump stations shall be of a wet well / dry well configuration, with typically four (4) or more pumps installed in the dry well. The electrical controls for the station shall be housed in a service building, constructed above the dry well.

.3 The wet well(s) are required to store the sewage before it is pumped and contains the level monitoring devices, while the dry well shall contain any required, below grade mechanical and electrical equipment. The arrangements of a large station are not common with the small or medium station. For general station arrangements, refer to Figure 4.4: General Arrangements - Large Pumping Station.

.4 Pre-screening, if provided, shall be automatic mechanical means and not manual. Screenings shall be washed and compacted, with the wash water returned to the main influent stream.

.5 Pumps shall be dry-pit, submersible type.

.6 The dry well will be sized so that there is sufficient space between the pumps for the operator to access, maintain and remove them if necessary. In addition, there will be enough space for accessing and maintaining associated piping and other ancillary equipment.

.7 Provide sump pump for all dry wells and include suction and discharge isolation and check valves. Discharge the sump pump to the wet well above the highest water level of the wet well. Slope the dry well floor toward the sump. The sump pump will operate via integral level switch. A flood float shall also be provided in the dry well.

.8 The pipework inclusive of fittings and valves shall be so arranged that total dismantling is not necessary to allow replacement or maintenance of any component. Make up pieces and dismantling joints in appropriate locations shall be provided.

.9 Pipe penetrations between the wet well and dry well and on pipes exiting the dry wells will be secured with an appropriate link seal and grouted.

.10 The design for installation of the dry well pumps must take into consideration keeping vibration at acceptable levels to avoid fatigue, noises, and wear. Use adequate pipe and pump support/anchors and flexible joints at the pump tie-ins.

.11 Provide permanent mechanical ventilation for the dry well in accordance with applicable codes. Ventilation for electrical declassification is not required or desired. The intent is to minimize heating energy and to simply reduce the need for air-flow monitoring and other instrumentation/alarm devices for building systems.

.12 Where ventilation is provided in the wet well, the suction inlet(s) are to be above overflow level.

.13 Pumps must be mounted on a minimum 100 mm housekeeping pad.

.14 Provide access to the dry well by staircases. Use corrosion resistant materials such as FRP, concrete, aluminum, hot dipped galvanized steel, or 316 stainless steel. The staircase will meet applicable building and safety codes.

.15 Cable junction boxes should be above flood level in dry well.

.16 The elevation of the maximum water surface is to be below the invert of the lowest incoming sewer. However, by agreement with Halifax Water, when large fluctuations in flow occur, such as during rain events, the water may be allowed to back up and surcharge the sewer. However, the level should never exceed the elevation of the lowest lateral connection at the property line.

.17 The floor elevation and dimensions of the wet well are determined by site constraints and volume requirements. The minimum depth of the water should be sufficiently above the pump intake to avoid vortices.

.18 The wet well shall be divided into at least two (2) sections so that any section maybe taken out of service for inspection, cleaning, or repairs. Each section of the wet well shall have an individual inlet equipped with a slide gate designed to divert flow from the section that has been removed from service. Each of the wet well sections shall be interconnected with a slide gate that will be open during normal station operation. Access shall be provided for each section. Each wet well section shall be able to operate automatically, independently, or together as one (1).

.19 Sloping sump bottoms and filleted corners shall be provided in the wet well to direct sewage flow to the pump suction inlets and to minimize solids deposition on the bottom. Wet well to be arranged to minimize stagnant space where solids are likely to deposit.

.20 Sewage flow inside a wet well should not have to travel past one (1) pump suction inlet to reach another pump suction.

.21 Submerged concrete surfaces of wet wells shall be designed for highly corrosive sewage attack. Concrete surfaces to be designed for sulfide gas attack.

.22 Dry well access hatch size must accommodate removal of equipment (pumps, valves, check valves, etc.) but in no case be less than 750 mm by 750 mm (30” by 30”). Use corrosion resistant materials such as aluminum, or 316 Stainless Steel. All access hatches for dry wells must be watertight. Hatch frames must be poured in place or if mechanically fastened, shall be surface mounted on the slab. Hatches are to be equipped with a secondary protective grating device to provide fall-through protection. Provide temporary safety rail system for use when hatch is open.

.23 As per medium pump stations, a permanent fixed position generator shall be provided. Generator arrangements are as per that section. Indoor generator sets are not desirable. However, an indoor generator may be acceptable, with the approval of the Halifax Water Engineer. Indoor generators to be provided with exhaust silencer, air supply system, ventilation system, and sufficient room around the equipment to carry out all necessary maintenance tasks as per manufacturer’s recommendations. Generator shall operate automatically on power failure or disruption e.g. Automatic Transfer Switch (ATS).

.24 Depending on the shape and size of the wet wells, a means to access all sides of the wet well must be provided for cleaning. This will be assessed on a case-by-case basis with the Halifax Water Engineer. For example, a catwalk may need to be installed along the perimeter of the longest length of the well to allow for the operator to walk the length of the well for cleaning. However, it is Halifax Water’s intent that routine cleaning and maintenance can be carried out without entering the wet well.

.25 The same control philosophy for a medium station will apply for a large pumping station.

.26 Ventilation requirements to be reviewed with the Halifax Water Engineer.

Figure 4.4: General Arrangement - Large Pumping Station

4.3.5 Overview of Pre-start Up Testing, Start-up and Commissioning

The pumping station shall undergo the following three (3) steps, described in more detail in the following sections, prior to handover to Halifax Water:

- Pre-start Up Testing.
- Start-up.
- Commissioning.

The Consultant shall be responsible for the overall coordination of the Pre-start Up Testing, Start-up, and Commissioning. More specifically the Consultant shall:

- Develop a program with input from the Contractor, the Contractor's suppliers / Subcontractors, and Halifax Water to carry out the Pre-start Up Testing, Start-up, and Commissioning in an organized and timely manner.
- Ensure that sufficient Contractor, Consultant, and Owner resources are available and the roles and responsibilities within the program are understood.
- Develop a schedule for the program and maintain and update the schedule as required for communication with all parties.
- Facilitate meetings and distribution of information prior to the start of and throughout the program to ensure the activities are carried out and that parties are aware of the timing of upcoming activities.
- Collect and maintain testing results, start-up, and commissioning reports and prepare a commissioning report, as described in following sections, to Halifax Water.

Contractor to submit to the Halifax Water Engineer and Consultant, four (4) weeks in advance, a program for all Pre-start Up testing, Start-up arrangements, Commissioning, and Training processes. It is the responsibility of the Consultant to ensure that the Contactor issues this program. The program shall include, at a minimum, the phases identified above and detailed in subsequent sections of this document.

Program to clearly identify who shall be on site for each phase of Pre-start Up Testing/Start-up/Commissioning etc.

While it is the Consultant who oversees the plan and schedule, it is the Contractor that shall organize, plan, and carry out the majority of the testing activities. Halifax Water personnel and the Consultant shall attend, and witness testing/start-up as required.

The Contactor shall allow Halifax Water Operators access to the site during the construction, Pre-start Up Testing, Start-up, and Commissioning phases. Operators shall be allowed to inspect the site, provided it is safe to do so.

The Contractor shall provide the resources and information, in a timely manner and prior to commencing Pre-start Up Testing to the Consultant, so that the Consultant may create the commissioning plan. Where items cannot be provided prior to Pre-start Up a plan for providing same shall be given to the Consultant and Halifax Water. The program or "commissioning plan" will include:

- Commissioning Plan with detailed task list (distinct system test plan) and identified dates for each task.

- Identification of when parties are required on site, for each phase of the commissioning.
- List of all pumps/meters/electrical equipment/instruments/valves/ assemblies – stating make/model/HP/set points/inputs and outputs.
- List of all vendors and contacts, of systems incorporated into the station, that will be required during Start-up and/or Commissioning.
- List of SCADA tags to be provided to Halifax Water Technical Services.
- Operation and Maintenance manuals provided prior to any start-up tests for the various systems.
- HMI/PLC/SCADA signals and test arrangements.
- HMI/PLC/SCADA programs, in hard copy and electronic format. Where proprietary software is required to edit these programs, that shall be also be provided.
- Tabulated design and test conditions over various operation situations.
- Record of operational set points.
- Provision of flows for testing – live flow or tankered clean water.
- Confirmation that each distinct process unit has been test ran e.g. pressure, pump dry run, valves open/closed, instrumentation correctly operating.
- All PLC/SCADA/HMI signals to be tested for correct response. Also identify the nature of the response.
- List of simulation and failure alarms to be generated.
- Operating sequence / control narrative provided.
- Confirmation that Consultant has inspected construction works.

4.3.5.1 Pre-start Up Testing

.1 The Contractor shall have the prime responsibility to coordinate and execute Pre-start Up Testing. The following personnel shall be present for Pre-start Up Testing activities:

  .1 Contractor (Director/Task Control).
  .2 Subcontractors, as required.
  .3 Consultant.
  .4 Suppliers, as required.
  .5 Halifax Water Operations, as required.

.2 The Consultant shall ensure that all pre-start Up Testing has been completed in line with manufacturer’s recommendations and good practice, and in line with the Supplementary Specification Section 33 32 11.

.3 Pre-start-up Testing: refers to any work carried out on mechanical, electrical, or structural elements during the construction and installation works. Typical Pre-start Up Testing includes concrete testing, pressure testing of pipes, leaking testing, visual inspections, point-to-point electrical continuity, etc. Pre-start Up Testing is carried out to ensure that during the construction/installation phase that the supplied materials are correctly installed, meet Start-up criteria, and are safe for use. Electrical panels are to be provided with the manufacturer's written confirmation that point-to-point testing and work bench testing has been completed.

.4 Leakage Testing: Pressure test drainage, pressure and vent piping. Prior to installation of mechanical and electrical equipment, all wet wells and water retaining tanks shall be tested for leakage. Refer also to Supplementary Specification Section 33 32 11 for testing requirements.

4.3.5.2 Start-up

.1 The Contractor shall have the prime responsibility to coordinate and execute Start-up Activities. The following personnel shall be present for Start-up activities:

- .1 Contractor (Director/Task Control).
- .2 Subcontractors, as required.
- .3 Suppliers, as required.
- .4 Consultant.
- .5 Halifax Water Technical Services.
- .6 Halifax Water Operations, as required.

.2 Start-up refers to the preparation of mechanical and electrical equipment to perform its intended function after installation but prior to system commissioning, such as checking operation of equipment, testing of communication signals between monitoring devices and control panels, etc.

.3 During the Start-up period, the Contractor starts, operates and tests all equipment, controls, and communication systems to ensure proper function in accordance with the project documents and manufacturer's recommendations. The Contractor is responsible for 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 Consultant and the Halifax Water Engineer as necessary. The SCADA tag list is to be provided to Halifax Water Technical Services at least four (4) weeks prior to facility start-up to allow Halifax Water Technical Services sufficient time to program SCADA.

.4 The contractor shall generate and transmit all signals from the point of generation at the instrument to the PLC/HMI monitoring system. The Contractor shall arrange for Halifax Water Technical Services to be on site for all Start-up signal testing. Halifax Water Technical Services will verify signals have been received at the SCADA monitoring station. Contractor to liaise with Halifax Water when completing this task to ensure signals generated are received at the SCADA monitoring system.

.5 During the Start-up period, all technical issues related to the operation of the facility and all requests for information 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 Commissioning, the contractor shall provide:

.1 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 its intended use.
.2 Test and verify that all equipment and systems function in accordance with the Process Control Narrative (PCN).
.3 Written confirmation, from Halifax Water Technical Services, that all monitoring signals/alarms have been simulated and received by the Halifax Water's SCADA monitoring station.
.4 A full itemized list of technical difficulties encountered during Start-up and their resolutions.

.6 SCADA Commissioning occurs before advancement of Commissioning. During SCADA Commissioning, all communications will be verified between the local PLC and Halifax Water's SCADA System. The purpose of SCADA Commissioning is to confirm correct SCADA monitoring and labelling, not to test communication between PLC and Halifax Water's SCADA System.

.7 The Contractor shall provide a System Integrator to provide programming for the SCADA and HMI/PLC equipment and ensure all sub-systems are correctly communicating to the station's PLC. Under direction from the Halifax Water Technical Services representative, the Contractor/System Integrator 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 the time required to complete the SCADA Commissioning.

4.3.5.3 Commissioning and SCADA Verification

.1 The Consultant shall have the prime responsibility to coordinate the execution of commissioning activities. The Consultant will work closely with Halifax Water Technical Services to plan and execute commissioning. The following personnel shall be present for Commissioning and SCADA Verification activities:

.1 Consultant (Director/Task Control).
.2 Contractor.
.3 Subcontractors, if required.
.4 Suppliers, if required.
.5 Halifax Water Technical Services.
.6 Halifax Water Operations.

.2 Commissioning: refers to the over-all system testing that is performed to ensure an entire system, consisting of many subsystems, performs as specified. Commissioning shall be carried using a holistic approach for the entire system. Commissioning shall be completed to bring the mechanical, electrical and other systems and components from a state of "static completion" to a state of "dynamic operation" and to verify conformance to this standard, the submitted design report, and Halifax Water's Specification Section 33 32 11. The Commissioning phase shall confirm that the equipment provided meets the design intent and function in accordance with defined operational requirements. Commissioning includes for performance testing, system handover to Halifax Water, and training of Halifax Water's appointed personnel.

.3 Commissioning occurs after successful completion of Start-up and provision of a full itemized list of equipment, installation verification, certification, and a full itemized list of technical difficulties/resolutions. Once Consultant has reviewed and accepted this information, they shall advise that the pumping station is ready for Commissioning. The Contractor shall then schedule Commissioning date(s) a minimum of two (2) weeks in advance, subject to availability of all parties.

.4 During Commissioning, the Contractor demonstrates to Consultant, Halifax Water Technical Services, and Halifax Water Operations that all equipment and systems function properly and in accordance with the project documents.

.5 It is fully expected that all equipment and systems have been started successfully during Start-up and operate in accordance with the project documents. The Commissioning phase is not to be used for final or Start-up testing of systems. This ensures efficient use of resources during Commissioning (i.e. Halifax Water staff and Consultant 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 Consultant may, at their discretion, terminate the commissioning process and instruct the contractor to complete the Start-up and re-schedule Commissioning.

.6 The Consultant is responsible for ensuring that the Contractor provides a dedicated commissioning officer to lead the site commissioning process. It will be the commissioning officer's task to create the commissioning plan, create site acceptance testing protocols, and leading and directing the Commissioning process. As a minimum the Commissioning plan shall cover the following:

- .1 Full Input / Output listing and their function e.g.:
  - .1 Confirm pump switches ON/OFF at desired levels.
  - .2 Simulate failures.
  - .3 Confirm correct operation of speed drives.
  - .4 Methodology to test the pumps over various operating conditions.
  - .5 Communication arrangements.

- .2 Full list of equipment and system setpoints.

- .3 Test or simulate all Input/Output.

- .4 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.

- .5 Test (or simulate) and verify functionality of all alarms and ensure that response is in accordance with PCN.

- .6 Check and verify functionality of all mechanical systems (i.e. ventilation, pump lifts, heating, hatches and accessories, valving, etc.).

- .7 Demonstrate removal and reinstallation of all removable/serviceable mechanical equipment (i.e. screening baskets, pumps, etc.).

- .8 Confirm auxiliary power supply system functionality by:
  - .1 Simulating a power interruption at full demand, i.e. open the line power main disconnect switch.
  - .2 Conducting a load bank test - 100% load for 6 hours.

.7 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 Consultant and Halifax Water will be present to witness Commissioning and will liaise with, and call to the site, other Halifax Water staff as necessary.

4.3.6 Training

The Consultant shall have the prime responsibility to coordinate the execution of Training. The Consultant will work closely with Halifax Water Technical Services and Operations to plan and execute commissioning. The following personnel shall be present for Training:

- Consultant (Director/Task Control).
- Contractor.
- Subcontractors, as required.
- Suppliers, as required.
- Halifax Water Technical Services.
- Halifax Water Operations.

After successful Commissioning, the Consultant shall organize Training for Halifax Water Technical Services and Operations, in the proper operation of the pumping station and each unit process that makes up the facility. Such training shall include, at minimum:

- Safety orientation.
- System description.
- Identification of all individual pieces of equipment and explanation of their purpose.
- Review and description of control logic.
- Sequencing and set points for all control equipment and systems.
- Review and demonstration of operator interfaces (HMIs).
- 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 force mains, their location, the location of the discharge manhole(s) and any downstream restrictions or interlocks.

Following Training, the Contractor is to allow for additional programming adjustments to operator interfaces as directed by Halifax Water Technical Services and Operations.

4.3.7 Post Commissioning Interim Operation

The "Post Commissioning Interim Operation" period follows successful completion of the above laid out Commissioning and Training arrangements. During this period, it is expected that the station is fully functional but has not been turned over to Halifax Water. The Contractor is responsible for operation and maintenance of the station. This period will end, and the station will be turned over to Halifax Water, when a satisfactory Commissioning Report and Operations Maintenance Manual have been submitted to, and accepted by, Halifax Water and after a two (2) week period.
Interim operation of the station, by the Contractor, is required for a minimum period of two (2) weeks.

4.3.7.1 Commissioning Report

.1 Following successful completion of Commissioning and Training, the Consultant shall ensure that a Commissioning Report, complete with certification that the pumping station has been constructed and operates in accordance with the design intent and project specifications, is provided to Halifax Water by the Contractor.

.2 The Commissioning Report should contain, at a minimum:
- .1 Executive summary, including:
  - .1 Observations.
  - .2 Conclusions.
  - .3 Outstanding Items and how/when they will be rectified.
  - .4 Recommendations.
- .2 Performance verification checklists (test results and evaluation).
- .3 System deficiencies that were discovered and measures taken to correct them.
- .4 Outstanding deficiencies.
- .5 Plan for resolution of outstanding deficiencies.
- .6 Summary of training process and records of those that were trained at the facility.
- .7 Certification from the Consultant that the facility meets the design intent, is operating within specified parameters and is ready for intended use.

4.3.8 Operations and Maintenance Manual

The Consultant 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 pumping station

Operation and Maintenance manual, in a form acceptable to Halifax Water. The manual must contain the following items in the same general order:

- Title Page including:
  - Identification of document as an Operations & Maintenance manual.
  - Pumping station name.
  - Pumping station Contractor.
  - Pumping station Consultant.
  - Date of issuance.

- Index:
  - A quick reference table (spreadsheet to accompany electronic submission) listing the following information for each piece of equipment within the pumping station:
    - Asset Registry: make, model and serial number.
    - Name, address and contact details for supplier and installer.
    - Lubrication and regular maintenance tasks and intervals.
    - An index reference to the full equipment manual contained within the operations and maintenance manual.
    - Spare part list.
    - Expiry date for guarantee / warranty.
    - System description.
    - Narrative on area served inclusive of mapping.
    - Pumping station design intent, parameters, and limitations (i.e. design report).
    - As constructed civil, structural, mechanical, HVAC, P+ID, and electrical/instrumentation 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.
    - Pumping station commissioning report.
    - Systematic lifecycle upgrade report (if applicable).
    - Process Control Narrative.
    - Final Record Drawings of HMI/SCADA/PLC terminations.
    - Any original software and interface cables required for programmable equipment installed within the pumping station.
    - Construction and post-construction color digital photos. Construction and post-construction photos are to be taken at various angles showing the main features of the inside and outside

of the pumping station. A detailed plan index is to be provided showing location and angle of each photo in relation to the pumping station. When provided in electronic format the photos shall be labelled to identify the area of the pumping station and the main piece of equipment shown.

- Photos, including those that are not included in the O+M manual will be provided to Halifax Water on CD or pen-drive. The CD/Pen-drive shall be clearly identified with the name of the Pumping Station, name of the Contractor, name of the Consultant, and the date of construction.
- Record Drawings:
  Drawings are to be signed and stamped by a Professional Engineer (P.Eng.) licensed to practice in Nova Scotia. An electronic copy in PDF and CAD/REVIT/Civil 3D shall also be provided.
- Details regarding the temporary or phased operation must be included in the Operations & Maintenance Manual explaining the nature of each temporary or phased construction element. Instruction shall be provided for operating the system on partial influent loads.

4.3.9 Force Main Design

4.3.9.1 Force Main Material

.1 Pump stations shall be provided with dual force mains, each capable of handling the peak design flow.

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

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

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

.5 The Design Engineer shall assess the force main for possible damage from sulfide generation. In sections of the force main 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.

.6 The force main 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".

4.3.9.2 Force Main Minimum Diameter

.1 The minimum diameter of the force main is 100 mm.

4.3.9.3 Force Main Cover

.1 The depth of cover is measured from the finished surface design grade over the pipe to the crown of the force main.

- Minimum cover is 1.6 metres.
- Maximum cover is 2.4 metres.

4.3.9.4 Force Main Location

.1 Force mains 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.

.2 Force mains shall terminate in a well benched manhole such that the flow is directed down the barrel of the receiving gravity Wastewater System. The downstream pipe receiving flow from a force main must be of sufficient size and grade to prevent surcharging from the force main. The force main must be mechanically restrained to the manhole and where applicable mechanically restrained within the manhole to prevent movement.

4.3.9.5 Force Main Valves

.1 Automatic air relief and vacuum valves, suitable for wastewater applications, shall be located in a manhole at high points of the force main 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 the Supplementary Standard Specifications for Standard Details).

.2 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.

.3 Valving shall be provided at the pumping station to allow dual force main arrangements to operate independently.

.4 Plug valves on a force main sewer shall close clockwise (right) and open counterclockwise (left). Anodes are to be installed on all valves located outside of a chamber or pump station.

4.3.9.6 Force Main Bends and Deflections

.1 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.

.2 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.

.3 Refer to *Supplementary Standard Specifications* for Standard Details on thrust restraint requirements.

4.3.9.7 Force Main Velocity

.1 The minimum velocity of a wastewater force main at average design flow is 0.6 m/s.

.2 The maximum velocity of a wastewater force main at peak design flow is 3.0 m/s.

5.0 STORMWATER SYSTEM – DESIGN REQUIREMENTS

5.1 SCOPE

A Stormwater System is a complete and properly functioning system of stormwater mains, service connections from the stormwater main to the street lines and appurtenances, including stormwater ponds. The design will ensure that Wastewater and Stormwater Operations are not exposed to hazards when conducting operation and maintenance of the stormwater collection system.

All Stormwater Systems are to conform to any requirements established by NSE. Stormwater Systems cannot be constructed until the design has been approved by the Engineer.

Stormwater discharged into the Stormwater System must comply with *Halifax Regional Water Commission Act*, 2007, c. 55, s. 2; 2012, c. 60, s.1., Halifax Water Regulations and applicable bylaws.

For an extension to the Stormwater System, the Engineer will require the Applicant to enter into a Halifax Water Systems Agreement which defines the rights and obligations of Halifax Water and the Applicant regarding construction, inspection, record collection, acceptance and warranty of the new Stormwater System.

The design criteria contained herein are included to illustrate the more common aspects encountered in the design of Stormwater Systems. Any Stormwater System within the core boundary of the Municipality shall be designed to achieve the following objectives:

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

Halifax Water owns and operates various infrastructure whose operation can be impacted by the tide level of the Atlantic Ocean. These impacts can result from normal tidal fluctuations or from storm surges and wave run-up. Halifax Water infrastructure should also be resilient to adapt to sea level rise as a result of climate change throughout the life cycle of the infrastructure.

As a result, Halifax Water has developed a plausible upper bound flooding scenario of 4.86 meters (CGVD2013). It is recognized that for some infrastructure, the impact of temporary flooding due to storm surge is negligible and therefore low risk. In other instances the impact of a short duration flood can be catastrophic.

For any infrastructure to be installed below 4.86 meters (CGVD2013), The Design Engineer is to provide a statement for how the infrastructure still provides an acceptable level of service.

High High Water Level (HHWL):	0.73 metres (CGVD2013)
Sea level rise as a result of climate change:	1.50 metres
Storm surge and wave run-up:	2.63 metres
Total:	4.86 metres (CGVD2013)

Table 5.1 – Stormwater System Component Ownership

Component / Feature	Responsibility/ Owner
Municipal ditch (outside core area *)	NSDPW
Cross culverts (outside core area *)	NSDPW
Driveway culverts – across municipal ditch (outside core area *)	NSDPW
Municipal ditch (within core area *)	Halifax Water
Cross culverts (within core area *)	Halifax Water
Driveway culverts – across municipal ditch (within core area *)	Halifax Water
Driveway culverts (outside municipal right of way)	Property Owner
Rear yard swales	Property Owner
Side yard swales located in an Halifax Water easement (as part of overall municipal drainage system)	Halifax Water / Property Owner
Subsurface interceptor drains (within the municipal right of way)	the Municipality
Subsurface interceptor drains (outside municipal right of way)	Property Owner
Roadways	the Municipality
Curb and gutter	the Municipality
Municipal catch basins, ditch inlets/outlets	Halifax Water
Catch basins on private property (rear, side or front yard **)	Halifax Water / Property Owner
Manholes (part of municipal system only)	Halifax Water
Pipes (part of municipal system only)	Halifax Water
Stormwater management facilities	Halifax Water
Stormwater Service Connections (main to street line)	Halifax Water
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 the Municipality core area boundary drawing in Halifax Water's *Supplementary Standard Specifications* for Standard Details)

(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.

5.2 HYDROLOGY

Hydrology is the estimation of runoff produced from rainfall and/or snowmelt, and understanding the factors which influence it, and hydraulics is the determination of water flow characteristics in the channels, pipes, streams, ponds, and rivers which convey stormwater.

The selection of the method best suited for a stormwater design requires a Design Engineer. For stormwater design work, hydrologic and hydraulic modelling is required for the design of piped stormwater drainage systems, overland stormwater drainage systems, and stormwater management facilities

5.2.1 Meteorological Data

Rainfall data is used in a variety of forms including intensity-duration-frequency curves, synthetic design storms, historical design storms, and historical long-term rainfall records. Stormwater System design is based on intensity-duration-frequency curves and synthetic rainfall hyetographs only.

The Atmospheric Environment Service (AES) of Environment Canada produces an intensity–duration–frequency (IDF) curve for the Shearwater Airport weather station. This IDF curve is based on over 50 years of recorded annual maximal rainfall and is considered representative for the serviced areas of HRM. The IDF curve is based on the assumption that the climate is static and therefore the previous 50 year precipitation intensity record will be representative of the next 50 years. However, it is now commonly understood that climate is not static and that climate change will result in an increase in the intensity of precipitation.

Stormwater infrastructure owned and operated by Halifax Water has a life expectancy of approximately 100 years. In order to adapt to climate change, it is important that infrastructure be designed to accommodate the precipitation intensity that it anticipated throughout the life cycle of that infrastructure.

Based on climate change scenario data for HRM published by the Government of Nova Scotia (Nova Scotia Environment - Climate Change Unit https://climatechange.novascotia.ca/climate-data?tid=8#climate-data-map), Halifax Water has prepared a modified IDF curve based on the projected 2080 change in intensity short period rainfall. Figure 5.1 contains the climate change short duration rainfall intensity-duration-frequency curve.

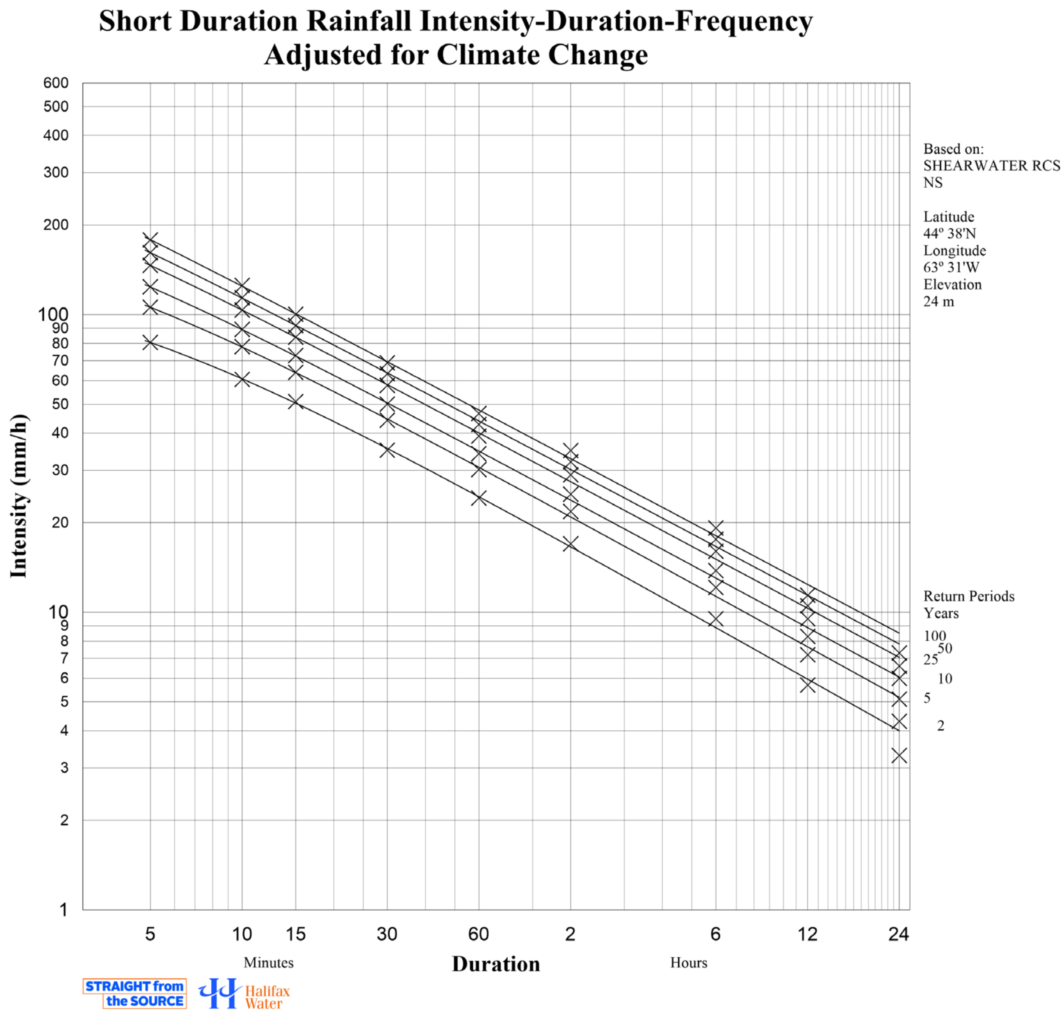


Figure 5.1 - Short Duration Rainfall Intensity-Duration Frequency Data

Storm	a	b	C
2YR	25.112	0.04959	0.578
5YR	31.196	0.03178	0.565
10YR	35.114	0.01905	0.553
25YR	40.265	0.01159	0.548
50YR	44.089	0.00874	0.544
100YR	47.924	0.00594	0.544

$$i = \frac{a}{(T_d + b)^c}$$

5.2.2 Synthetic Design Storm

Advanced procedures for the design of storm drainage systems requires the input of rainfall hyetographs or unit hyetographs, which specify rainfall intensities for successive time increments during a storm event. For the purpose of design, the Engineer requires the uses the Modified Chicago Storm hyetographs derived from the rainfall intensity-duration-frequency (IFD) curves presented above. Figure 5.2 through Figure 5.7 present the 24 hours Modified Chicago Storm distribution for the 2, 5, 10, 25, 50 and 100 year return periods.

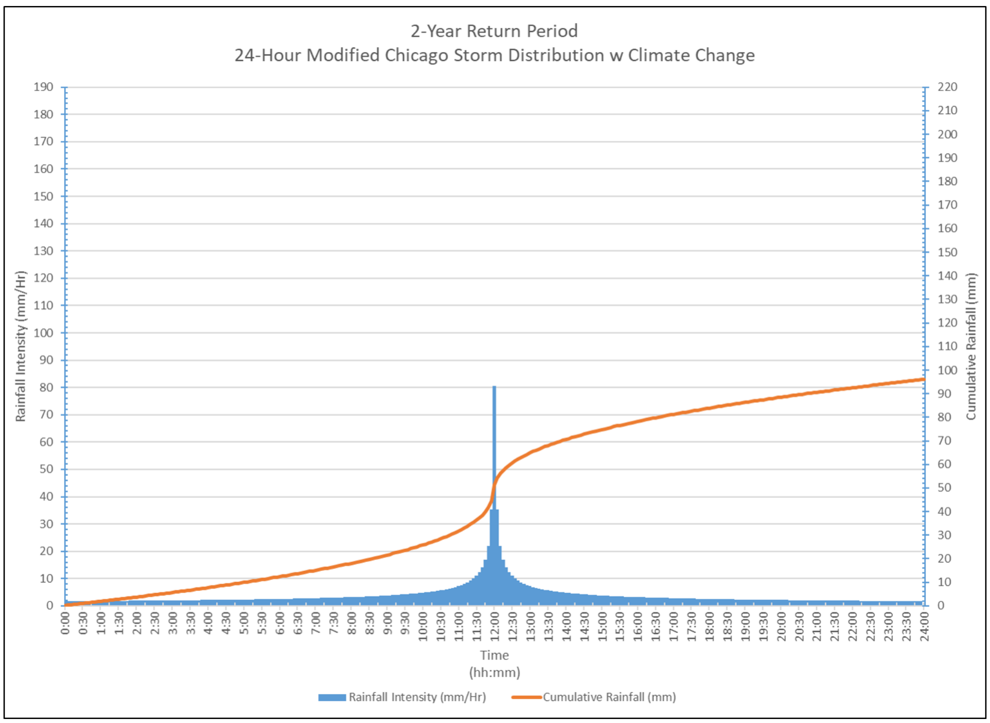


Figure 5.2 - 24 hours Modified Chicago Storm distribution for the 2 year return period

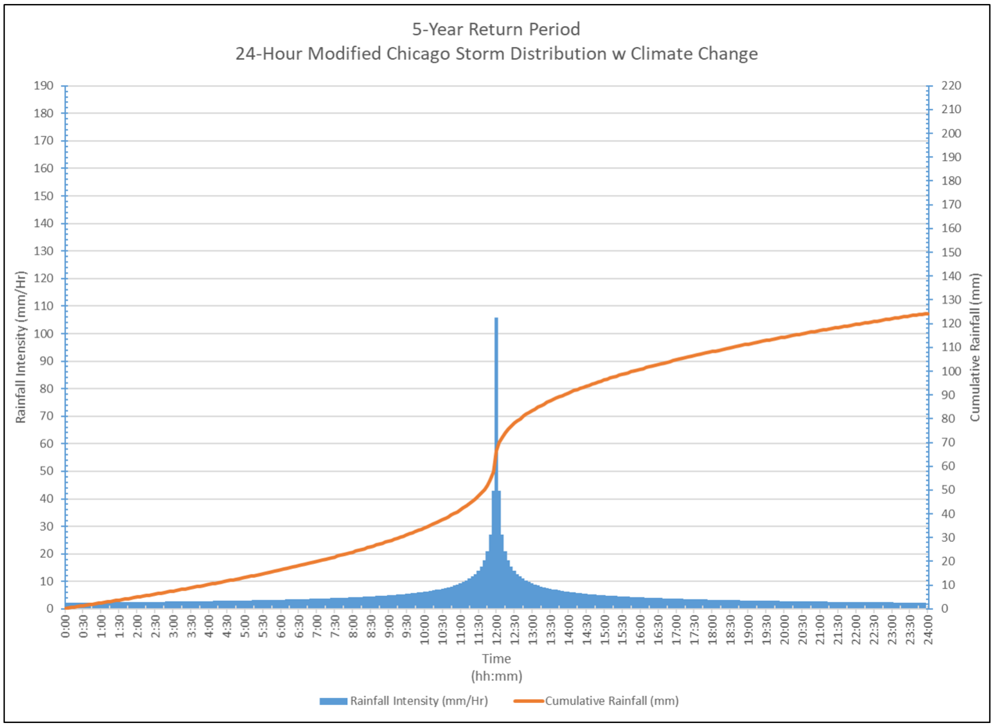


Figure 5.3 - 24 hours Modified Chicago Storm distribution for the 5 year return period

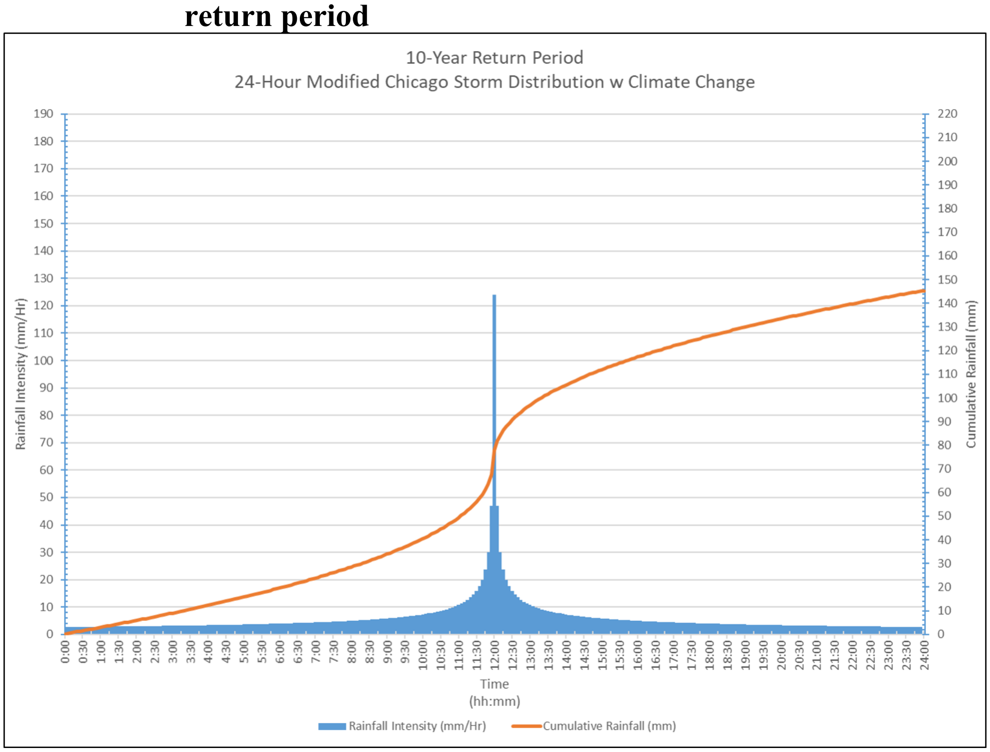


Figure 5.4 - 24 hours Modified Chicago Storm distribution for the 10 year return period

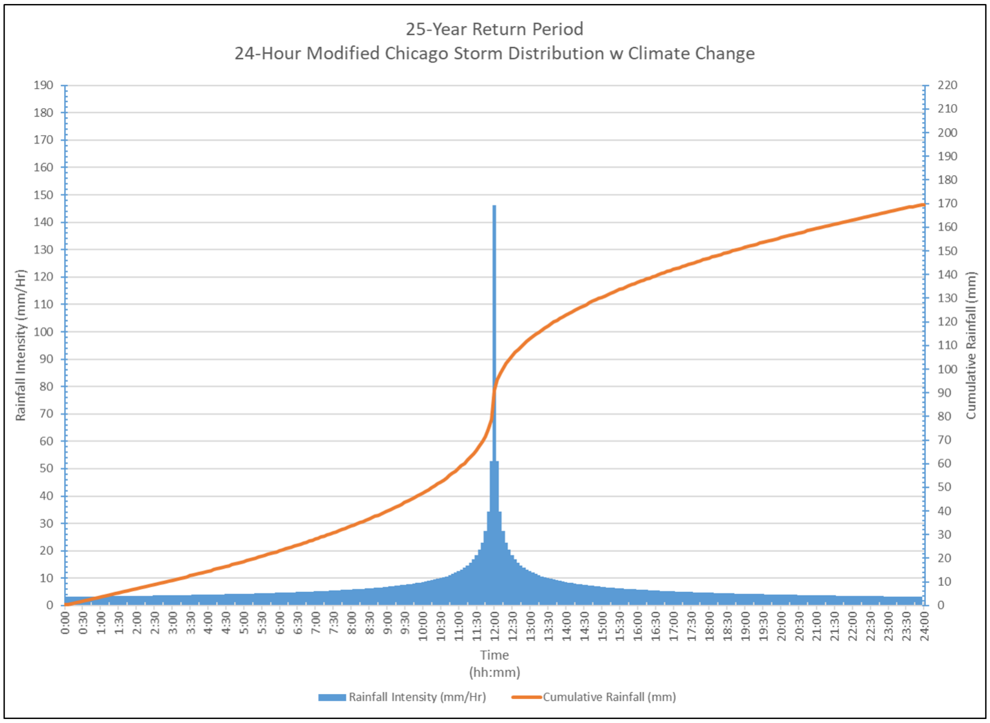


Figure 5.5 - 24 hours Modified Chicago Storm distribution for the 25 year return period

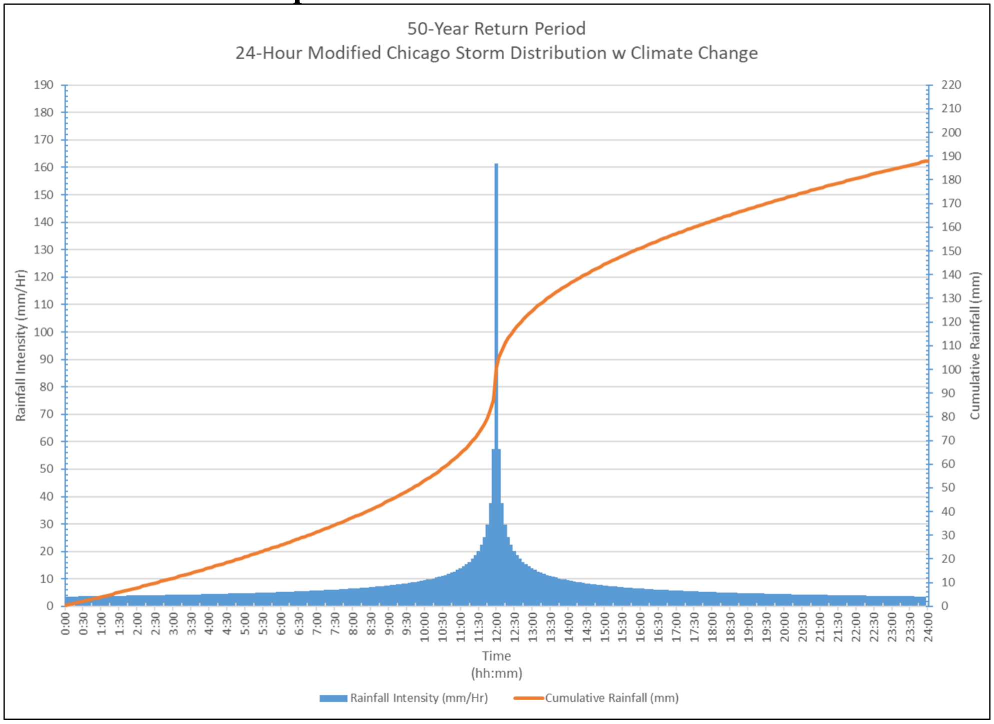


Figure 5.6 - 24 hours Modified Chicago Storm distribution for the 50 year return period

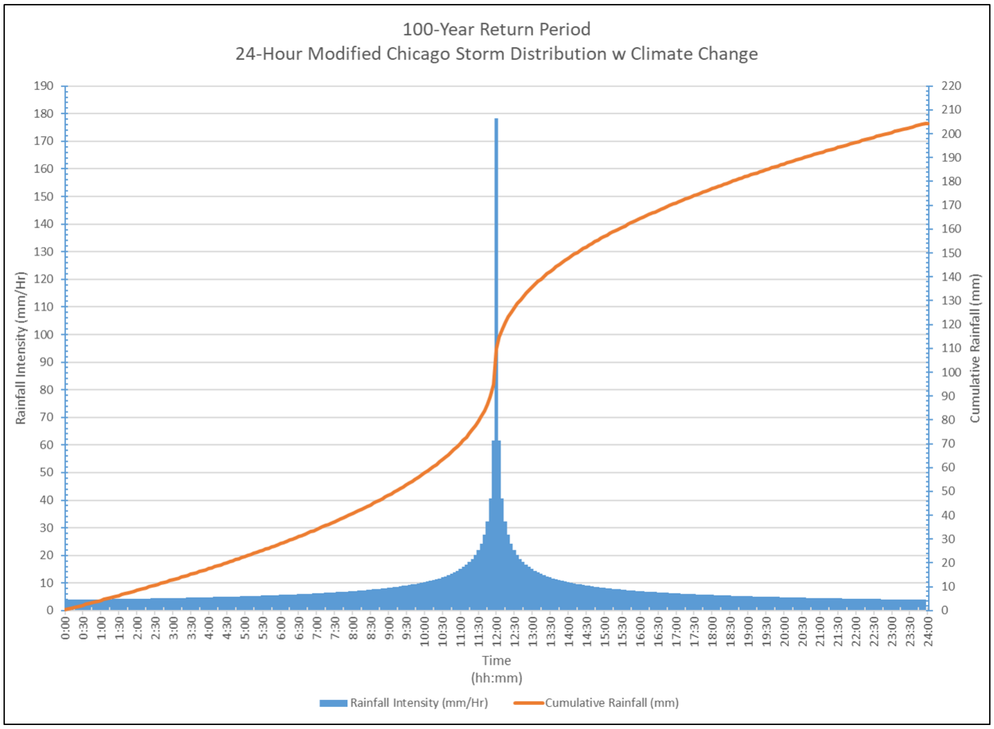


Figure 5.7 - 24 hours Modified Chicago Storm distribution for the 100 year return period

5.2.3 Runoff Methodology

The quantity and rate of flow of stormwater to the piped system is influenced by the characteristics of the surface on which the rain falls. There are numerous techniques and models available to the Design Engineer based on both empirical investigations and theoretical calculations. Halifax Water will accept only the following methods for applications:

- USDA Natural Resources Conservation Service (NRCS)
- Horton Method
- Green-Ampt Method

Depending on the methodology chosen by the Design Engineer, the following variables are to be reported in the Stormwater System design for each sub-area (pre-development and post-development)

5.2.3.1 USDA Natural Resources Conservation Service

Formerly known as the Soil Conservation Service (SCS), the USDA Natural Resources Conservation Service (NRCS) developed the runoff curve number to predict direct runoff and infiltration from rainfall. It is widely used and is an efficient method for determining the approximate amount of direct runoff from a rainfall event in a particular area.

The Stormwater System design plan must show the following:

- Ia/S - Initial Abstraction Ration (if different than 0.2)
- Antecedent Runoff Condition (Also referred to as Antecedent Moisture Condition)
- Area (Ha)
- CN – Curve Number
- Short Description of cover type/hydrologic condition
- Tc – Time of Concentration
- Peak Flow (L/s)

5.2.3.2 Horton Method

The Horton method utilizes an empirical formula which states infiltration begins at a constant rate and then decreases exponentially with time. When the soil saturation level reaches a certain value the rate of infiltration levels off.

The Stormwater System design plan must show the following:

- Area (Ha)
- Maximum Infiltration Rate (mm/hour)
- Minimum Infiltration Rate (mm/hour)
- Decay Constant (1/hour)
- Maximum Infiltration Volume (mm)
- Surface Depression Storage Depth (mm)
- n - Manning’s Roughness Coefficient
- Peak Flow (L/s)

5.2.3.3 Green-Ampt Method

The Horton equation captures the basic behavior of infiltration but the physical interpretation of the exponential constant is uncertain. The Green-Ampt method is based on fundamental physics and is a function of the soil suction head, porosity, hydraulic conductivity and time.

The Stormwater System design plan must show the following:

- Area (Ha)
- Suction Head (mm)
- Conductivity (mm/hour)
- Initial Deficit
- Surface Depression Storage Depth (mm)
- n - Manning's Roughness Coefficient
- Peak Flow (L/s)

5.2.3.4 UKWIR Method

The UKWIR method utilizes an empirical formula based on statistical analysis of urban watersheds in United Kingdom. The UKWIR treats pervious and impervious surfaces differently and both surfaces have a range of adjustable parameters to add additional detail to the hydrology compared to traditional fixed runoff methodology. Impervious surfaces can account for depression storage and can assume a small amount of permeability through surface cracking. The primary adjustable parameters for pervious surfaces are soil type, depression storage and catchment wetness. This method accounts for a limit on infiltration through soil saturation resulting in an increasing amount of surface runoff as the soil becomes saturated. The UKWIR methodology can be linked to the ground infiltration model so that a proportion of rainfall that does not enter the Stormwater System via runoff can be assigned as ground water infiltration. This method is also better suited to long duration modelling as it accounts for soil drying in the intra-event periods.

The Stormwater System design plan must show the following:

- Area (Ha)
- For Paved Surfaces:
  - Effective impermeability, IF
  - Precipitation decay coefficient, Cpv
  - Power coefficient for PI, b
  - Storage depth, PFpv
- For Pervious Surfaces:
  - Wetness decay for NAPI, Cs
  - Power coefficient, Cr
  - Storage depth, PFs
  - Minimum NAPI
- Peak Flow (l/s)

5.3 DOWNSTREAM EFFECTS

The downstream Stormwater System must have the capacity to convey discharge from its fully developed watershed. Upgrades may be required to the downstream Stormwater System to reduce adverse impacts.

Explicit consideration shall be given to public safety, NSE regulations, NSDPW regulations, nuisance, and maintenance implications of ditches, open channels, and drainage courses. Attempts shall be made to limit the number of partial enclosures of a ditch, open channel, or drainage course by driveways, roadways, and other crossings.

5.3.1 Stormwater Control Facilities

Investigation of requirements to mitigate the downstream effects of a proposed development shall be carried out to determine the requirements for and feasibility of the utilization of a storage facility for stormwater runoff control. If a determination is made that a storage facility is required, its design shall be carried out using appropriate methods and sound engineering principles. The design shall take into consideration various factors including, but not limited to, watercourse protection, erosion and sediment control, impact on adjacent property, maintenance requirements, public safety, access, liability, and nuisance.

Such storage facilities shall be designed to control the peak runoff conditions for multi-storm events up to the 100 year return period storm.

5.3.2 Stormwater System

No stormwater runoff is to be carried onto, thru, or over private property, within a subdivision, other than by a natural watercourse or Stormwater System. To guarantee access to the Stormwater System, a Halifax Water service easement agreement between the land owner and Halifax Water is necessary in the following cases:

- Stormwater Systems within the boundary of the subdivision.
- Where a need is identified by the Engineer and the Municipality to accommodate future upstream drainage, a Halifax Water service easement agreement is to be provided from the right-of-way boundary to the upstream limits of the subdivision.
- May be required for Stormwater Systems or designed overland flow routes adjacent to and immediately downstream of the subdivision.
- Natural watercourses are not to be carried in roadside ditches or minor storm drainage systems.

5.3.3 Discharge to Adjacent Properties

All stormwater drainage is to be self-contained within the subdivision limits, except for natural drainage associated with runoff from undeveloped areas. However, runoff from within the subdivision may be directed to a watercourse, or storm drainage system owned by Halifax Water, the Municipality or NSDPW.

In all cases, concentration and conveyance of stormwater to adjacent properties outside the subdivision limits is prohibited unless the Applicant obtains permission from the adjacent property owners, and private drainage or Halifax Water service easement is provided.

The subdivision grading along the limits of the subdivision is to avoid disturbance of adjacent properties or increase the discharge of stormwater to those properties.

The subdivision grading is to provide for drainage from adjacent properties where no other alternative exists. This may be achieved by utilizing an interceptor swale or other system components.

The subdivision grading is to provide for temporary drainage of all blocks of land within the subdivision that are intended for future development.

5.4 ANALYSIS OF EXISTING STORMWATER SYSTEM

In the absence of existing Master Planning, it may be necessary to analyze the capacity of the existing Stormwater System. This may be required if a proposed development may increase stormwater runoff to an existing system, therefore the existing system needs to be analyzed to confirm its capacity. It may also be necessary to analyze an existing Stormwater System due to complaints of flooding or problems within the system. Where an existing stormwater drainage system within the core boundary of the Municipality is to be analyzed, the Design Engineer is to submit the following.

5.4.1 Hydrologic Analysis

Where existing Stormwater Systems are being analyzed, it is crucial to determine the peak stormwater runoff to a given point in a system caused by severe rainfall events and snowmelt events. Where storage facilities are included in the study, it may be necessary to determine the hydrograph of the stormwater runoff to a particular point; that is, the simple instantaneous peak flow will not be adequate to analyze storage facilities. In determining the stormwater runoff or hydrographs, the methods as described herein are to be used.

In preparing the hydrologic and hydraulic model, it may be necessary to determine the drainage area to each individual storm manhole and each individual storm catch basin. This information should be compiled on a master drawing of the area being studied with appropriate labels for the areas, manholes, and catch basins such that calculations can be easily compared to the plan. For minor stormwater drainage systems (stormwater mains and catch basins), the 1:5 year return period storm shall be checked for the points of interest. For open channels, watercourses, and major drains on streets, the 1:100 year return period storm shall be checked for the points of interest.

5.4.2 Hydraulic Analysis

For each component of the existing Stormwater System such as a stormwater main, open channel, watercourse, or culvert, the hydraulic capacity of that portion of the system needs to be determined and compared to the flow determined from the hydrologic calculations. Follow these procedures in determining the hydraulic capacity of Stormwater Systems.

5.4.2.1 Open Ditches, Channels, and Watercourses

To determine the capacity of open channels, ditches, and watercourses, the Manning equation may be used where grades are relatively steep, greater than 1%. Where grades are less than 1%, it may be necessary to account for backwater effects using the energy equation and the direct-step or standard-step methodologies. Also to be considered in these calculations is the water surface elevation at the outlet of the ditch, watercourse, or channel.

5.4.2.2 Culverts

To calculate the hydraulic capacity of a culvert, the inlet capacity of the culvert and the outlet capacity should be checked taking into consideration maximum tailwater elevation at the outlet of the culvert. Also to be checked is the barrel capacity of the culverts using the Manning equation. In general, the inlet capacity of the culvert will be the limiting factor in determining the capacity.

5.4.2.3 Stormwater System

The piped Stormwater System consists of stormwater mains, manholes, catch basins, inlets and outlets. The capacity of a Stormwater System is to be checked as follows:

- Preliminary sizing of pipe diameter assuming full flow conditions for each pipe in the minor storm drainage system using the Manning equation for the 1:5 year return period storm. Manning's roughness coefficients (n) have been tabulated in Table 5.2. The ratio of the 1:5 year design flow (Q_5) to full flow pipe capacity (Q_{cap}) should not exceed 80%.

$$\frac{Q_5}{Q_{cap}} \leq 0.80$$

where:

Q_5 1:5 year design flow (L/s)
Q_{cap} full flow pipe capacity (L/s))

- A determination of the hydraulic grade line for the 1:5 year return period storm should be conducted assuming the actual captured flow (Q_c) is 100% of the 1:5 year design flow (Q_5). Analysis should account for pipe friction losses, junction and bend losses, outlet tailwater elevation, and capacity constraints of the downstream system. Hydraulic grade line profiles may be determined by the standard-step method, the direct-step method, or acceptable energy equation principles. The hydraulic grade line profile should be plotted on the plan and profile drawing to ensure that the water surface profile is contained in the pipe. An elevated hydraulic grade line may require a pipe diameter larger than that which is determined by the Manning equation in order to avoid surcharging of the minor storm sewer system.

- A determination of the hydraulic grade line for the 1:100 year return period should be conducted assuming the actual captured flow (Q_c) is some percentage of the 1:100 year design flow (Q_{100}). The actual captured flow should be the lesser of the maximum catch basin inlet capacity, the maximum catch basin lead capacity, or the 1:100 year design flow (Q_{100}). Analysis should account for pipe friction losses, junction and bend losses, outlet tailwater elevation, and capacity constraints of the downstream system. Hydraulic grade line profiles may be determined by the standard-step method, the direct-step method, or acceptable energy equation principles. The hydraulic grade line profile should be plotted on the plan and profile drawing to ensure that the water surface profile is at an acceptable level. The elevated hydraulic grade line profile should not threaten back-up into service laterals, or basements.

5.5 STORMWATER SYSTEM DESIGN

A Stormwater System design is to be prepared and included as part of the submission for any proposed Stormwater System extension. At a minimum the Stormwater System design must contain the design criteria for the 1:5, 1:10, 1:25, 1:50 and 1:100 year events. The stormwater design is also to address watercourse protection, erosion and sediment control, impact on adjacent property, maintenance requirements, public safety, access, liability and nuisance.

Pre-development lands have a combination of natural stormwater infiltration and overland stormwater flow. NSE requires proposed publicly owned development submissions to balance pre-development and post-development stormwater runoff. The method of balancing is left up to the Design Engineer, these may include, but not limited to stormwater ponds and artificial wetlands. Balancing of all stormwater flows up to, and including the 1:100 year storm is required.

The detailed design submission is to include a stormwater drainage plan which will include pre-development runoff calculations and post-development runoff calculations. Make effort to contain this information on a single sheet.

The stormwater drainage plan will show the key runoff variable described in section 5.2.3 for each sub-watersheds for pre-development and post-development. The plan will also show all stormwater management alternatives; and output information demonstrating the main steps of the calculations and the peak discharge at key points in the system. Peak flow must be shown at the points of discharge from the proposed development. The flow route of the major drainage path shall be indicated.

The Stormwater System design must 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)
- the 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 tables and any other information required by the Engineer.

5.5.1 Minor Stormwater System

The minor Stormwater System consists of lot grading, ditches, swales, roof leaders, foundation drains, Stormwater Service Connections, curbs & gutters, mains, catch basins and culverts. The piped Stormwater System is designed to convey the 1:5 year storm without surcharge. The 1:10 year storm is conveyed within the curb & gutter and cross culverts of the Municipality street system unless otherwise approved by the Engineer and the Municipality.

5.5.1.1 Minor System Design

The capacity of a proposed Stormwater System or an existing Stormwater System shall be confirmed by accounting for the head loss through the pipe system and through any junctions including manholes and bends. The Manning's Equation may be utilized to calculate the capacity of the piped Stormwater System. A detailed analysis of the Stormwater System as a whole will be required. This analysis will determine the hydraulic grade line when the Stormwater System is conveying the 1:5 year flows, and will take into account losses at manholes and other junctions, the head loss through the pipes, and any backwater conditions at the outlet of the Stormwater System.

The Design Engineer is required to calculate the inlet capacity at each entry point to the Stormwater System.

5.5.1.2 Minimum Velocity

Under peak design flow conditions from the tributary area, when fully developed, stormwater flow velocities must be a minimum of 0.75 m/s.

5.5.1.3 Maximum Velocity

Under peak design flow conditions from the tributary area, when fully developed, stormwater flow velocities must be a maximum of 7.5 m/s.

5.5.1.4 Stormwater Main Material & Fittings

.1 Reinforced concrete pipe meeting the requirements of the latest CSA Standard A257.2 or ASTM Standard C76.

.2 PSM Polyvinyl Chloride pipe and fittings meeting the requirements of the latest CAN /CSA B1800.

.3 Profile Polyvinyl Chloride pipe and fittings meeting the requirements of the latest CAN /CSA B1800.

.4 Profile High Density Polyethylene (HDPE) pipe and fittings (up to 900 mm) meeting the requirements of the latest CAN /CSA B1800, with a minimum pipe stiffness of 320 KPa (46 Psi) and Type 1 (Water-tight) joints with integrated bells/welded joints.

.5 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 CSA Standard B1800.

.6 Steel reinforced polyethylene (SRPE) pipe and fittings to CAN/CSA-B182.14-12/B182.15-12 with a minimum pipe stiffness of 320 kPa.

Pipe gaskets are to be utilized for all stormwater main installations.

5.5.1.5 Stormwater Main Friction Factors

.1 The following are Manning Roughness Coefficients:

Table 5.2 - Manning Roughness Coefficients

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

5.5.1.6 Minimum Diameter

.1 Stormwater main – minimum diameter is 300 mm
.2 Catch basin lead – minimum diameter is 200 mm
.3 Cross culvert – minimum diameter is 525 mm
.4 Driveway culvert – minimum diameter is 450 mm
.5 Inlet to a stormwater structure – minimum diameter is 450 mm

5.5.1.7 Changes in Diameter

Stormwater main diameter must 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. Manholes are to be provided where the stormwater main diameter changes.

5.5.1.8 Minimum Slope

.1 Stormwater main – minimum slope is 0.4%
.2 Stormwater main dead-end – minimum slope is 0.6%
.3 Catch basin lead – minimum slope is 1.0%
.4 Ditch or open channel – minimum slope is 2.0%

Under special conditions, if full and justifiable reasons are given, slopes less than 0.4% and 0.6% may be permitted provided that self-cleansing velocities under full flow conditions are maintained.

5.5.1.9 Minimum Depth

.1 Stormwater main – minimum depth is 1.6 metres
.2 Cross culvert – minimum depth is 0.5 metres

Measure the depth of cover from the finished surface to the top of the pipe.

However, in order to service full residential basements, the depth of stormwater main must be adequate to service the dwelling by gravity and maintain a Stormwater Service Connection minimum cover of 1.2 metres.

5.5.1.10 Maximum Depth

The depth of stormwater mains, from the finished surface to the top of the pipe must not exceed 5.0 metres. However, under special conditions, if full and justifiable reasons are given, the maximum depth of stormwater mains may be increased such that the depth to the crown of the pipe at any manhole location shall not exceed 8.0 metres.

5.5.1.11 Stormwater Main Location

All Stormwater Systems are to be located within the Municipality street right-of-way. Stormwater Systems on private property will be considered at time of design review, and will require an easement agreement jointly signed by the land owner and the Halifax Water Board. All stormwater drainage outfalls are to be located within an easement agreement in favour of Halifax Water.

Where a need is identified to facilitate future development on the adjacent lands, Stormwater Systems, are required to be extended to the midpoint of the frontage of the last lot as per the Municipality Regional Subdivision By-law.

Halifax Water service easement shall be of sufficient width to allow safe excavation of the Halifax Water Systems in accordance with the requirements Occupational Health and Safety Act of Nova Scotia. Depending upon the length and location of the service easement, the Engineer may require a travel way to be provided within the Halifax Water service easement for access and maintenance purposes.

Where Master Planning indicates a need to accommodate future upstream lands naturally tributary to the drainage area, a service easement is to be provided from the edge of the street right-of-way to the upstream limit of the subdivision.

Refer to Section 6.0 for Halifax Water easement requirements.

5.5.1.12 Stormwater Manhole

Provide a stormwater manhole where:

.1 A Stormwater System begins in a street right-of-way.

.2 There is a change in horizontal or vertical alignment.

.3 There is a change in diameter.

.4 There is a change in stormwater main material.

.5 Where a catch basin is to be connected to the Stormwater System.

.6 Where two stormwater mains come together.

Where a stormwater main diameter is less than 1500 mm, manhole spacing shall not exceed 100 metres. Where a storm sewer main diameter is equal to or greater than 1500 mm, manhole spacing will be determined in consultation with the Engineer.

The following criteria shall be used for pipe elevation and alignment in stormwater manholes to account for energy losses through the manhole:

.1 An invert drop equal to the difference in pipe diameter shall be provided unless a different drop is determined by appropriate calculations.

.2 The obvert of a downstream pipe shall not be higher than the obvert of an upstream pipe.

.3 An internal drop manhole shall be constructed where the vertical drop between pipe inverts in the manhole exceeds 1.0 metre.

.4 The Design Engineer is to take into consideration energy losses at manholes during peak flow conditions to ensure that surcharging of the system does not occur.

.5 The minimum internal diameter of a manhole shall be 1050 mm. The internal diameter is required to accommodate all pipe and appurtenances in accordance with manufacturer's installation recommendations. Manhole ladders are not permitted.

5.5.1.13 Stormwater Manhole Connections

.1 A maximum of two (2) Stormwater Service Connections are permitted to connect to a stormwater manhole.

.2 Flexible rubber connectors can used for connecting pipe to stormwater manholes. Rubber connectors are either cast-in-place during manufacture of the pre-cast product or installed into a cored or preformed hole in the finished stormwater manhole.

.3 Pipe connections to stormwater manholes must not protrude more than 25 mm from interior wall.

5.5.1.14 Stormwater Catch Basin

The following are the requirements for stormwater 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 metres.

.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 publicly 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 hydraulic grade line 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, or areas that may have sediment laden runoff) the Engineer will require a stormwater treatment unit (e.g. "Stormceptor, CDS, or other comparable technology") connected prior to discharging to the public system.

.9 Catch basin depth is not to exceed 4 metres.

5.5.1.15 Stormwater Catch Basins Lead

The following are the requirements for catch basin leads:

.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 metres 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 metre 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.

5.5.1.16 Groundwater Migration

The Design Engineer shall assess the possibility of groundwater migration through mains, service connections, and service connection trenches resulting from the use of pervious bedding material. Corrective measures, including provision of impermeable collars or plugs, to reduce the potential for basement flooding resulting from groundwater migration should be employed.

5.5.2 Minor Stormwater System Connection

5.5.2.1 Stormwater Service Connection

The following are the requirements for Stormwater Service Connections:

.1 Every building is required to be connected separately to the mains from any other building, except that an ancillary building on the same property may be serviced by the same Stormwater Service Connection (National Plumbing Code of Canada).

.2 Semi-detached are permitted to share foundation drains.

.3 A single Stormwater Service Connection to each lot is required when extending Halifax Water Systems. Extend the Stormwater Service Connection at least 1.5 metres inside the property line. Cap the bell end of the Stormwater Service Connection with a PVC cap.

.4 Break the rock 3.0 metres beyond the plugged end of the Stormwater Service Connections.

.5 Stormwater Service Connection 200 mm or smaller are to connect to the stormwater main utilizing a factory tee or wye fittings. Saddle Connections utilizing flexible rubber connectors may also be used. Utilize vertical long radius bend of 45° at the stormwater main.

.6 Stormwater Service Connection 250 mm or greater connect to the stormwater main utilizing a precast stormwater manhole.

.7 One horizontal, long radius 22½° bend is permitted along the length of a Stormwater Service Connection. If more than one bend or a bend greater than 22½° is required, an access type structure is to be installed at each additional bend.

.8 Stormwater Service Connections smaller than 200 mm and an overall length greater than 25 metres require an access type structure every 25 metres. Place a 300 mm x 300 mm x 6 mm steel plate above the structure 150 mm below the ground surface to allow for detection by a metal detector.

.9 Stormwater Service Connections 200 mm or greater require manholes for changes in direction and maximum spacing of 100 metres.

.10 Stormwater Service Connections are not permitted to decrease in size from the building connection to the main.

.11 Minimum 2% grade.

.12 Maximum 8% grade.

.13 Minimum 1.2 metres cover. Halifax Water may require private Stormwater Service Connections to Combined Systems be installed shallower than 1.2 metres to accommodate future sewer separation projects. This will be determined during permit review.

.14 When a property has access to a Combined and Stormwater System, the Stormwater Service Connection must connect to the Stormwater System.

.15 Minimum 300 mm horizontal and vertical separation distance from a Water Service Connection.

.16 Minimum 450 mm vertical separation when crossing below a Water Service Connection.

.17 Minimum 3.0 metre horizontal separation from an outdoor fuel tank and septic tank.

.18 Minimum 2.0 metre horizontal separation from gas lines, underground electrical / telephone conduit, steam or hot water piping, transformer pads, utility poles or other utilities.

.19 One PVC coupling is permitted along the length of the Stormwater Service Connection prior to where it enters the building. Minimum 2 meter length of pipe is required on either side of the coupling for this section.

.20 One additional PVC coupling is permitted between the in-line tee at the main and the long radius bend of the Stormwater Service Connection.

5.5.2.2 Stormwater Service Connection Residential

In addition to the general requirements, Stormwater Service Connection Residential requires the following:

.1 Minimum 100 mm diameter.

.2 Stormwater Service Connections PVC DR35 (green).

.3 Locate the public portion of Stormwater Service Connections 1.5 metres from driveways.

5.5.2.3 Stormwater Service Connection Multi-Unit & ICI

In addition to the general requirements, Stormwater Service Connection Multi-Unit & ICI requires the following:

.1 Minimum 150 mm diameter

.2 Grade less than 2% permitted under the stamp of the Design Engineer.

.3 Stormwater Service Connections PVC DR35 (green).

.4 Locate the public portion of Stormwater Service Connections 1.5 metres from driveways, if possible.

.5 A Monitoring Access Point stormwater manhole is required and is to be located on private property, adjacent to the right-of-way. Stormwater Service Connections to buildings with zero setback from the right-of-way boundary may be eligible to have the Monitoring Access Point stormwater manhole waived at the discretion of the Engineer.

.6 These applications are required to manage stormwater on-site such that the rate of stormwater flow discharged from the site matches or betters the post-development peak flow rate with the pre-development peak flow rate for the 1:5, 1:10, 1:25, 1:50 and 1:100 year storm events. If the Stormwater System (piped and/or ditches) is the only discharge point for the developed property, all storm events above are to be detained such that the peak discharge rate from the site never exceeds the peak flow rate for the minor system. Any on-site retention must consider the major overland flow route.

.7 Applications within an approved major subdivision stormwater management plan must adhere to that stormwater management plan. Site balancing may not be required depending on the conditions of the major subdivision stormwater management plan.

5.5.2.4 Stormwater Service Connection Abandonment

Stormwater Service Connections are required to be abandoned at the stormwater main for all Municipality Demolition Permits. The method for abandonment is dependent on the site conditions specific to the Stormwater Service Connection in question. Wastewater & Stormwater Operations will dictate the abandonment method to be used.

5.5.2.5 Stormwater Service Connection Reutilization

An existing Stormwater Service Connection may be reused subject to all of the following conditions being met:

.1 The proposed land use and building size is known.

.2 The Stormwater Service Connection is of adequate size and meets current pipe material specifications.

.3 A Closed Circuit Television video is to be provided to Engineering Approvals confirming the Stormwater Service Connection condition warrants reuse.

5.5.2.6 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 a Halifax Water 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 a Halifax Water ditch system and must be terminated at the property line. Discharge to the ditch system shall be achieved using clear stone or rock drain.

Where a minor storm drainage system does not exist, other options are permitted as specified in the National Building Code.

5.5.2.7 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 the Municipality requirements.

Multi-Unit, Industrial, Commercial & Institutional

Roof drains may be connected to the internal private stormwater arrangement, provided that the rainwater flows are incorporated into the pre-development and post-development flows for this site.

5.5.3 Major Stormwater System

5.5.3.1 Minor Storms

The minor system consists of lot grading, ditches, swales, roof leaders, foundation drains, curb & gutters and the Stormwater System. The piped Stormwater System is designed to convey the 1:5 year storm without surcharge. The depth of flow in gutter cannot exceed 50 mm in the minor storm.

The 1:10 year storm is to be conveyed within the curb & gutter and cross culverts of the Municipality street system unless otherwise approved by the Engineer and the Municipality.

5.5.3.2 Major Storms

For curb & gutter applications, storm drainage design shall provide that the depth and spread of flow in a 1:10 year storm shall be contained within the right-of-way.

For mountable-type curb applications, the area located directly behind the curb must be graded in order channel the flow and prevent discharge from the right-of-way except within a Halifax Water service easement designed to convey the overland flow.

All low points in the roadway profile must be designed to collect and convey stormwater runoff off the roadway via a Halifax Water service easement designed to convey the overland flow.

Provision shall be made to remove runoff into drainage channels, watercourses, and pipe systems at low points and at intervals that will assure that this criteria is observed.

5.5.3.3 Ditches and Open Channels

Roadway ditches, where curb and gutter systems are not required, shall be designed to conform to the typical cross section for rural roads as prescribed by the Municipal Design Guidelines by the Municipality. Ditches shall be designed with adequate capacity to carry the flow expected from the 1:100 year return period storm.

5.5.3.4 Maximum Velocity

To prevent erosion, maximum velocities in a 1:100 year return period storm in ditches or open channels that convey stormwater runoff shall not exceed values set forth in Table 5.3 unless the channel is lined or acceptable energy dissipation facilities are provided.

Table 5.3 presents maximum permissible mean channel velocities for swales, ditches, open channels, and drainage courses.

Table 5.3 – Maximum Permissible Mean Channel Velocity

Channel Material	Maximum Permissible Mean Channel Velocity (m/s)
Fine Sand	0.45
Coarse Sand	0.75
Fine Gravel	1.85
Earth – Sandy Silt	0.60
Earth – Silty Clay	1.05
Earth – Clay	1.20
Bermuda Grass Lined – Earth – Sandy Silt	1.85
Bermuda Grass Lined – Earth – Silty Clay	2.45
Kentucky Blue Grass Lined – Earth – Sandy Silt	1.50
Kentucky Blue Grass Lined – Earth – Silty Clay	2.15
Sedimentary Bedrock – Poor	3.05
Sedimentary Bedrock – Sandstone	2.45
Sedimentary Bedrock – Shale	1.05
Igneous Bedrock	6.10
Metamorphic Bedrock	6.10

5.5.4 Culvert

5.5.4.1 Minimum Diameter

.1 Driveway culvert – minimum 450 mm, nor smaller than the upstream driveway culvert.

.2 Cross culvert – minimum 525 mm, minimum 500 mm cover.

.3 The stormwater system servicing plan submitted to the Engineer in support of system extension projects are to include a driveway culvert table and a cross culvert table indicting pipe size and material.

5.5.4.2 Minimum Depth

Minimum cover for culverts under roadways is 500 mm.

5.5.4.3 Maximum Depth

The Design Engineer may be required to submit pipe strength calculations including earth loading, line loading, and induced loading, accounting for site conditions and construction practices.

5.5.4.4 Hydraulic Capacity

Culverts are to be sized to convey instantaneous peak flows with a headwater depth to culvert diameter ratio of 1.0 accounting for both inlet control and outlet control.

Culverts located under driveways and roadways are to be designed to accommodate the 1:10 year return period storm, unless otherwise directed by the Engineer.

Culverts located in drainage courses or natural watercourses are to be designed to accommodate the 1:100 year return period storm, unless otherwise directed by the Engineer.

5.5.4.5 Maximum Headwater Depth

Maximum headwater elevation for both inlet control and outlet control should be checked relative to adjacent ground surface and adjacent structures for compatibility. The Design Engineer may reduce maximum headwater elevations for culverts under inlet control by improving inlet hydraulics. Table 5.4 present entrance loss coefficients for reinforced concrete pipe.

The values presented in Table 5.4 should be used for the determination of required headwater from the energy equation, or a nomograph solution of the energy equation.

Table 5.4 - Entrance Loss Coefficients for Reinforced Concrete Pipe Culverts Under Inlet Control

Inlet Geometry	Inlet Type	Entrance Loss Coefficient (k_e)
Projecting from fill (bell end)	1a	0.2
Projecting from fill (square cut end)	1b	0.5
Mitered to conform to slope	2	0.7
Headwall or headwall and wing walls (bell end)	3a	0.2
Headwall or headwall and wing walls (square cut end)	3b	0.5
Flared inlet conforming to slope	4	0.5
Headwall or headwall and wing walls (rounded edge)	5	0.1
Beveled ring	6	0.25

5.5.4.6 Inlet & Outlet

The design must address hydraulic criteria, energy dissipation, head losses, embankment stability, erosion, public safety, appearance and the effect of the grating (if required) has on restricting the stormwater flow into the pipe.

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

Inlet & Outlet Pipe 300 mm to 1500 mm

- Precast concrete headwall, wing walls and apron
- Grates are required on inlets of culverts or piped systems greater than 30 metres in length and diameters of 450 mm and greater.
- The inlet grate shall have a minimum area 6 times the inlet pipe area (this does not negate the Design Engineer's responsibility to investigate the possibility that a ratio higher than 6 may be required).
- Inlet grates shall be constructed of vertically oriented bars.
- Grates are not permitted on outlets
- 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 Halifax Water.

Inlet & Outlet Pipe greater than 1500 mm

- Precast concrete headwall, wing walls and apron
- 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.
- Handrail on the headwall shall be constructed in two separate, hinged sections.
- Grates are required on inlets of culverts or piped systems greater than 30 metres in length and diameters of 450 mm and greater.
- The inlet grate shall have a minimum area 6 times the inlet pipe area (this does not negate the Design Engineer's responsibility to investigate the possibility that a ratio higher than 6 may be required).
- Inlet grates shall be constructed of vertically oriented bars.

- 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 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.
- Grates are not permitted on outlets
- 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 Halifax Water.

5.5.4.7 Outlet Velocity

The maximum culvert outlet velocity is 4.0 m/s. A rip rap splash pad and apron must be designed to transition the culvert outlet velocity to the mean downstream channel velocity. Rip rap should be sized in accordance with the following equation.

$$D_{mean} = 0.019 * V^2$$

where:

D_{mean} is the diameter of rip rap (m)

V is the culvert outlet velocity (m/s)

Culvert outlet velocities must not exceed the maximum permissible mean channel velocities for a given channel material as presented in Table 5.3

5.5.4.8 Culvert Material

.1 Reinforced concrete pipe meeting the requirements of the latest CSA Standard A257.2 or ASTM Standard C76.

.2 Profile High Density Polyethylene (HDPE) pipe and fittings (up to 900 mm) meeting the requirements of the latest CAN /CSA B1800, with a minimum pipe stiffness of 320 KPa (46 Psi) and Type 1 (Water-tight) joints with integrated bells/welded joints.

.3 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 CSA Standard B1800.

.4 Steel reinforced polyethylene (SRPE) pipe and fittings to CAN/CSA-B182.14-12/B182.15-12 with a minimum pipe stiffness of 320 kPa

Pipe gaskets are to be utilized for all culvert installations.

5.6 EROSION AND SEDIMENT CONTROL

Stormwater management systems shall be an integral part of overall site design and development. The Design Engineer is to 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's *Erosion and Sediment Control Handbook for Construction Sites*.

5.7 STORMWATER MANAGEMENT FACILITES

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 Halifax Water as part of the subdivision acceptance process. The Engineer may consider easements under special circumstances, at the discretion of the Engineer.

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 1:2, 1:5, 1:10 and 1:100 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.

5.7.1 Design Submission

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

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

As an alternative to constructing stormwater management ponds, the Engineer may consider the use of alternate measures, such as oversized inline pipe storage. The Design 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.

5.7.2 Stormwater Management Ponds

5.7.2.1 Location

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.

5.7.2.2 Dry Ponds

Properly constructed and maintained wet ponds provide the additional benefit of stormwater treatment and improved stormwater quality over that of a dry pond. However, current restrictions governing the maintenance of wet ponds limit their acceptance by the Engineer for stormwater management ponds that are to be owned and operated by Halifax Water.

In cases where stormwater management ponds are to be owned and operated by private owners, wet ponds will be considered on a case-by-case basis.

5.7.2.3 Design Volume

Stormwater management ponds are to be sized in order to provide adequate storage volume necessary to limit post-development peak discharge rates to pre-development peak discharge rates for the 2, 5, 10, 25, 50 and 100 design storm events.

An additional volume allowance must be made so that a 300 mm freeboard is available for the 100-year design storm event.

5.7.2.4 Inlet & Outlet

Inlets and outlets are to follow the same requirements as those listed in the Culverts section of these specifications.

Energy dissipation measures should be employed to reduce velocities through the pond and reduce the likelihood of re-suspending settled solids.

5.7.2.5 Flow Control Structures

Typical flow control structures include large diameter manholes with a concrete bulkhead separating the inlet and outlet sides of the structure. A series of circular orifices and weirs are arranged in the bulkhead to restrict peak discharge rates to pre-development levels.

An access manhole frame and cover or an access hatch must be provided on both the inlet and the outlet sides of the flow control structure in order to facilitate inspection and maintenance.

5.7.2.6 Low Flow Channel

Low flow channels serve two purposes. Firstly, a low flow channel prevents erosion as runoff enters the stormwater management ponds during a storm event. Secondly, a low flow channel conveys the last remaining runoff to the outlet control structure ensuring that the pond dries completely.

Stormwater management ponds must provide a low flow channel from the inlet structure to the flow control structure, or the outlet structure. Low flow channels may consist of a concrete channel, half-pipe, or perforated pipe within a granular drain.

5.7.2.7 Emergency Spillway

Stormwater management ponds must have an emergency spillway to manage excess flows that may exceed the 1:100 design storm event, or manage overflows in the event that the outlet structure fails.

The emergency spillway elevation should be set at 300 mm above the 1:100 flood elevation in order to meet minimum freeboard requirements.

The emergency spillway must be integrated into the major drain system to limit property damage from an overflow event.

5.7.2.8 Drawdown Time

Stormwater management ponds should empty within 48 hours of the design storm event to avoid creating vector breeding habitat.

5.7.2.9 Maximum Side Slope

Stormwater management ponds must be constructed with maximum side slope of 4:1 (H:V). Side slopes of 5:1 (H:V) are preferred where conditions permit.

5.7.2.10 Minimum Floor Slope

Stormwater management ponds must be constructed with a minimum floor slope of 1.0% to ensure positive drainage from the pond margins to the low flow channel.

5.7.2.11 Under Drains

In some instances, the excavation of the stormwater management pond may intercept the groundwater table. In such instances, seepage into the pond may become problematic if no additional means are employed to address the issue.

In areas with a high groundwater table, or in areas of high seepage potential, under drains consisting of perforated pipes and granules may be required to intercept seepage from within the stormwater management ponds and direct it to the low flow channel.

5.7.2.12 Access Road

Maintenance access roads shall be provided to access the stormwater management pond including all inlet structures, outlet control structures and emergency spillway structures.

The access road is to be specified by the Design Engineer. The base gravels are to be a minimum of 150 mm of Type 2 gravel and 150 mm of Type 1 gravel to a minimum width of 4.0 metres. In some instances, additional drivable surface width must be provided where sharp turns are to be negotiated. Where grades exceed 6%, the surface shall be paved with asphalt.

If a full loop road is not proposed, a turning circle, or a turning-tee must be provided so that maintenance vehicles may exit the facility without requiring reverse maneuvers. Turning movement analysis may be required in support of the proposed access road.

5.7.2.13 Fencing

In general, stormwater management ponds do not require fencing. Construction using maximum side slopes of 4:1 (H:V), and preferably 5:1 (H:V) where conditions permit should allow for safe egress from the stormwater management pond. However, fencing may be required at inlet structures and outlet control structures in some instances.

Select planting and other landscaping features are a preferred access deterrent and a means of providing natural visual screening of the stormwater management pond.

Contingent upon location and proximity to private properties or lands for public purposes, fencing may be required as a matter of public safety.

In instances where fencing is required, fencing shall be as per the requirements contained in the *Supplementary Standard Specifications*.

5.7.2.14 Standard Operating Procedure

A Standard Operating Procedure must be provided to the Engineer as an appendix to the Engineering Design Report. The Standard Operating Procedure should address all recommended inspections and maintenance for the stormwater management pond. Consult the Engineer for the Standard Operating Procedure layout and template.

5.7.2.15 Hydraulic Grade Line Effects

The water elevation in the stormwater management pond will directly influence the hydraulic grade line in the upstream piped storm drainage system. Typically, piped storm drainage systems are subjected to hydraulic grade lines associated with the 1:5 year design storm. When the piped storm drainage system discharges to a stormwater management pond, the piped storm drainage system will be subjected to hydraulic grade lines associated with the 1:100 design storm.

Elevated hydraulic grade lines in the piped storm drainage system for the 1:100 design storm must be taken into consideration when setting minimum basement floor elevations on Subdivision Grading and Drainage Plans. As a result, dwellings within close proximity to stormwater management ponds may only be able to accommodate a half-basement, or a slab-on-grade foundation design.

5.7.2.16 As-Constructed Certification

Prior to acceptance of the subdivision and any associated stormwater infrastructure, the stormwater management pond shall be certified by a 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.

5.7.3 Stormwater Inline Storage

The Engineer may consider the use of oversized in-line pipe storage for stormwater management. 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 directed to the oversized inline pipe storage.

6.0 EASEMENTS

All Water, Wastewater and Stormwater Systems are to be constructed within a Municipality street right-of-way and installed closest to the crown or center line of the street. Easement agreements are only permitted when there are no alternative servicing routes and the option of locating a street over a servicing corridor has been precluded.

Easement widths are governed by pipe separations set by Nova Scotia Environment, these specifications as well as the ability to excavate, remove and replace Halifax Water Systems utilizing a safe trench to the requirements of the Nova Scotia Department of Labor and Advanced Education.

The Engineer will determine the placement of the underground infrastructure, on centre or offset, within the easement. The minimum easement widths required for Water, Wastewater and Stormwater Systems is as follows:

Table 6.1 – Minimum Easement Widths

Halifax Water Systems	Minimum Easement Width
One main < 3.7 metres in depth	6.0 metres
Two mains < 3.7 metres in depth	7.5 metres
One mains > 3.7 metres in depth	7.5 metres
Two mains > 3.7 metres in depth	9.0 metres
Trunk wastewater / stormwater mains or transmission water main	12 metres
Three or more mains, no closer than 3.0 metres to easement limits	Add 3.0 metres for each additional main

All applications that include Halifax Water Systems proposed to be within an easement are to be accompanied with a profile (cross-section) of the arrangement demonstrating conformance to separations and the ability to excavate a safe trench. Any excavation within the proposed easement cannot undermine other structures outside the easement boundary.

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

Halifax Water Systems with an easement in a private walkway, will be granted to Halifax Water prior to the transfer of ownership of the walkway to the Municipality.

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

All Halifax Water easements are Easement Agreements that require the signature and seal of both the Grantor and the Grantee.

7.0 DRAWING REQUIREMENTS

All surveys are required to be referenced to horizontal datum NAD83 (CSRS) v6 and vertical datum Canadian Geodetic Vertical Datum 2013. (Referred to as NAD83 and CGVD2013).

7.1 SCOPE

The purpose of this section is to standardize the preparation and delivery of all digital drawings and geographic data submitted to the Engineer.

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 and profile shall be drawn to any of the following acceptable scales, provided that the maximum sheet size is not exceeded, with exception of Integrated Projects with HRM:

Acceptable Horizontal Scale:

- 1:10 / 1:100 / 1:1000 / 1:10 000
- 1:20 / 1:200 / 1:2000 / 1:20 000
- 1:25 / 1:250 / 1:2500 / 1:25 000
- 1:50 / 1:500 / 1:5000 / 1:50 000
- 1:75 / 1:750 / 1:7500 / 1:75 000

Acceptable Vertical Exaggeration:

- 10x
- 5x

Integrated Projects with HRM will be drawn with a horizontal scale of 1:500 and a vertical scale of 1:50.

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 size for plan/profile drawings 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 (ARCH D).

Occasionally a single sheet project area may stretch slightly beyond the ARCH D size. In these cases, a 610 mm wide x 1067 mm long format will be accepted.

In the case of ‘building’ type drawings, an ARCH E1 format may be utilized; 762 mm wide x 1067 mm long page size.

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, proposed, and abandoned location and horizontal alignment of:

  .1 The water distribution system including all valves, hydrants, hydrant branches, tees, bends and appurtenances (i.e. chambers, reducers, couplings), booster stations, structures and buildings, chambers, and pipe with the length, size, material and class; sprinkler service connections and water service connections with the length, size, material and class to the street lines.

  .2 The wastewater and stormwater systems including all manholes, catchbasins, culverts, fittings, pump stations, chambers, structures and buildings, and pipe with the length, size, material, and offsets from the water system; wastewater and stormwater service connections with the length, size, and material to the street lines.

  .3 All other public services and their appurtenances including any underground power, telecommunication system, or gas lines.

.2 All topographic features.

.3 The street dimensions, street name and 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 metres intervals with labels every 50 metres along the centerline of the street, and the chainage of all intersecting street centerlines.

.7 Any control monuments and benchmarks 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 NAD83 (CSRS) v6. **All surveys are required to be referenced to horizontal datum NAD83 (CSRS) v6 and vertical datum Canadian Geodetic Vertical Datum 2013. (Referred to as NAD83 and CGVD2013).**

.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.

.13 Impervious area delineation for each parcel as closed polygon(s) on the impervious surface specific CAD layer (HRWC-IMPERVIOUS-AREA).

7.2.4 Profile

The profile of the engineering design drawing shall include the existing, proposed, and abandoned 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 centerline, 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 a water, wastewater and/or stormwater main where the pipe(s) are not under a street.

.4 Aboveground water, wastewater, and stormwater structures, including buildings, standpipes, or vents.

.5 The wastewater and stormwater pipe inverts at manholes (inlet/outlet), manhole cover elevations and catchbasin lead invert information. Show all culvert crossings in profile.

.6 Any other underground services and appurtenances.

7.2.5 Professional Engineer's Stamp

All drawings submitted to Halifax Water, regardless of phase (i.e. design, construction, record, etc.) shall be stamped and signed by the issuing Engineer; signifying that the drawings are reviewed and approved by the issuing party for the use for which they're intended.

7.2.6 Drawing Disclaimer

All drawings submitted shall include the following disclaimer along with regular drawing notes (as included in provided templates):

The infrastructure information shown on this plan is based on our best available records. However, the location of this infrastructure may not be accurate or complete. For any work being done in this area the design engineer and contractor are responsible to confirm information in the field including existing dimensions, elevations and locations.

7.2.7 Delivery Format

As of January 2022, projects no longer have hardcopy delivery requirements. The format of design drawing submission shall be:

.1 A DWG and PDF file for each drawing sheet. The files 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 systems. In addition to these systems, the CAD file shall include any proposed buildings (outline) and property parcels. Templates are available through Halifax Water's Specifications and Forms website (https://www.halifaxwater.ca/halifax-water-specifications-forms). See Section 7.5.

7.3 RECORD DRAWINGS

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

- Water mains
- Pipe bells
- Fittings
- Tees
- Bends
- Valves
- Hydrants
- Corporation stops
- Curb stops
- ARV & PRV drains
- ARV vent pipe
- Wastewater mains
- Stormwater mains
- Manholes (tops)
- Manhole (inverts/obverts)
- Catchbasins (tops)
- Catchbasin (obverts)
- Stormwater system inlet/outlets
- Stormwater system ditches
- Finish grade
- Building outlines

7.3.1 Additional Information

The following additional information must be included on the record drawings:

.1 Swing ties from permanent above ground fixtures (i.e. buildings, power poles, hydrants) to locate main line valves, manholes, catchbasins, 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 centre 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 systems encasement pipes.

.8 The location of restrained joints/pipe.

.9 Impervious area delineation for each parcel as closed polygon(s) on the impervious surface specific CAD layer (HRWC-IMPERVIOUS-AREA).

7.3.2 Delivery Format

As of January 2022, projects no longer have hardcopy delivery requirements. The following guidelines define digital delivery requirements (Survey files [CSV ASCII], Source drawing files [DWG], Drawing files [TIF & PDF]).

.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 Halifax Water 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, 25569268.10332, 94.21780, WCWM400,
168, 4940716.75418, 25569266.91370, 94.33934, WCFTTE, copper
169, 4940716.09661, 25569267.76330, 94.25489, WCWM250,
170, 4940715.74929, 25569268.16287, 94.25133, WCFTRD, 400x300
171, 4940715.68923, 25569268.40306, 94.24447, WCWM150,

.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 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.

7.3.3 Delivery Media

Digital files will be delivered using OneDrive; Halifax Water's approved secure file transfer software. Files must be clearly labeled with the project name, project phase, date, and Design Engineer's name. In the absence of access to OneDrive (or another comparable, approved, and secure FTP site), USB flash drive media will be accepted.

7.3.4 Computer Aided Drafting Standards

Design Engineers preparing submissions may obtain essential computer aided drafting (CAD) resources from Halifax Water's Specifications and Forms website (https://www.halifaxwater.ca/halifax-water-specifications-forms). The provided drawing template includes Halifax Water standard sheets & title blocks, logo, north arrow, and standard water, wastewater, and stormwater system symbology. The provided legend and layering resources include existing and proposed symbology, layer names, and block names for CAD drawings.

7.3.5 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 (ARCH D).

Occasionally a single sheet project area may stretch slightly beyond the ARCH D size. In these cases, a 610 mm wide x 1067 mm long format will be accepted.

In the case of 'building' type drawings, an ARCH E1 format may be utilized; 762 mm wide x 1067 mm long page size.

7.4 COORDINATE REFERENCING

All geographic data and drawings provided to Halifax Water must adhere to the following geo-referencing and accuracy requirements.

7.4.1 Geo-Referencing

All surveys are required to be referenced to horizontal datum NAD83 (CSRS) v6 and vertical datum Canadian Geodetic Vertical Datum 2013. (Referred to as NAD83 and CGVD2013).

.1 All work referenced using the NAD83.

.2 Map projection: Nova Scotia Modified Transverse Mercator projection and grid system (MTM NS Zone 4 and Zone 5).

.3 Datum: horizontal datum NAD83 (CSRS) v6

.4 Units: coordinates and dimensions in metric units.

7.4.2 Coordinate Accuracy

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

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

7.5 FEATURE CODES

7.5.1 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).

7.5.2 Refer to Halifax Water's Specifications and Forms website (https://www.halifaxwater.ca/halifax-water-specifications-forms). For current feature codes, legends, and CAD resources.

8.0 APPLICATION, INSPECTION & ACCEPTANCE

8.1 APPLICATION REQUIREMENTS

8.1.1 System Extension Application

The Halifax Water Systems are extended through the Municipality subdivision process. Where no subdivision is taking place, a Halifax Water System is extended by making application directly to Halifax Water. Both processes require a Halifax Water Systems Agreement with Halifax Water and the requirements are the same for both processes. A Halifax Water Systems Agreement is valid until the expiry specified in the Agreement. If construction has not commenced by the terms stipulated in the Agreement, the Applicant is required to reapply to Halifax Water, complying with the current specifications.

The Water, Wastewater and Stormwater Systems are to be designed to the *Design Specifications* and in accordance with the *Halifax Regional Water Commission Act*, the Halifax Water Regulations, the *Supplementary Standard Specifications*, the Municipality By-laws, and the Municipality Regional Plan.

Information provided by Halifax Water (Record Drawings, GIS data agreements, Service Connection cards, etc.) are for information purposes only. The Design Engineer must field check all provided information to ensure its accuracy prior to submission of new water, wastewater and stormwater projects.

The following information is to be provided with all applications involving an extension to the Water, Wastewater and Stormwater Systems, or work impacting existing plants or facilities:

.1 Water System design calculations consistent with Section 3.0.

.2 Wastewater System design calculations consistent with Section 4.0.

.3 Stormwater System design calculations consistent with Section 5.0.

.4 Plan and profile, cross section and detail drawings.

.5 A geotechnical report prepared by the Design Engineer. The geotechnical report is to address the geological and hydrological aspects of the development and will determine soil types for the proposed Water, Wastewater and Stormwater Systems locations.

.6 A cost estimate for the proposed Water, Wastewater and Stormwater Systems extension.

8.1.1.1 Water Boosted System

Refer to Section 3.0 for design requirements. The following information is to 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, brake horsepower (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.

8.1.1.2 Wastewater Pumped System

Refer to Section 4.0 for design requirements. The following information is to 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 Service Connection Application

Design and construct the Water, Wastewater and Stormwater Service Connections (public and private portions) to the *Design Specifications, Supplementary Standard Specifications* and the *Water Meter & Backflow Prevention Device Design & Installation Manual* and in accordance with the *Halifax Regional Water Commission Act*, the Halifax Water Regulations, and the Municipality By-laws.

Information provided by the Engineer (record drawings, GIS data agreements, service connection cards, etc.) are for information purposes only. The Design Engineer must field check all provided information for accuracy prior to submission of new water, wastewater and stormwater projects.

Approvals to connect to the Halifax Water Systems are valid for two years. If construction has not commenced within two years of the approval, the Applicant is required to reapply to Halifax Water, complying with the current specifications.

8.1.2.1 Multi-Unit & ICI Service Connection Application

The following is to be provided with all the Municipality building permit applications for multi-unit residential and ICI projects:

.1 *Water Meter Sizing Calculation Sheet (Form DM1)*

.2 *Water Service Connection, Water Meter & Backflow Prevention Device Application (Form DM2)*

.3 *Sprinkler Service Connection & Backflow Prevention Device Application (Form DM3)*

.4 *Servicing Plan and Profile / Water Meter & Backflow Prevention / Calculation Drawing*:

a. The template for this single plan can be found in the *Water Meter & Backflow Prevention Device Design & Installation Manual*.

b. **Servicing Plan Quadrant**. Detail the proposed Water, Wastewater and Stormwater Service Connections to be installed, show:
   - street right-of-way containing the mains, sizes and material.
   - natural gas, power, electrical conduits, transformers.
   - communications, fuel tanks, and other structures.
   - 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 is to be provided for in tabular form and indicated on the plan.
   - indicate the square footage of industrial, commercial and institutional building space and the number of residential multi-units.
   - Irrigation systems

c. **Profile Quadrant**. A profile perspective drawing of the water meter and backflow prevention device arrangement, all components, sizing and materials are to be clearly identified, in the profile quadrant.

d. **Plan Quadrant**. Detail a plan perspective drawing of the water meter and backflow prevention device arrangement, all components, sizing and materials are to be clearly identified, in the plan quadrant.

e. **Calculation Quadrant**. Detail exactly the two page *Water Meter Sizing Calculation Sheet* in the water meter sizing quadrant. Drain calculations.

f. Provide two copies of this drawing. The record drawing for the Service Connection will be presented in the same format.

.5 Design calculations for the sizing of Wastewater Service Connection.

.6 Wastewater System hydraulic analysis of the receiving mains and the downstream system for capacity may be necessary. The Engineer will determine in the review of the application if the analysis is a requirement prior to approval.

If it is determined that capacity does not exist in the local Combined/ Wastewater System, it is the responsibility of the Applicant to complete the required upgrades to ensure capacity exists in the System.

.7 A *Stormwater Management Site Plan* of the private stormwater management system and design calculations, in the form of a table, confirming the stormwater management system for the property either matches the post-development peak flow rate with the pre-development peak flow rate for the 1:5, 1:10, 1:25, 1:50 and 1:100 year storm events, or betters the post-development peak flow rate to a larger storm event.

If the Stormwater System (piped and/or ditches) is the only discharge point for the developed property, all storm events above are to be detained such that the peak discharge rate from the site never exceeds the peak flow rate for the minor system. Any on-site retention must consider the major overland flow route.

8.1.2.2 New Residential Service Connection Application

New single-unit and townhouse dwellings submit application for connection to the Halifax Water Systems via Municipality building permit process. A site plan of the proposed service connections is required.

8.1.2.3 Existing Residential Service Connection Application

Existing single-unit and townhouse dwellings are to submit application directly to Halifax Water for connections to the Halifax Water Systems. The *New Services & Renewal Application* form can be found at www.halifaxwater.ca and submitted through the online PPLC system found at Halifax.ca.

This type of application requires permission of the property owner. Permission is granted through the property owner's signature on the *New Services & Renewal Application*.

8.2 INSPECTION REQUIREMENTS

8.2.1 System Extension Inspection

.1 A pre-construction meeting is to be arranged by the Applicant after the Engineer's approval and prior to construction. Representatives from the Municipality, Halifax Water, the Applicant's Design Engineer and Contractor are required to attend. Provide the Engineer with 48 hours' notice of pre-construction meetings.

.2 Prior to the pre-construction meeting, the Applicant is to provide the Engineer three (3) hard copy sets and a digital file (both CAD and PDF) of the "Issued For Construction" drawings.

.3 Applicant is required to provide **full-time** inspection, approved by a Professional Engineer. The certificate of compliance, signed by a Professional Engineer, stating all Halifax Water Systems and appurtenances have been installed in accordance with the *Design Specifications* and *Supplementary Standard Specifications* is required prior to acceptance by the Engineer. Engineering & IS will provide audit inspection services.

.4 Applicant is to provide Engineering & IS with 24 hours' notice of preparation of pipe bedding, pipe installation, trench backfilling, and testing. All tests are to be conducted by the Applicant's Professional Engineer or their representative, and are to be witnessed by Engineering & IS.

.5 Applicant is to provide Engineering & IS site access to the work, and to locations where products to be incorporated into the work are being prepared. Engineering & IS are required to check-in with the site superintendent for required safety orientation.

.6 Applicant is to provide inspection assistance to Engineering & IS when requested.

.7 Applicant is to provide coordinate control points at appropriate locations within the limits of construction. Control locations are to be related to the NAD83 (CSRS) Epoch 2010.0 in metric. The control is to be approved by a NSLS. Control is to be established prior to commencement of trenching. **All surveys are required to be referenced to horizontal datum NAD83 (CSRS) Epoch 2010.0 and vertical datum Canadian Geodetic Vertical Datum 2013. (Referred to as NAD83 and CGVD2013).**

.8 The Applicant's Professional Engineer is responsible for independently collecting and recording all of the required record drawing information. Use of the Contractor's survey information by the Applicant's Professional Engineer for Record Drawings is not permitted.

8.2.2 Service Connection Inspection

8.2.2.1 Multi-Unit & ICI Service Connection Inspection

.1 Prior to construction of Water, Wastewater and Stormwater Service Connections all permit approvals must be in place.

.2 Applicant to provide Engineering Approvals Operations Technologist with access to the work, and to locations where products to be incorporated into the work are being prepared.

.3 Applicant is to notify Engineering Approvals Operations Technologist at least twenty-four (24) hours in advance of requirements for tests and inspections. All tests are to be conducted by the Applicant's Professional Engineer or their representative, and are to be witnessed by the Engineering Approvals Operations Technologist.

.4 Engineering Approvals Operations Technologist will visit the site at intervals appropriate to the progress of construction to become familiar with the progress and quality of the work. The Applicant is required to provide **<u>full-time</u>** inspection, by a Professional Engineer or their designate, for all aspects of the construction (public and private) and testing of the Water, Wastewater and Stormwater Service Connections, including all pipe bedding, pipe laying and backfilling of trenches.

.5 Applicant is to notify Engineering Approvals Cross Connection Control Technologist at least twenty-four (24) hours in advance of requirements for inspection.

.6 The Applicant's Professional Engineer or their representative is responsible for independently collecting and recording all the required record drawing information. Use of the construction contractor's survey notes and data by the Applicant's Professional Engineer for record drawings is not permitted.

.7 The Applicant's Professional Engineer is to 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.

8.2.2.2 Residential Service Connection Inspection

All service connections and driveway culvert installations, including renewals and repairs require inspection and approval by Engineering Approvals Operations Technologist prior to backfilling.

Inspection fees are detailed in the Halifax Water Regulations, and the contact information for Engineering Approvals Operations Technologist is listed in the permit approval letter from the Engineer.

8.3 ACCEPTANCE REQUIREMENTS

This section summarizes the Halifax Water requirements for the acceptance of Halifax Water Systems and service connections. **All submission requirements to be provided in electronic (PDF) format.**

8.3.1 System Extension Acceptance

A *Systems Extension Acceptance Check Sheet* which summarizes these requirements is available at www.halifaxwater.ca. The Applicant may complete and submit the check sheet as a cover page to the systems extension acceptance package.

.1 A completed *Systems Extension Acceptance Check Sheet.*

.2 Record drawings are to be in electronic (DWG & PDF) format, stamped by a Professional Engineer, in accordance with these specifications.

.3 Completed service connection cards for each lot, including valve field forms for valves greater than 50 mm.

.4 *Professional Engineer's Certificate of Compliance for Halifax Water Systems Extension* stating that the Halifax Water Systems have been installed in accordance with the approved drawings and specifications.

.5 *Nova Scotia Land Surveyor's Certificate of Compliance* stating the Halifax Water Systems have been installed within the boundaries of the Municipality right-of-way, within easements agreements with Halifax Water or on a parcel owned by Halifax Water.

.6 Summary of construction quantities and costs associated with the installed Water, Wastewater and Stormwater Systems. All components of the Halifax Water Systems are to be broken out for quantities and unit rates.

.7 Copy of the *Certificate to Construct* from NSE.

.8 Warranty deeds including property descriptions and plans for property which is to be transferred to Halifax Water.

.9 A survey plan and easement agreements signed and sealed by the Grantor where Halifax Water Systems are located on private property.

.10 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 24 months. This maintenance bond may be waived if the project is part of the Municipality's subdivision process, where the Municipality holds maintenance security on behalf of Halifax Water.

.11 Where applicable, a final survey plan and payment of a capital cost contribution, in the amount calculated by the Engineer from the final survey plan, and subject to the terms of a Halifax Water Systems Agreement.

.12 All applicable design reports.

8.3.1.1 Water System Requirements

.1 Records of Water System hydrostatic tests and certification of compliance.

.2 Records of bacteriological test compliance.

.3 Completed valve cards.

.4 Completed hydrant cards.

.5 Operation and maintenance manual for water booster station as outlined in Section 3.0 of these specifications. Include special tools and standard spare parts for water booster station equipment.

.6 All applicable design reports, including, but not limited to, the Hydraulic Analysis Report and Booster Station Design Report.

Note: The private portion of all service connections will not be inspected, nor will water meters be issued until the Engineer has accepted the Water, Wastewater and Stormwater Systems and has been advised by the Municipality that all Primary Services have been accepted.

8.3.1.2 Wastewater System Requirements

.1 Closed Circuit Television (CCTV) inspection and report (also required four weeks prior to end of warranty period) of the wastewater mains, refer to the *Supplementary Standard Specifications* for CCTV requirements.

.1 Deflection gauge test report (also required four weeks prior to end of warranty period).

.2 Wastewater main vacuum test report test report including Wastewater Service Connections to the property lines.

.3 Manholes vacuum test and inspection report.

.4 Completed valve cards.

.5 Operational and maintenance manual for wastewater pumping stations as outlined in Section 4.0 of these specifications. Include any special tools and standard spare parts for pumping station equipment.

.6 A completed *Wastewater Pumping Station Inventory Sheet*.

.7 All applicable design reports, including, but not limited to, the Pump Station Design Report and Pump Station Commissioning Report.

Note: The private portion of all service connections will not be inspected, nor will water meters be issued until the Engineer has accepted the Water, Wastewater and Stormwater Systems and has been advised by the Municipality that all Primary Services have been accepted.

8.3.1.3 Stormwater System Requirements

.2 Closed Circuit Television (CCTV) inspection and report (also required four weeks prior to end of warranty period) of the stormwater mains, refer to *Supplementary Standard Specifications* for CCTV requirements.

.3 Deflection gauge test report (also required four weeks prior to end of warranty period).

.4 Driveway culvert sizing tables.

.5 Operational and maintenance manual for stormwater management facilities as outlined in Section 5.0 of these specifications. Include any special tools and standard spare parts.

.6 All applicable design reports, including, but not limited to, the Stormwater Management Report and Stormwater Management Facilities Report.

Note: The private portion of all service connections will not be inspected, nor will water meters be issued until the Engineer has accepted the Water, Wastewater and Stormwater Systems and has been advised by the Municipality that all Primary Services have been accepted.

8.3.2 Service Connection Acceptance

Prior to a water meter installation, service connection installations require inspection by Engineering Approvals Operations Technologist. The requirements for the different types of building uses are contained in this section.

8.3.2.1 Multi-Unit & ICI Service Connection Acceptance

A *MICI Service Connection Acceptance Check Sheet* which summarizes these requirements is available at www.halifaxwater.ca. The Applicant is to complete and submit the check sheet as a cover page to the service connection acceptance package to the Engineering Approvals Operations Technologist.

.1 A completed *MICI Service Connection Acceptance Check Sheet*

.2 The *Servicing Plan / Water Meter & Backflow Prevention / Calculation Record Drawing* and *Stormwater Management Site Plan* are to be in electronic (DWG & PDF) and hardcopy (mylar) format, stamped by a Professional Engineer and in accordance with Section 7.0 of these specifications.

.3 Completed service connection card.

.4 Valve field form for Water Service Connection valves greater than 50 mm.

.5 *Professional Engineer's Certificate of Compliance for Installation of MICI Service Connections* stating the service connection has been installed in accordance with the approved drawings and specifications.

.6 Inspection and approval of the Water, Wastewater and Stormwater Service Connections by Engineering Approvals Operations Technologist.

.7 Records of hydrostatic test compliance for Water Service Connections 100 mm and larger.

.8 Inspection and approval of the backflow prevention device Engineering Approvals Cross Connection Control Technologist.

.9 Records of bacteriological test compliance for Water Service Connections 100 mm and larger.

.10 Closed Circuit Television (CCTV) inspection and report of the Wastewater and Stormwater Service Connections, refer to *Supplementary Standard Specifications* for CCTV requirements.

.11 Records of Wastewater Service Connection vacuum test.

.12 Records of manhole vacuum test and inspection report.

.13 Deflection gauge testing is required on the Wastewater and Stormwater Service Connections 250 mm and larger.

8.3.2.2 Residential Service Connection Acceptance

.1 Inspection and approval of the Water, Wastewater and Stormwater Service Connections by Engineering Approvals Operations Technologist.

.2 Inspection and approval of the backflow prevention device Engineering Approvals Cross Connection Control Technologist, if required.

8.4 INDEX TO HALIFAX WATER FORMS

Application Forms

- NSA1 - New Service & Renewal Application
- DM1 - Water Meter Sizing Calculation Sheet
- DM2 - Water Service Connection, Water Meter & Backflow Prevention Device Application
- DM3 - Sprinkler Service Connection & Backflow Prevention Device Application
- DM4 - Change of Water Meter Size Application
- DM5 - Temporary Water Meter Application
- DM6 - Backflow Prevention Device Tester's License Application
- SSS1 - New Product Request Application
- DS12 – Non-Residential Customer Stormwater Credit Application
- DS13 – Stormwater Credit Renewal Application

Inspection Forms

- BFP1 - Backflow Prevention Device Inspection Record
- DM7 - Cross Connection Control Accuracy Verification Report

System Acceptance Forms

- DS1 - Professional Engineer's Certificate of Compliance for Halifax Water Systems Extension
- DS2 - Nova Scotia Land Surveyor's Certificate of Compliance for Halifax Water Systems Extension
- DS3 - Halifax Water Systems Extension Acceptance Check Sheet
- DS4 - Wastewater Pumping Station Inventory Sheet
- DS5 - Service Connection Card
- DS6 - Hydrant Attribute List
- DS7 - Hydrant Field Form
- DS8 - Valve Attribute List
- DS9 - Valve Field Form

Service Connection Acceptance Forms

- DS10 - Professional Engineer's Certificate of Compliance for Installation of MICI Service Connections
- DS11 - MICI Service Connection Acceptance Check Sheet
- Service Connection Card

All forms are available at www.halifaxwater.ca.