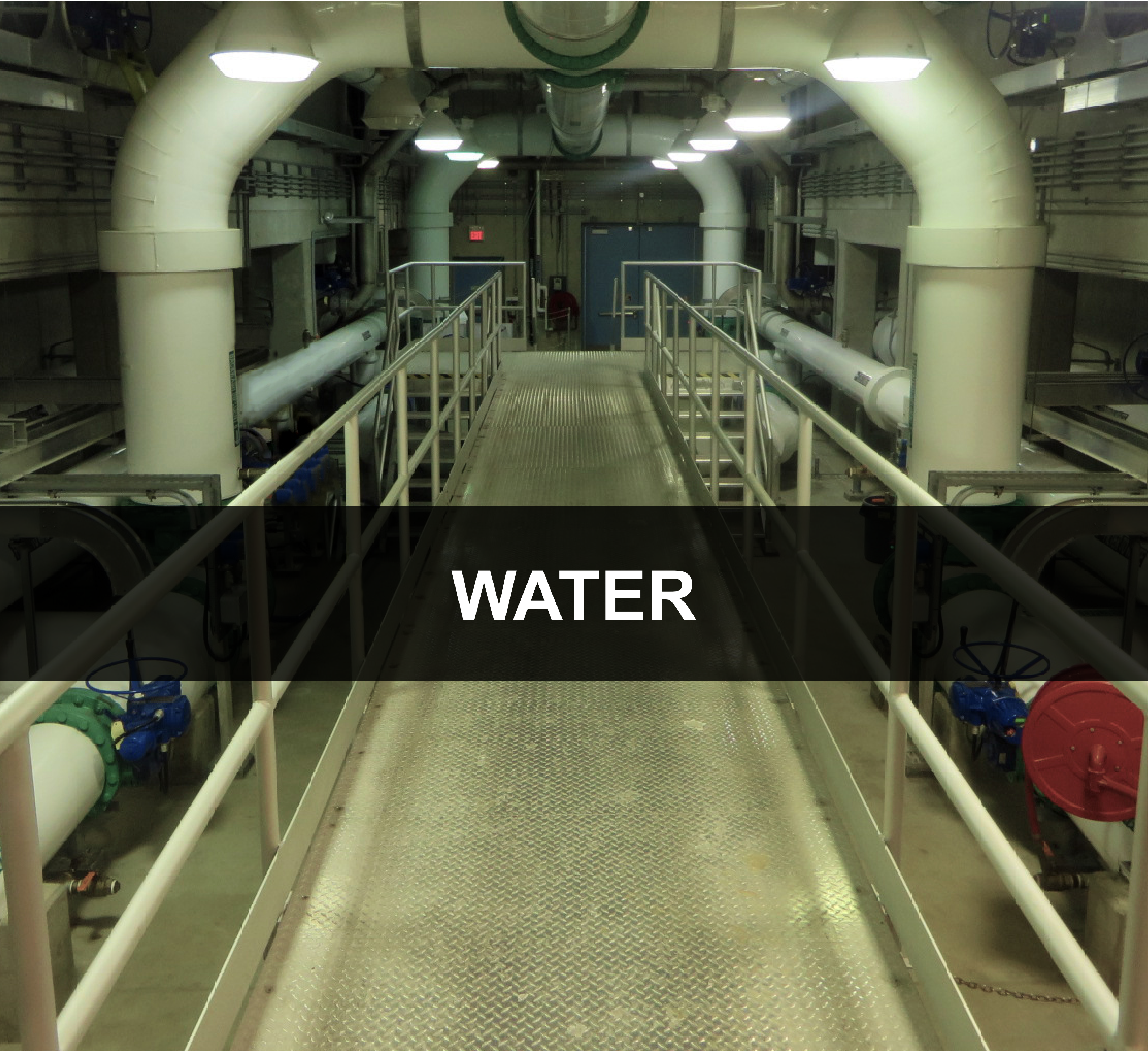

WATER

DESIGN AND CONSTRUCTION MANUAL

Vertical Municipal Infrastructure Standards

THE CORPORATION OF THE CITY OF BRANTFORD

V5 - March 2024

REVISION TRACKING

EXISTING VERSION	VERSION NUMBER
March 2019	N: V1 - Original Final Submission
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2024 REVISION SUMMARY

SECTION	MODIFICATION & COMMENTARY
4.12 Elevated Tanks	hydrodynamic mixing system CL2 and Ammonium Sulfate booster system, if necessary water tank recirculation system, if necessary

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1.0 INTRODUCTION

1.1 Scope

This section of the manual is intended to address requirements related to the treatment, storage, and distribution of drinking water within the City of Brantford. This document should be read in conjunction with the **General Preface** and **Common Elements** sections of the **Vertical Municipal Infrastructure Standards.**

1.2 Description of the Drinking Water System

The City of Brantford Drinking Water System is a Large Municipal Residential System, owned and operated by the Corporation of the City of Brantford, consisting of a Class IV Water Treatment Plant and a Class III Distribution System.

The City's water vertical infrastructure consists of the following major facilities:

- **Holmedale Water Treatment Plant (WTP):** The City's raw water supply is drawn from the Grand River and treated through a multi-barrier disinfection process at the Holmedale WTP.
- **High Lift Pumping Stations and Booster Stations:** Facilities throughout the City that pump treated water from the WTP through the distribution system to the end user. These include, but are not limited to, high lift pumping stations, booster pumping stations, and bulk water fill stations.
- **Reservoirs and Elevated Tanks:** Reservoirs and elevated tanks equalize water demand, stabilize distribution pressure, and provide emergency storage for fire flows, power outages, process upsets, and emergency repairs.

2.0 TREATMENT

2.1 Overview

The design of the Water Treatment Plant and its components shall be in accordance with the *Safe Drinking Water Act*, associated regulations, and the latest version of the Ontario Design Guidelines for Drinking-Water Systems.

2.2 Alternative Technologies

Where a change in the treatment technology is suggested/required, a LCC analysis and efficiency comparison between the existing and proposed technology must be completed to determine if it is an applicable replacement.

2.3 Plant Layout

Maximize the site's ultimate capacity in planning the plant layout. Design of expansion works should be carried out to permit the orderly and economical construction of the facility with minimal disruption of the existing facility. Space for any future expansion shall be considered in determining the overall layout.

2.4 Head Gate and Raw Water Intake Canal

The head gates at the mouth of the intake canal allows for ice control, modifications of water levels, as well as complete isolation of the intake canal to the Holmedale WTP in the event of source water contamination.

The lowlift intake canal to the Holmedale WTP shall be equipped with means to address ice formation during the winter months. Process equipment (such as air blowers) used for ice control shall include one duty unit and one standby unit.

2.5 Low Lift Pumping

Each cell of the low lift intake shall be equipped with coarse and fine travelling mechanical screens to remove large debris. Where feasible, the design of the low lift pumps and intake structure shall comply with the latest edition of the Hydraulic Institute Standards. The low lift pumping station shall be sized to meet the rated plant capacity with the largest pump out of service.

2.6 Sand Ballasted Flocculation

The flocculation and sedimentation process incorporates a high rate, low footprint technology complete with plate settlers. The plate settlers are to be equipped with an automatic cleaning system. A minimum of two trains of flocculation/sedimentation tanks, each sized based on average daily demand, are required.

Provide a minimum of two ballasted flocculation recirculation pumps per train for microsand separation at the hydrocyclone cabinet. Each hydrocyclone cabinet shall be equipped with an inspection port. Provide a dedicated area for microsand storage complete with adequate ventilation to control dust exposure. Generated sludge shall be conveyed to the Residue Management Facility (RMF).

2.7 Ozonation Process

The design of the ozonation system shall include a minimum of one standby unit for the liquid oxygen vaporizer unit, ozone contact chamber, and off-gas ozone destruct unit. Provide permanent ozone gas detectors in the ozone generation and off-gas ozone destruct rooms with an alarm system connected to SCADA in the event of an ozone gas leak. Design the ozonation system with sufficient injection ports for hydrogen peroxide for seasonal injection as needed.

2.8 Biological Filtration and Backwash Systems

The filtration train shall include a minimum of one standby filter at the peak hydraulic loading rate. The filter underdrain system shall be made of minimum Type 304L stainless steel. The backwash system shall be designed with the capacity to allow for consecutive filter washes. The chosen method shall include appropriate on-line detection and monitoring systems.

2.9 UV Disinfection

The UV disinfection train shall include a minimum of one standby unit at the peak hydraulic loading rate and be sized for seasonal flow rates. Selection of the UV system shall consider the total life cycle cost of the unit.

2.10 Primary Disinfection

The disinfection process shall be designed and operated to achieve the target log removal/inactivation credits stipulated in the Municipal Drinking Water License (MDWL) and incorporate a multi-barrier disinfection approach. The chosen method for primary disinfection shall include appropriate on-line detection and monitoring systems, complete with appropriate chemical handling and storage.

Chlorine gas is the current method used as part of the primary disinfection process, and vacuum is the preferred method for transferring and injecting chlorine gas. Sulfur dioxide gas is used to quench excess chlorine residual if necessary.

Chlorine gas storage and handling systems must be designed in accordance with the guidelines of the Chlorine Institute. Chlorine storage using one tonne cylinders must be sized to provide a minimum of 48 hours of storage at the plant's rated capacity.

The chlorine gas and sulfur dioxide storage area must be equipped with a dedicated scrubber unit that automatically operates if chlorine levels are detected. Chlorine storage and feed areas shall be equipped with chlorine and sulfur dioxide gas detectors equipped with emergency shut off system and an emergency eyewash/shower station that provides tepid water.

Provisions for continuous monitoring of primary disinfection must be provided under the current regulations. On-line free chlorine residual analyzers must include a minimum of one standby (spare) analyzer.

2.11 Secondary Disinfection

Chloramination is the current method used for secondary disinfection. A pressurized injection system is the current method for transferring and injecting ammonia gas to create chloramines for secondary disinfection. The Water Treatment Division will be looking at other secondary treatment options in future upgrades. A dedicated chemical room must be provided for the storage and feeding of the chemical for secondary disinfection.

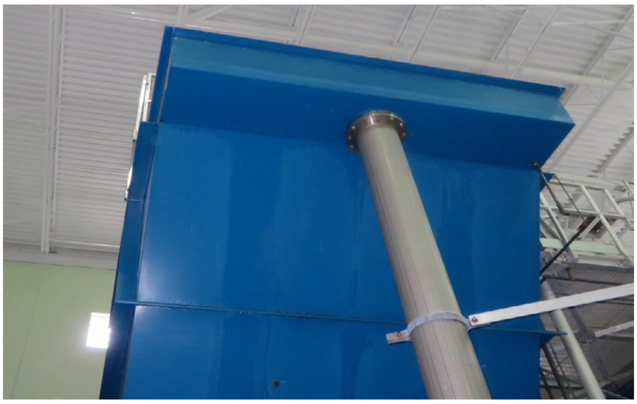
All chemical storage and feed areas shall be equipped with appropriate gas or leak detectors.

2.12 Residual Management

Waste sludge from the pre-treatment process and wastewater from the filter backwash drain are directed to the backwash equalization tank at the RMF. The backwash equalization tank includes a mixer that maintains the solids in suspension. Overflow piping is required to direct excess flow to the emergency storage lagoon. Bypass piping is required around the backwash equalization tank to direct waste flows directly to the thickeners if necessary.

Pumps used for backwash equalization tank transfers to the thickeners shall be designed to withstand high grit and solids content. Sludge pumps used to transfer sludge to the sludge dewatering system must be designed to handle the maximum solids percentage cake for the equipment.

Provide provisions for waste sludge thickening prior to offsite disposal. Polymer is the thickening technology and belt presses are the dewatering technology utilized at the RMF.



3.0 PUMPING

3.1 Firm Capacity

The definition of firm capacity for water pumping or booster stations shall adhere to the Ontario Design Guidelines for Drinking Water Systems as follows:

- Capacity of the pumping station with the *largest unit out of service* if the station supplies a pressure zone with adequate storage available; or,
- Capacity of the pumping station with the *two largest units* (including fire pumps, if any) if the pumping station serves a pressure zone that does not have adequate floating storage available and is the sole source of water supply in the area.

3.2 Pump Selection and Sizing

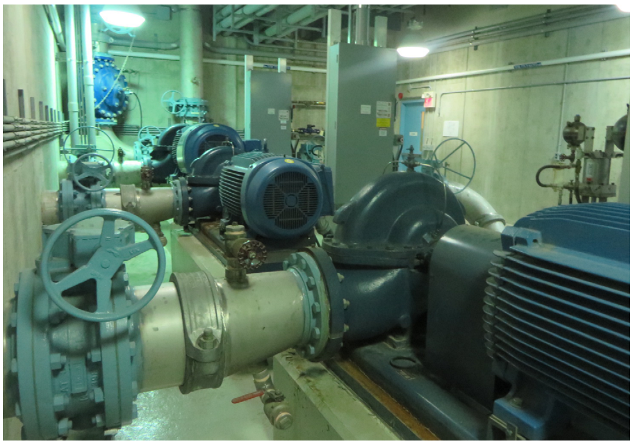
Pump selection shall take into consideration the full range of anticipated flows from low flow (minimum hour) to peak flow and full range of pressures. Energy management shall be an integral part of the pump selection process. Complete life cycle cost evaluation on different pump types and specify the combination of pumps that provide the lowest energy usage per unit of flow. The evaluation should consider a realistic range of flows and not base the life cycle costing on a single duty point such as the pump's best efficiency point (BEP).

The use of variable frequency drives (VFDs) for variable speed control should be carefully evaluated to optimize pump selection and combination of pumps to minimize energy usage and maximize the life of all pump components. VFDs will be considered on a case-by-case basis when evidence of energy savings can be shown compared to constant speed pumping. Pumps must be designed to run within their operating curves under various conditions.

3.2 Pump Selection and Sizing (Cont'd)

It shall be taken into consideration to use VFDs for all closed pressure systems or when stable pressure regulation is required.

Review the net positive suction head (NPSH) at various operating conditions and ensure the minimum NPSH margin and margin ratio are maintained under the full design flow range. Review pump material and seal specifications and select suitable materials for the desired application.



3.3 Pump Layout and Supports

Each pump line should be designed to allow for isolation of individual pump lines without impacting the overall pumping system. Design pump supports in consultation with pump manufacturers to ensure the pumps are adequately supported to minimize vibration. Minimize drain line runs and be cognizant of tripping hazards around the pump base.

3.4 Pump and Motor Testing

Pumps with motor sizes less than 186 kW (250 hp) shall be specified with certified non-witnessed factory testing in accordance with ANSI/HI 14.6 Standards, Acceptance Grade 1U (rate of flow, total head, and hydraulic efficiency). Motors shall have the highest possible efficiency available to adhere to the City's Climate Change Plan.

Pumps with motor sizes equal to or greater than 186 kW (250 hp) shall be specified with certified factory testing in accordance with ANSI/HI 14.6 Standards, Acceptance Grade 1U (rate of flow, total head, and hydraulic efficiency). Specify the guarantee point in the pump specifications based on an analysis of various pump vendors.

The pump manufacturer must publish certified pump curves prior to shipping the pumps, regardless of the pump size. The use of job motor or job VFD in factory testing is not required regardless of the pump motor size.

When considering witnessed factory testing discuss with the City the required number of attendees and the anticipated costs. Any pump that does not meet the specified acceptance criteria shall be rejected, regardless of the motor size. The use of performance penalties is not preferred.

3.5 Field Testing

All pumps, regardless of motor size, shall be field-tested by the contractor and witnessed by the City and the Proponent to confirm attainment of the design objectives. Develop a specific testing procedure as part of the contract specifications to suit the requirements of the pumping facility.

Pump vibration testing shall be completed in the field by the pump manufacturer for all pump sizes. Vibration testing in the factory is not required. Field vibration shall be less than the limits specified in the latest version of ANSI/HI 9.6.4. Harmonic testing to be completed where applicable.

Following testing and commissioning of new pump systems, develop a field pump curve to establish baseline conditions.

3.6 Piping Design

The pump suction (intake) and discharge piping design shall comply with the latest edition of ANSI/HI 9.6.6. Where space for new construction permits, provide two independent suction headers from which the individual pump suction lines connect. Each header shall be designed to allow for isolation without shutting down the entire pumping station.

3.7 Valve Selection and Design

Provide inlet and outlet isolation valves for each pump, as well as valves on the main inlet and discharge headers to allow for total isolation of the station. Provide a combination air valve on suction and discharge headers.

3.8 Process Instrumentation and Control, and Transient Control

The pump control system shall be designed to reduce the frequency and magnitude of hydraulic transients in the piping, particularly during pump start-ups and shut-downs. The main discharge header of a pumping system must be equipped with a total chlorine analyzer, flowmeter, and a pressure indicating transmitter connected to SCADA. Each pump suction and discharge pipe shall be equipped with a pressure gauge and a pressure indicating transmitter. All pump and motor bearings shall include heat and vibration monitoring.

Slow pump start-up and slowdown using VFD speed control is preferred over a modulating control valve for transient control. The Proponent shall provide a life cycle assessment in the design report for the recommended hydraulic transient control method.

3.9 Surge Relief

The pumping system shall be designed to minimize the risk of damage from hydraulic transients. Review the recommendations of the hydraulic transient analysis and incorporate the recommendations into design as applicable. Provide redundancy for all critical surge protection systems.

Surge relief valves should discharge flows back to the suction header or storage reservoir as far away as possible from the nearest pump to minimize turbulence in the pump intake line. Each surge relief valve must be equipped with a position indicating transmitter connected to SCADA that generates an alarm if the valve opens.

3.10 Flood Protection

New pumping station facilities shall be designed with an automatic flood detection, alarm, and response system. All electrical disconnects, conduits, and equipment located within the flood-prone zone inside a facility shall be rated for full submergence without damage.

4.0 RESERVOIRS AND ELEVATED TANKS

4.1 Applicability

The guidelines in this section apply to all treated potable water storage structures, including treated water clear wells within the Holmedale WTP as well as storage reservoirs and elevated tanks located throughout the City's water distribution network.

4.2 Configuration and Layout

In-ground reservoirs shall consist of a minimum of two independent cells, and all necessary piping and valving shall be provided to allow for the bypassing of any cell so that it can be taken offline for maintenance work without impacting the other cell(s).

For expansion of an existing reservoir, design new cell(s) capable of being isolated from existing cell(s) for repair and/or cleaning or to float independently on the water supply distribution system.

Submerged interconnecting piping and valving between reservoir cells should be avoided. Instead, locate all isolation pipes and valves in a dedicated valve chamber.

4.3 Structural Design of Reservoirs

Concrete water retaining structures shall be designed in accordance with the latest edition of CSA Standards A23.1, A23.2, A23.3 and A23.4. They must be designed and constructed to withstand the process environment without the need for an additional interior protective coating system.

Provide at least two access hatches in each reservoir cell. Ensure at least one hatch is sized to accommodate removal of the largest pipe or equipment. Provide separate personnel access hatches complete with ladders made of fibreglass-reinforced plastic (FRP) suited for chlorinated water. Access hatches must include a properly located davit base for entry into the reservoir. Refer to Common Elements for more information.

The number and location of personnel access hatches shall limit the maximum travel distance from any location in the reservoir to the nearest personnel hatch to less than 50 m. Side-entry points and removable wall openings into the reservoir structure are not permitted. All access points shall be provided from the roof. All hatches must be sealed and equipped with drain pipes to direct collected water away from the reservoir cell.

4.4 Reservoir Roof Membrane

Provide a continuous, fully adhered, watertight membrane over the entire reservoir roof with a minimum warranty period of 25 years from the date of being placed into service.

4.5 Submergence Levels

Set a minimum required submergence level in the reservoir cells in accordance with the required net positive suction head available (NPSHA) margins at the maximum outlet conditions from the reservoir. This level should be equipped with a low-level float alarm connected to SCADA.

The volume of water corresponding to the minimum submergence level shall not count towards the nominal (working) storage volume of the reservoir. Similarly, the volume of water above the maximum operating level and below the overflow weir elevation shall not count towards the nominal storage volume of the reservoir.

Calculate the minimum required submergence level to avoid air entrainment and vortexing in the reservoir outlet pipe in accordance with ANSI/HI 9.8 and compare this level against the low level required for NPSHA purposes.

4.6 Mixing Systems

Evaluate static and dynamic mixing systems on a life cycle cost basis to minimize hydraulic short-circuiting, provide uniform water age and maintain water quality inside the reservoir under various demand scenarios. A computational fluid dynamics (CFD) model shall be completed by a specialist vendor to confirm the efficacy of the recommended inlet mixing system.

4.7 Reservoir Venting

The reservoir cells shall be provided with a means of natural venting to equalize air pressure inside the reservoir with atmospheric pressure during filling and draining cycles. The reservoir vent size shall be the greatest of the following calculations:

- Reservoir draining resulting from a catastrophic transmission watermain break (full cross section) at either the inlet or outlet side of the reservoir, resulting in admission of air at a velocity of 5 m/s
- Reservoir filling at a fill rate equal to 100% of the maximum flow rate to reservoir according to the latest City of Brantford Master Servicing Plan projections
- Reservoir draining at a draw rate equal to 100% of the firm capacity of the pumping station downstream of the reservoir (i.e. the reservoir feeding the suction header of the pumping station)

Reservoir vents and overflow piping shall be equipped with screens which have opening sizes to prevent the ingress of insects and small debris. Overflow piping shall be equipped with duckbill valves. Vents shall be located away from any potential sources of contaminants.

4.8 Access House

In-ground reservoirs shall be equipped with an above grade access house that provides controlled access to the reservoir cells. The access house shall include:

- Exterior vandal- and tamper-resistant lights. Lights shall be automatically turned on or off by motion sensors or light sensors and shall also be capable of being manually turned on or off from a designated central location;
- Intrusion alarm detection system connected to SCADA including closed-circuit television (CCTV) day/night vision cameras mounted strategically to maximize security coverage;
- Vestibule area separating exterior access doors and the reservoir by a 200 mm high concrete curb and reservoir access door. All electrical panels to be located within the vestibule;
- Interior lighting shall be wall-mounted light-emitting diode (LED) light fixtures which are readily accessible for replacement and maintenance purposes. The access house shall not include any windows;
- Staircase reservoir access through sealed doorway from vestibule;
- Overflow trough access hatch and ladder;
- Ventilation louvres to accommodate reservoir ventilation requirements; and,
- Instrumentation.

4.9 Overflow System

An overflow system shall be provided for the reservoir or tank to protect the roof structure from inlet water pressure. The location of the high-high water level backup float shall be such that a minimum of ten-minute storage time is provided at a flow rate equal to 150% of the maximum inlet flow rate of the upstream pumping station according to the City's most current Water Master Servicing Plan.

The overflow weir shall be designed for 150% of the maximum inlet flow rate of the upstream pumping station with a maximum allowable crest rise of 200 mm above the overflow weir elevation while maintaining a minimum of 100 mm freeboard from the top of the crest to the underside of the lowest roof structural member. Where multiple reservoir cells are available, the overflow weir system shall be capable of meeting the design criteria with the largest cell out of service.

An overflow alarm float that sends an alarm to SCADA to confirm an overflow event shall be provided in the overflow channel or piping and not in the reservoir cells. Any overflow outlet piping, whether from a reservoir or elevated tank shall include a duckbill valve on the discharge end of the pipe.

4.10 Washdown Piping

Washdown piping inside the reservoir shall be sized for two hoses operating simultaneously with a minimum flow rate of 4.5 L/s each at 690 kPa (100 psi). Provide connection points at 20 m intervals to cover the entire reservoir floor area as applicable. All hose outlets shall be 38 mm in size and equipped with full port ball valves and camlock connections.

The washdown line shall be protected by a dedicated reduced pressure principle backflow preventer located in an accessible location that is not a confined space.

4.11 Reservoir Drainage

Reservoir floor slabs shall be sloped at a minimum slope towards a dedicated sump pit to facilitate draining and cleaning. Provide access points for dechlorinating the reservoir drainage volume discharge

4.12 Elevated Tanks

New designs of elevated tanks shall be composite structures with concrete base and steel bowl. A minimum of 2 mm steel corrosion allowance shall be included. In addition, evaluate interior and exterior coating systems for corrosion protection including glass lined steel tanks. All process piping must be delivered to site factory capped and sealed. Any pipe not capped will be rejected. Immediately following the cut down of the outlet pipe within the tank, the pipe must be capped and sealed. Elevated tanks shall be designed to limit thermal stratification and prevent ice bridging.

The following features shall also be provided:

- A painter's rail and drip edge in the tank exterior
- Safety railing surrounding the top of the tank
- Minimum 900 mm diameter access tube extending from the top of the pedestal to the reservoir roof
- Ladders and platforms inside the pedestal and access tube
- Minimum 900 mm diameter watertight access hatch at the bottom of the tank
- Vacuum relief and overflow in all elevated tanks
- Anchor points for communication equipment and future painters' tie-off;
- A central antenna base support structure for the mounting of communications systems on the top of the elevated storage tank
- Separate inlet and outlet piping equipped with flow monitoring
- Inlet and outlet CL2 monitors connected to SCADA
- Double door entrance at the pedestal base
- Artwork developed during the design process and reviewed with the City to suit the location
- Hydrodynamic mixing system
- Waterproof roof sleeves are required for equipment and communication wiring
- CL2 and Ammonia Sulfate booster system, if necessary
- Water recirculation system, if necessary

5.0 BOOSTER PUMPING STATIONS

5.1 Applicability

Booster Pumping Stations, as opposed to high lift pumping stations, refer to pumping station facilities whose suction (intake) lines are directly connected to a pressurized watermain instead of an open reservoir.

Design of new booster stations shall comply with the standard process flow schematic for Booster Pumping Stations included in the Manual Appendices.

5.2 Design Criteria

The Proponent shall define the required domestic and fire flow demands and provide the data to the City for modelling. The data will be modelled against the City's specified pressure bands to confirm the booster station size and pumping requirements. These will form the basis of facility design by the Proponent.

5.3 Pump System Design

Evaluate the anticipated range of flows and evaluate alternative pump types and sizes to achieve an efficient system design. Provide VFD-operated pumps for all booster pumping stations. Pump start and stop ramp times shall be confirmed through transient analysis.

5.4 Considerations for Low Flow Operation

During low flow periods, consider utilization of jockey pumps and/or pressure tanks to prevent excessive pump cycling.

5.5 Piping, Valving, and Instrumentation

Refer to the High Lift Pumping and Process Instrumentation and Control, and Transient Control section for details.

5.6 Surge Relief

The outlet of the surge relief valve shall be equipped with a rubber check valve to prevent rodent and insect entry. The outlet pipe shall be located at least 1.0 m above the finished grade outside of the facility. The discharge of the surge relief valve should be directed to a catch basin draining into the storm sewer system. Provide an alarm to SCADA for surge relief valve monitoring. Bulk Water Fill Stations

6.0 BULK WATER FILL STATIONS

6.1 Applicability

Bulk water fill stations are intended to provide a reliable means of supplying water in large quantities for construction or commercial activities.

6.2 Site Layout

A bulk water facility shall be equipped with a minimum 3.0 m wide paved asphalt apron around the bulk loading panel.

6.3 Process Design

Bulk water stations are part of the City's water distribution system and must be designed to prevent freezing of water lines and avoid the possibility of cross-contamination with the City's water system.

Provide an electrical/control panel complete with an automatic card reader system to control and monitor the operation of the bulk water system. The card reader and control system shall be utilized to quantify water takings for billing purposes. The card reader and control system must be designed in complete consultation with City staff to ensure compatibility and integration with the City's billing system.

Provide a flow meter, online pressure indicator transmitter and testable reduced pressure principle backflow preventer assembly on the main line. Design should consider adequate sampling ports and means for draining water.

Provide positive drainage around the bulk loading station to direct spillage and stormwater away from the station. Site design shall include provision for drive-through tanker circulation with no requirement to reverse direction or backup. Sufficient space should be provided for queuing of at least one tanker truck waiting to fill without impacting local traffic or blocking the street.

Site selection for new bulk loading stations shall be in consultation with the City and local community stakeholders to ensure public acceptance prior to design.