Water Security Agency

Water Pipeline Design Guidelines

June 2015

EPB 276

Foreword

This design guide is a supplement to EPB 501 – Waterworks Design Standard. This guide applies to all water pipelines regulated by *The Waterworks and Sewage Works Regulations* and should be used as a companion to the applicable Acts, Regulations and other provincial publications currently in use or as may be published from time to time. These include, but are not limited to:

- *The Environmental Management and Protection Act, 2010 (EMPA)*
- *The Waterworks and Sewage Works Regulations*
- EPB 202 – Municipal Drinking Water Quality Monitoring Guidelines
- EPB 219 – Waterworks Log Record Sheets
- EPB 232 – Hygienic Water Use
- EPB 233A – Waterworks System Assessment Round 3 Standards
- EPB 236 – Annual Notification to Consumers: Guidelines for Compliance
- EPB 243 – Quality Assurance and Quality Control Policy for Waterworks: An Overview for Smaller Waterworks
- EPB 258 – Monthly Review of Waterworks Operational Records by Permittee
- EPB 501 – Waterworks Design Standard
- EPB 507 – Saskatchewan Drinking Water Quality Standards and Objectives
- EPB 541A – Water Quality Emergency Planning – An Overview
- EPB 542 – Guidelines for Quality Assurance and Quality Control for Water Utilities

For designers and owners, the guidelines:
- identify items and factors that should be considered for water pipelines; and
- provide accepted practices suitable for Saskatchewan conditions.

The design guide is not intended to be a detailed engineering manual. However, the guide addresses the aspects pertinent to the design of water pipelines so as to safeguard the public and protect the environment. If special circumstances warrant, the design guideline can be revised to address special needs. The guidelines outline the minimum requirements for water pipeline designs for human consumptive use.

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To find information online about drinking water in Saskatchewan, including all legislation and guidelines referenced in this document, please see our SaskH20 website (www.SaskH2O.ca).

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1. General

The purpose of this guideline is to assist owners and designers of small water pipelines to safeguard the public and protect the environment.

The design basis for urban or municipal water supply systems in the prairies has evolved over time. For cities, towns and villages, we have established records and a clear understanding of safety requirements, historic population statistics, water consumption and demands. Over the years, many municipal design guidelines and design standards were developed for larger communities. The design basis for water pipelines has a much more recent history.

Section 2(mm) of *The Waterworks and Sewage Works Regulations*, (the *Regulations*) defines a water pipeline as:

> "water pipeline" means all or a portion of a waterworks, distribution system or extended network of pipes that:
> (i) is owned by a person other than a municipality;
> (ii) is intended or used to provide water for human consumptive use or hygienic use; and
> (iii) serves one or more of the following:
> (A) permanent or seasonal residences;
> (B) acreages or farmsteads;
> (C) trailer courts;
> (D) commercial or industrial buildings, or any other similar facilities.

Pipeline systems that treat and distribute their own source of water are classified as waterworks and are subject to the same design requirements and features as pipelines that do not own their own water source works.

This guideline refers to all pipeline systems regulated by the WSA as water pipelines.

2. Permits

A Permit for Construction of Waterworks must be obtained from the WSA before starting construction of a water pipeline. Every water pipeline must also have a valid Permit to Operate a Waterworks. For construction of extensions and alterations to existing water pipelines, an Application for Permit to Construct, Extend or Alter Existing Works must be submitted. For new water pipelines that are not an extension or alteration of existing works, an Application For a Permit to Construct and/or Operate a Waterworks must be submitted, which can also be used as the application for a Permit to Operate. The application forms may be obtained from the WSA's SaskH20 website: www.saskh2o.ca/foroperators.asp.

3. Information Required for Application

Permit applications must contain information as outlined below. Information should be in a concise form and logical order. Drawings and plans should conform to good engineering practices. Previously submitted information need not be resubmitted unless it is affected by the construction, extension or alteration or updating is appropriate.

The following summarizes the submissions that will facilitate the review and processing of applications. When a person applies for a permit, as required in Section 24 of *The Environmental Management and Protection Act 2010*, (*EMPA*) the application shall include:

- name(s) of owners and responsible party for operation and maintenance;
- designer or responsible engineer or engineering firm;
- proposed period of construction and anticipated operation date;
- cost estimates for the work;
- engineering reports;
- design information including design flow capacity, design water demand and population served;
- site plan showing the location of pipes in relation to legal survey boundaries such as section lines, location relative to other underground utilities, the depth of pipe burial, any profile elevations, the type

and size of pipe, and location of hydrants, valves and appurtenances, backflow prevention, flushing points and initial locations of water quality sampling;

- drawings showing structural, piping and equipment details for connections to source and subscriber, building service entrance details, booster stations and chlorination facilities;
- if easements are required, the permit application shall include easement agreement(s) containing the following information and provisions:
  a) the name of the person proposing to construct, extend, alter or operate the water pipeline that is the subject of the easement;
  b) the nature and extent of the construction, extension, alteration or operation of the water pipeline that is the subject of the easement;
  c) the name of the registered owner of the land on which the water pipeline is to be constructed, extended, altered or operated and, if different, the name of the registered owner of the land affected by the water pipeline;
  d) the legal description of the lands mentioned in clause (c);
  e) a provision that:
     i) grants an easement by the registered owners of the lands affected by the water pipeline that is the subject of the easement;
     (ii) conveys a right to use the land for the purposes and to the extent required to construct, alter, extend or operate the water pipeline that is the subject of the easement; and
     (iii) states that the easement runs with the land and is binding on the present and subsequent registered owners of the lands affected by water pipeline that is the subject of the easement and their heirs, executors, administrators and assigns; and.
- as-built drawings are required once construction has been completed.

Please refer to EPB 501 – Waterworks Design Standard for a complete list of required information. Use of non-conventional or innovative water pipeline design should have substantial documentation to support the applicability of the design. The supporting documentation should be submitted to the WSA for review prior to applying for a permit.

4. Water Quality

For water pipelines supplying water used or intended for human consumption, water shall meet the water quality standards laid out in *EMPA*, the *Regulations*, EPB 207 - Saskatchewan Drinking Water Quality Standards and Objectives, and the system's Permit to Operate a Waterworks.

The WSA does not allow the construction of new hygienic use water pipelines.

5. Disinfection

5.1 Required Disinfection

The single most important factor for determining the efficiency of a disinfectant in a water pipeline is the CT factor. Disinfection with chlorine requires time. The CT factor is defined as the residual disinfectant concentration (C in mg/L) multiplied by the contact time (T in minutes) between the point of disinfectant application and the point of residual measurement or first consumptive use, whichever is less. Water pipelines shall conform to the Disinfection Profile Methodology presented in Section 3.2.11 of EPB 501 - Waterworks Design Standard. The point of initial disinfection used in CT calculations can be upstream of the water pipeline. User's small storage reservoirs such as cisterns are not considered as part of contact time T.

5.2 Location of Disinfection Equipment

Disinfection equipment in water pipelines shall be located to maintain chlorine residual levels set out in Section 27(6) of the *Regulations* throughout the entire water pipeline. If design and construction fails to provide adequate disinfection, then installation of additional disinfection equipment or alterations shall be made to the existing disinfection system to comply with the *Regulations*.

5.3 Disinfection of Water Pipelines After Construction, Alteration, Extension or Repair

Section 27(4) of the *Regulations* states "No permittee shall cause the operation of a distribution system, or portion of a distribution system, that is new, altered, extended or repaired to commence operation until it has been disinfected".

Section 23(4) of the *Regulations* states "The permittee of a water pipe used to supply water intended for a human consumptive use or hygienic use shall cause the water pipe to be cleaned, disinfected and pressure tested before the commencement of its use".

Affected water pipelines shall be disinfected following construction, alteration, extension or repair and shall be proven bacteriologically safe prior to operation. During installation, pipes and appurtenances will be kept free of foreign material. Pipes shall be flushed with at least two line volumes of water prior to chlorination. Pipes shall be chlorinated so that a free chlorine residual of 10 mg/L exists in all affected sections of the water pipeline after 24 hours of contact time. Water pipeline disinfection shall follow the most current version of C651 American Water Works Association (AWWA) Standard for Disinfecting Water Mains, which contains options for rapid disinfection. After completion of the chlorination process, the chlorinated water in the water pipeline shall be completely removed by thorough flushing. The chlorinated water must be disposed in an environmentally safe manner. Water pipelines shall be pressure tested prior to operation. After disinfection, water delivered by pipelines shall be proven bacteriologically safe prior to operation.

5.4 Bacteriological Safety of Water Pipelines After Construction, Alteration, Extension or Repair

Proof of bacteriological safety of new, altered, extended and repaired water pipelines shall be complete prior to the operation of the affected water pipeline section. Proof of bacteriological safety is obtained by performing startup bacteriological sampling and analysis. Two consecutive sets (on different days) of three samples along with free and total chlorine residual data for each sample are required for each isolated water pipeline section. Sampling will continue until two consecutive sets of all samples meet the regulatory requirements for free and total chlorine residual and provide acceptable bacteriological results for total coliform and fecal coliform and background bacteria.

The requirement for startup bacteriological quality is no positive bacteriological test result. A positive bacteriological result means a test result indicating unacceptable levels of bacteria per 100 ml of sample volume in accordance with the following criteria:

- 1 or more total coliforms (TC); or
- 1 or more faecal coliforms (FC); or
- overgrowth (OG) or >200 colonies of background bacteria; or
- presence of *Escherichia coli*.

For new water pipelines (not an extension of an existing water pipeline), seasonal water pipelines and existing water pipelines new to WSA regulation, a Precautionary Drinking Water Advisory (PDWA) will be issued immediately after the pipeline starts operation. A PDWA for existing water pipelines new to WSA regulation may be waived by the WSA depending on results of a site assessment by WSA staff.

5.5 Emergency Disinfection

Water pipelines shall have the ability to boost chlorine residuals near water source connections and at other locations as necessary to maintain regulated chlorine residual levels or emergency chlorine residual levels. This ability to boost chlorine levels may be in the form of installing nipples where adjustable chlorine feed pumps can be connected as required. An alternative to purchasing an adjustable chlorine feed pump is to demonstrate short notice access to chlorine feeder pump(s) for use when required. If chlorine residuals are not meeting the minimum requirements, permanent chlorine booster station(s) or other measures, such as pipe looping, will be required. Permanent or mobile power sources must be established for operation of chlorine booster equipment.

6. Sampling Within the Water Pipeline

The pipeline system must be built with the ability for bacteriological and chlorine monitoring sampling near all source water entry locations, at each user connection and at all pumphouse locations. Within the system's Permit to Operate a Waterworks, a requirement for bacteriological water sampling will be based on the population served. Samples should be taken from various locations throughout the water pipeline.

Total and free chlorine residual data will also be required for each sample. Samples cannot be taken from cisterns or from any water that has passed through a cistern as this would compromise the water quality results. Each user connection must be fitted with a sampling tap or spigot located before entry to a cistern or other storage at the service connection. The WSA may take non-scheduled samples to ensure compliance with chlorine disinfection regulations and other water quality standards and objectives.

Water pipelines must comply with EPB 202 - Municipal Drinking Water Quality Monitoring Guidelines for bacteriological, chlorine disinfectant and trihalomethane (THM) parameters or as set out in the system's Permit to Operate a Waterworks. Turbidity monitoring within the water pipeline is recommended for operational information and management and may be a monitoring requirement for systems with storage or pumping facilities. Where a water pipeline is supplied by a WSA-regulated waterworks (such as a municipal system), further monitoring for parameters such as Chemical Health & Toxicity, if previously performed by the municipal system, are not generally required by the water pipeline unless specified in the Permit to Operate a Waterworks.

Water pipelines that treat and distribute their own source of water are classified as waterworks and are subject to the same water source type and population based monitoring requirements as municipal water treatment and distribution systems.

7. Water Pipeline Flushing

The mainline system must be designed and built with the ability for routine and emergency flushing through fire hydrants, blow-offs, yard hydrants or other similar measures. Pigging facilities are to be considered where pipe deposits and biological growth are evident or expected. Substantial flushing devices such as yard hydrants or large diameter hose connections may be used at pipe service connection entrances. Water pipelines without adequate flushing flow must also have access to pumps and the ability to connect the pumps and a water source to accommodate flushing.

8. Backflow Prevention

During a depressurization or backflow event, contaminants can be drawn or pushed back into the water system. Strict precautions must be taken in the design of water pipelines to prevent the entrance of contaminants into the pipeline. The water pipeline design shall layout backflow prevention devices (BPD) to eliminate cross-connection hazards, which are any points in a water pipeline where chemical, biological or radiological contaminants may come into contact with water intended for human consumption or hygienic use. An example of a cross-connection hazard is the backflow of pesticides into drinking water while spray tanks are filled by a customer at a yard hydrant fed by a line experiencing negative pressure.

Degrees of cross-connection hazard include:

- **Severe** - A cross connection or potential cross connection involving any substance in sufficient concentration to cause death, spread disease or illness or contain any substance which has a high probability of causing such effect. A suitable BPD for severe hazards are air gap assemblies or reduced pressure zone devices. Moderate and minor hazards are also covered by these devices.

- **Moderate** - A cross connection or potential cross connection involving any substance which has a low probability of becoming a nuisance or be aesthetically objectionable if introduced into the domestic water supply. A suitable BPD is a double check valve assembly (DCVA) or similar.

- **Minor** - An existing connection or a potential connection between the water main and any pipe, vat or tank intended for carrying or holding drinking water which has a low probability of becoming a moderate hazard. A suitable BPD is a dual check valve assembly (DUC).

A BPD shall be installed at every point of cross-connection to prevent contaminated water from entering the water pipeline.

Source connections shall be equipped with a BPD rated for at least a moderate cross connection hazard. Ensure any testable BPD can be tested in-place without removing the unit. Operation and maintenance of the water pipeline must include regular testing and maintenance of testable BPDs.

Service connections shall also be equipped with a BPD rated for at least a moderate cross connection hazard. If the rural water user has a cistern or other storage tank and will be re-pumping, an air gap can often be inexpensively designed simply by ensuring that the outlet elevation of the service line is above the lip or overflow elevation of the water reservoir. The air gap must equal or exceed two diameters of the incoming service water line. Use of air gap BPDs at cisterns provides a high degree of safety.

Under high risk conditions, such as a yard hydrant that may service chemical tanks or a stand-alone tank fill on a water pipeline or a cattle watering point, an BPD rated for severe cross connection hazard is required.

In the interest of increased safety and liability reduction, designers may chose to add a BPD at mainline locations where pipe ownership changes. Manhole BPD design and installation must prevent flooding problems and cold temperatures which may interfere with correct operation of the BPD. The service connection BPD may be located in the water user's basement or other heated room as close as possible to the service line entrance point, while maintaining easy access for servicing. Ensure the BPD is not subject to flooding, cold or other adverse conditions.

With a basement BPD or similar service line BPD, if any other line or object withdraws water from the service line, ensure the withdrawal point is downstream of the BPD, regardless of the volume of water withdrawn. The basement BPD (if a DCVA) is not a sufficient BPD for a yard hydrant and the basement BPD may protect only the service line and not the residence, therefore the designer should incorporate an air gap BPD into the yard hydrant. Do not source water for yard hydrant lines from before the service line BPD because of the potential for easy bypassing or removal of the yard hydrant air gap device. The same applies to large-scale withdrawal such as a livestock watering operation.

Interconnecting a private water supply system to the water pipeline is not acceptable. Regulation of backflow prevention at a private residence falls under the jurisdiction of the Ministry of Health.

9. Estimating Water Quantity Requirements

9.1 Pipeline Water Demands

Pipeline water demands are to be based on evaluation of the number of people living in the household, number and types of livestock, extent of lawn and garden irrigation, existing wells and/or dugouts, tank filling and other yard water use, local plans for future water use and other related information. Systems with two days storage typically have a design flow based on peak day water demand. Systems without storage typically have a design flow based on the much higher instant water demand. The design flow must be increased for systems with less than two days storage. Design flow is to include allowance for future water demand growth.

Many average rural farm connections, for household purposes only, have a design peak day water demand of approximately 6.5 m^3/day (1.0 igpm) if no other design information is available. Many operating water pipelines show average day water demands as low as 0.65 m^3/day (0.1 igpm) for domestic demands.

9.2 Modelling Flow in Pipes

For empirical purposes, the flow capacity of a water pipeline is commonly modelled by the Hazen-Williams equation:

$$V = 0.849\, C_{hw}\, R^{0.63}\, S^{0.54}$$

Where: V is Velocity
C_{hw} is the Hazen-Williams friction coefficient
R is the hydraulic radius
S is the slope of the total head line

Many flow calculation equations and associated computer simulation packages operate under derivations of the Hazen-Williams equation. Design velocity should be a maximum of 1.5 m/s (5 ft/s), and a minimum of 0.6 m/s (2 ft/s). Typical friction coefficients C_{hw} are shown in the table below. C_{hw} must be conservatively estimated.

The C_{hw} coefficients shown below are designed to represent those that could be experienced in the long-term and include allowances for typical fittings and changes in fluid flow direction. The friction coefficients are conservative and should be used only when more site-specific information is not available.

Hazen-Williams Friction Coefficients

Pipe Description	Long-Term H-W Friction Coefficient C_{hw}
Polyethylene (PE)	
Nominal diameter <= 150 mm	130
200 to 250 mm	132
300 to 600 mm	135
Polyvinyl chloride (PVC)	Same as above.

10. Water Storage

10.1 Water Pipelines with Storage

All water pipelines should have water storage. If customers have proper storage, the water pipeline has a greater economy and safety. Storage adds reliability to the water supply in the event of reduced water pipeline flow due to accident or normal maintenance. Properly designed storage facilities can also reduce the instant demand on the water source and thereby reduce the size and cost of pipes, pumps and related infrastructure.

For water pipelines with storage, each residential connection should have a storage tank such as a cistern that is sized for at least two days of future average day water demand. The typical size of water storage for in-house use with a family of three persons is 1.4 m^3 (300 imperial gallons).

10.2 Water Pipelines Without Storage

If the proposed water pipeline calls for no storage, then water pipelines must be sized to meet the future instant water demand of the water pipeline which is considerably greater than the future peak day demand of a system with storage. The design flow of a system without storage may be more than 10 times greater than the design flow of a system with storage. In a zero storage water pipeline, mainline and lateral and service connection pipes must be designed to supply a higher flowrate than systems with storage.

As an example, a kitchen tap supplies about 2 igpm. Assuming 15 out of 20 customers on a non-storage system are simultaneously operating just one garden tap, the instant water demand may be 30 igpm (2.3 L/s). A similar system with storage may have a peak day demand of less than 5 igpm (0.4 L/s).

If a water pipeline is designed to supply water to a zero-storage customer at below the instant water demand, then the system will not meet water demands, rationing is in effect and negative pressure may be experienced.

11. Classes of Water Pipelines

Pipes from a water user's property line to the household or other point of use are classed as service lines. Pipes from mainlines to service lines are classed as laterals. Pipes from water sources to laterals are classed as mainlines.

12. Water Pipeline System Layout

12.1 Grid Design

When possible, water pipelines should be designed to eliminate dead-end mainline sections. One option is to ensure a supply lateral feeds from the end of any mainline. If a dead-end main greater than 100 m in length cannot be avoided, a hydrant should be installed to prevent problems associated with stagnation.

Pipe looping and other methods such as re-chlorination must be used in designs, where required, in order to maintain regulated disinfectant residuals.

12.2 Valve Placement

Intersecting mainlines should be equipped with isolation or shut-off valves to minimize disruption during repairs. 'T' intersections typically require two valves and cross intersections typically require three valves. Isolation valves should be installed at a mainline maximum spacing of 10 kilometers. Curb stops are typically installed at the boundary of a customer's property.

Air release valves should be placed at all significant high points of the system. Existing small mainlines can often exceed three or four kilometers of pipe without placement of an air release valve.

12.3 Thrust Restraint

For PVC pipe, thrust blocking should be provided where changes in water direction occur, where reductions in pipe diameter are made, and where lines are terminated. A concrete mass or a mechanical joint restraint device may provide thrust restraint.

For PE pipe, thrust restraint is not typically required for small diameter water pipelines.

13. Depth of Cover

The minimum depth of cover to the crown of water pipelines and service connections should not be less than the depth of frost penetration, with shallow-bury winter-drained systems as the exception.

As an example, the typical minimum ground cover of some existing water supply pipelines is 2.5 meters for areas near Swift Current, Moose Jaw, Regina and Weyburn; 2.7 meters near Saskatoon, Biggar, Humboldt and Yorkton and 3.0 meters near Prince Albert and Nipawin. These depth of cover guidelines are examples only. Depth of cover is to be based on calculation of depth of frost penetration or taken from a similar water pipeline.

Depth of frost penetration is to be based on consideration of soil type, moisture content, snow cover, snow pack and ambient temperature Freezing Index in Degrees-Days. Depth of cover increases in wet areas and sandier soils. Designs using a depth of cover shallower than the frost depth require a specific, detailed evaluation of the method (insulation, recirculation, etc.). Designs for depth of bury based on existing successful similar systems are typically more reliable than designs based solely on theoretical calculations.

14. Pressure Requirements

In water pipelines, water demands are mainly for domestic and stock-watering requirements, and there is typically no fire-fighting flow. The normal operating pressure range for water pipelines is 350 kPa (50 psi) to 550 kpa (80 psi). The maximum pressure should not exceed 700 kPa (100 psi) to protect household piping. Under special circumstances where the main lines are allowed to exceed 700 kPa (100 psi), the adjacent lateral pipelines or service lines must be protected with pressure reducing valves.

In addition to the maximum operating pressures, there are transient pressures due to pump starts and stops, power failures or rapid valve operation. Pumps should be designed to minimize these surges and pipes should be designed to withstand these surges in addition to the maximum operating pressure. As a minimum, a surge pressure created by instantaneous stoppage of a water column moving at 0.3 m/s (1 ft/s) must be considered in the water pipeline design.

The minimum acceptable water pressure at water pipeline withdrawal points is 98 kPa (14 psi) if all serviced connection withdrawal points are protected by an air gap backflow preventer or equivalent. The minimal acceptable water pressure at all other withdrawal points is 138 kPa (20 psi).

Rural water users with a storage tank or cistern may pressurize their own system to meet their own pressure requirements.

15. Pipe Size

The minimum mainline size should not be less than 50 mm (2 in) nominal diameter and the minimum lateral size should not be less than 38 mm (1.5 in) nominal diameter. The minimum acceptable service line diameter is 25 mm (1 in).

When an existing water pipeline has or is suspected to have pressure problems, design calculations will be required to demonstrate the acceptability of the proposed works regardless of pipe sizes.

16. Pipe Design

The two most commonly used thermoplastics for water pipelines are polyvinyl chloride (PVC) and polyethylene (PE). Both materials are acceptable for use in the Province of Saskatchewan.

16.1 Polyvinyl Chloride

Rigid PVC small diameter pipe of nominal diameter of 100 mm (4 in) or greater for water pipelines should be manufactured in accordance with the latest edition of CSA B137.3 Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications, or the latest standards issued by the AWWA and Canadian General Standards Board (CGSB).

The CSA B137.3 standard has a maximum allowable internal pressure in kPa (psi) to which the pipe can be subjected (operating or working pressure and surge pressure) which is designated by the series number (Series 100, 125, 160, etc) for IPS-Schedule, SDR and DR sized PVC pipe. As a rule of thumb, the maximum allowable working pressure would be approximately 62 per cent of the series rating. For example, the allowable working pressure of Series 160 PVC would be 160 X 0.62 = 100 psi.

CI-DR and SDR PVC pipe sizes may be referred to by the class system where class 100 is equivalent to 690 kpa (100 psi) DR 25, Class 150 is equivalent to 1035 kpa (150 psi) DR 18 etc. The class number (100, 150, 200, etc.) corresponds to the maximum allowable working pressure in psi (kpa) to which the pipe can be subjected. The class ratings provide for a pressure rise above the maximum working pressure caused by a surge that does not exceed that caused by an instantaneous velocity change of 0.6 m/s (2ft/s).

If the pipe is to be used at a temperature above 23^{o}C, then the effective pressure rating of the pipe must be lowered.

For normal water pipeline installations, the expected internal pressures will dictate the pipe strength requirements for PVC. For water pipelines, a minimum of Series 160 or Class 100 or equivalent should be used.

16.2 Polyethylene

PE Pipe for water pipelines should be manufactured in accordance with the latest edition of CSA B137.1 Polyethylene Pipe, Tubing and Fittings for Cold Water Pressure Services, or the latest standards issued by AWWA and CGSB. The CSA B137.1 standard covers pipe up to and including 150 mm (6 inch) nominal diameter. Most existing water pipelines use PE pipe, primarily due to less expensive installation methods.

With PE pipe, the Series number (100, 160, etc.) represents the maximum allowable working pressure in psi (kPa) to which the pipe should be subjected at 23°C, with an allowance for surge pressure of approximately three times the series number. Transient or surge pressures normally experienced in pipes can be permitted to raise the total internal pressures above the pipe series rating provided the normal working pressure is below the series rating and the duration of the excessive pressure is short and followed by a period of recovery.

The effective pressure rating of PE pipe must be reduced if it is to be used at working temperatures above 23°C. As an example, at temperatures between 30 and 38°C, PE pipe should typically not be operated in excess of 80 per cent of the Series pressure rating.

Internal pressures will normally dictate PE pipe strength requirements for water pipelines. Manufacturer's design curves can provide sufficient information to allow a designer to select the required pipe Series. Much of the pipe supplied for existing water pipelines is coiled PE pipe. For water pipelines, a minimum of CSA Series 100 PE pipe (DR 17) may be used for mainlines and laterals. Working pressures may be, for example, 60 psi, but the pipe could be subjected to 100 psi during flushing and cleaning. Service lines should be a minimum of CSA Series 160 PE pipe.

Glossary of Symbols and Abbreviations

Water Pipeline and Waterworks Abbreviations

AWWA	American Water Works Association
BPD	Backflow Prevention Device
CGSB	Canadian General Standards Board
CI	Cast Iron
CSA	Canadian Standards Association
CT	the residual disinfectant concentration (mg/L) multiplied by the contact time (T, min)
DCVA	Double Check Valve Assembly backflow prevention device
DUC	Dual Check Valve assembly backflow prevention device
igpm	imperial gallons per minute
kpa	kilopascals
PDWA	Precautionary Drinking Water Advisory
PE	Polyethylene
psi	pounds per square inch
PVC	Polyvinyl Chloride
WSA	Water Security Agency