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The City of Winnipeg
Winnipeg Sewage Treatment Program

Process Mechanical Design Guideline

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Approved By:	 <hr style="width: 100%;"/> Linda McCusker, Project Director, WSTP	March 10, 2025 <hr style="width: 100%;"/> Date
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1 INTRODUCTION

This document identifies the standard design guidelines that are applicable to any process mechanical work within the City of Winnipeg (City) wastewater treatment facilities.

1.1 Scope of the Standard

These design requirements will apply to the following facilities:

- Wastewater treatment plants

1.2 Application

The scope and intent of this document is to convey general design guidance and expectations regarding process mechanical systems. This document does not address specifics related to design type, selection, and configuration; however, the indicated guidelines are presented without knowledge of the specific mechanical implementation. It is not within the scope of this document to provide detailed design direction and it will be the responsibility of the respective mechanical designers to fully develop the mechanical design details with general conformance to the concepts presented herein. This standard shall not be construed as comprehensive engineering design requirements or negate the requirement for professional engineering involvement. Any design must be executed under the responsibility and seal of the respective engineer in each instance, and must be performed in conformance with all applicable codes and standards, as well as good engineering practice.

Existing facilities do not necessarily comply with this standard. The expectations regarding the application of this standard to maintenance and minor upgrades at existing facilities must be assessed on a case-by-case basis; however general guidelines for application are presented as follows:

- All new buildings and sites are expected to comply with this standard.
- All major upgrades to a building or site are expected to comply with this standard; however, in some cases, compromise with the configuration of the existing facility design may be required.
- All minor upgrades should utilize this standard as far as practical for new work; however, in some cases, compromise with the configuration of the existing facility design may be required.

1.3 Deviations from Standard

It is expected that there will be occasional situations where the design engineer will propose a deviation from this design guideline. The rationale for potential deviations from the design guideline may include:

- Evolution of technology,
- Updates to standards and regulations,
- Practical limitations due to existing on-site conditions, or
- Significant cost benefits to the City due to specific project constraints.

For each proposed deviation from this standard, fully complete a *WSTP Standards Deviation Form* and submit to the City Project Manager for approval. Do not proceed with the proposed deviation unless approval is received from the City Project Manager.

1.4 Acronyms and Abbreviations

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
API	American Petroleum Institute
BEP	Best Efficiency Point
CGA	Canadian Gas Association
CSA	Canadian Standards Association
FRP	Fiberglass Reinforced Plastic
HI	Hydraulic Institute
MLD	Megalitres Per Day
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NBC	National Building Code of Canada
NFC	National Fire Code
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NPSHA	Net Positive Suction Head Available
NPSHR	Net Positive Suction Head Required
OSHA	Occupational Safety and Health Administration
POR	Preferred Operating Range
TDH	Total Dynamic Head
VFD	Variable Frequency Drive
WSTP	Winnipeg Sewage Treatment Program

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2 GENERAL

2.1 Design Codes and Standards

All designs shall comply with municipal, provincial, and national codes and bylaws. This includes but is not limited to:

- NBC with Manitoba Amendments
- Manitoba Workplace Safety and Health Act and Regulations
- CSA
- NFC
- ASME
- ANSI
- ASTM
- API
- AWWA
- NFPA
- MSS
- HI

In addition, ensure that the following guideline is complied with:

- NIOSH Work Practice Guideline for Manual Lifting

2.2 City Standards

While not exclusive, ensure that the following City Standards are adhered to:

- 1.1 Water and Waste Department Identification Standard
- 1.2 WSTP Piping Color Standard

2.3 Authority Having Jurisdiction

1. National Building Codes: The City of Winnipeg Property, Planning and Development Department, such as: Building Permits, Occupancy Permits, Internal building Fire Protection systems etc.
2. Non-National Building Codes: The City of Winnipeg Water and Waste Department, (water services, sewer services, land drainage and flood protection etc.)

2.4 Units

All drawings and documentation shall use the International System of Units (SI units). Imperial units will be provided in parenthesis after the metric unit, where requested or appropriate. Specific requirements are as follows:

1. All building dimensions are to be in millimetres.
2. All elevations are to be in metres, in the format EL. ###.### (example EL. 273.520).
3. All pipe sizes to be in millimetres.
4. All liquid flow units shall be consistent for a given process or system and general selected using the following criteria:

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- 4.1 Liquid flows may be expressed in m³/s for flows in the range of approximately 0.5 - 15 m³/s.
 - 4.2 Liquid flows may be expressed in L/s for flows in the range of approximately 0.5 - 10,000 L/s.
 - 4.3 Liquid flows may be expressed in MLD when indicating average flows (e.g. average dry weather flow) or unit process capacities.
 - 4.4 Liquid flows may be expressed in L/min for smaller volumetric flows, such as chemical feed applications.
5. All air flow units shall be consistent for a given process or system and general selected using the following criteria:
- 5.1 Process air flows may be expressed in Nm³/min.
 - 5.1.1 Nominal cubic meters per minute (Nm³/min) is defined as the volumetric flow rate in cubic metres per minute at 20 °C, 36% relative humidity and 101.3 kPa absolute pressure.
 - 5.2 Foul air flows may be expressed in m³/hr for flows in the range of approximately 1 - 50,000 m³/hr.
 - 5.2.1 Provide flow rate in cfm in parenthesis when referring to foul air flow rates in design reports and specifications.
6. All liquid and process air pressures should be in kilopascals or metres of H₂O.
- 6.1 Provide pressure in PSI in parenthesis where noted in design reports and specifications.
 - 6.2 Low pressure air, such as foul air, may be indicated in pascals or mm H₂O.

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3 EQUIPMENT SELECTION AND PACKAGING

3.1 Equipment Manufacturer Selection

1. For design-bid-build projects:
2. All designs must allow for more than one manufacturer to submit a bid for any given piece of equipment. 2-3 acceptable manufacturers should be named in the bid documents. Exceptions are only permitted when a specific manufacturer or piece of equipment has been:
 - 2.1 Standardized through an approved City process;
 - 2.2 Approved by the City to be sole-sourced; or
 - 2.3 Preselected via a separate Bid Opportunity.
3. It is recognized that the design must be based on a specific product (the 'design standard')
4. It is also recognized that products of different manufacturers will differ. Slight variations from the design standard (eg. pipes that need to be shifted less than a nominal amount, usually 1000 mm, shall not be considered a change.)
5. Where there are measurable and consequential differences between equipment manufacturers, such that the design must be based upon a specific manufacturer or model:
 - 5.1 Preliminary design shall provide a technical memorandum to the City describing the relevant differences between the equipment performance, layout, and cost. Make a recommendation to regarding the proposed equipment selection and design approach.
 - 5.2 If approved by the City, the design may be based upon the recommended manufacturer, provided that a means to consider alternates is included in the design and procurement strategy.

3.2 Package Systems

1. It is recognised that some designers may choose to specify certain multiple-component processes as a 'package' while others may specify the components individually and then design the interconnections and controls to integrate them into the process.
2. In some cases, it is preferred that some processes be specified as a package, in which a single supplier who is expert in such systems supplies each component and the related tie ins and controls. Specifically, these are:
 - 2.1 UV disinfection systems
 - 2.2 Aeration blowers
 - 2.3 Chemical systems
 - 2.4 Screens and compactors
 - 2.5 Grit removal and handling
 - 2.6 Odour control
 - 2.7 Submersible pump stations less than 100 hp
 - 2.8 DAF thickeners
 - 2.9 Biogas treatment systems
 - 2.10 Rotary Drum Thickeners
 - 2.11 Proprietary processes
3. In all other cases package systems may be proposed, but will require approval by the City.

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4. For design-build projects, the Contractor shall ensure that the requirements of the design guideline and all other standards and specifications are in no way diminished by the equipment packaging proposed by the Contractor.

4 LAYOUT AND ACCESS

4.1 General Requirements

1. Design the system layout with the following considerations:
 - 1.1 Safety
 - 1.2 Operability
 - 1.3 Cost
 - 1.4 Constructability
 - 1.5 Maintainability
 - 1.6 Expandability
 - 1.7 Mitigation of odours
2. Coordinate with all other disciplines. Use of 3D models is preferred, but only mandatory where specified by the City or indicated in the design proposal.

4.2 Operating Aisles and Platforms

1. All at-grade aisles and platforms shall have the following minimum dimensions:
 - 1.1 Clear height: 2100 mm
 - 1.2 Clear width:
 - 1.2.1 Regular Access: 1000 mm
2. All platforms and suspended walkways shall have the following minimum dimensions:
 - 2.1 Clear height: 2100 mm
 - 2.2 Clear width: 800 mm

4.3 Equipment

4.3.1 General Clearances

1. Provide adequate clearance for equipment operation, maintenance, removal, and replacement.
2. Meet the manufacturer's requirements for minimum clearances to perform maintenance tasks. Increase clearances as required to provide sufficient space for any portable lifting devices required to assist with the maintenance activities. Additionally, the following minimum clearances should be provided where possible:
 - 2.1 Horizontal pumps:
 - 2.1.1 1200 mm between adjacent pumps or in front of a single pump on the long side;
 - 2.1.2 600 mm clearance to the pump suction nozzle, excluding any conflicts with the suction piping; and
 - 2.1.3 600 mm at the back of the motor.

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- 2.2 Vertically mounted centrifugal pumps:
 - 2.2.1 1200 mm between adjacent pumps or in front of a single pump on the long side;
 - 2.2.2 600 mm clearance to the pump suction nozzle, excluding any conflicts with the suction piping;
 - 2.2.3 600 mm clearance all around the intermediate shaft bearings and joints, where applicable; and
 - 2.2.4 1200 mm between adjacent motors or in front of a single motor on the long side.
- 2.3 Blowers:
 - 2.3.1 1200 mm clearance between blowers or in front of a single blower on the long side; and
 - 2.3.2 600 mm clearance to the front and back of the equipment, excluding interconnecting piping or ductwork.
- 2.4 Screenings washer/compactors, centrifuges, and rotary drum thickeners:
 - 2.4.1 2000 mm clearance all around, excluding interconnecting piping/slucies/etc.
- 2.5 Pressure vessels or tanks
 - 2.5.1 1000 mm clearance to the side of the equipment where the main access and interconnecting nozzles are located; and
 - 2.5.2 600 mm clearance to all other sides.
- 3. Coordinate clearances with all engineering disciplines to ensure that the final commissioned installation meets all clearance requirements.
- 4. Do not place control panels and other ancillary devices not integral to the unit within the clearances specified above.
- 5. Coordinate with the architectural discipline to ensure that sufficient clearance is provided around equipment to meet egress requirements.
- 6. Ensure adequate clearance above or below units is provided for equipment that must be lifted or lowered for removal.
 - 6.1 These clearances must allow for the space occupied by the applicable lifting devices, whether permanent or portable.
- 7. Provide sufficient clearances for removal and refitting of the serviceable components of all installed equipment without removal or dismantling of either: (1) unrelated parts of the equipment being serviced equipment or (2) adjacent equipment in part or in whole. This includes scheduled service and unplanned failures throughout the life of the equipment.
- 8. Where lifting with portable manual equipment (A-frames, hand trucks, dollies, portable ladders or similar) is proposed, provide the minimum clearances for access:
 - 8.1 Horizontal clearance: 1.0 m
 - 8.2 Vertical clearance: 2.5 m
- 9. Provide permanent ladders and service platforms where necessary to facilitate equipment maintenance.
- 10. Coordinate with structural designers the locations of hatches, removable partitions, landing areas, and roll-up doors to facilitate removal and transportation of heavy equipment.
- 11. Any item weighing more than 23 kg (50 lb) that is expected to be moved in the normal course of operation requires a mechanical lifting device.

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4.3.2 Washdown and Drainage

1. Locate wash-down in logical areas to facilitate equipment clean-up and pipe flushing.
2. Provide sufficient numbers of hose stations appropriate for the size of the area and the environment (outdoor, indoor). Space to limit hose length to a maximum of 15 m.
3. Provide sufficient drains in each washdown area
4. Coordinate with structural to provide adequate floor slope to all drains. Take exceptional care NOT to place drains at high points.
5. Mount equipment and panels on concrete housekeeping pads to protect them from wash-down water.
6. All permanent tanks that cannot be completely drained by gravity or any related process pumps require a permanent sump be installed in an easily accessible location. Permanent pump infrastructure is preferred (guide rails, etc.) to ease locating the sump in a partially full tank and lowering of the drainage pump (if it is not normally in place), unless such devices would interfere with the process (eg. rotating clarifier mechanism). In which case, take every measure to allow the sump to be easily locatable so that a portable pump can be lowered in with a minimum of error.
7. Washdown water shall not to be used on the same distribution loop as seal water

4.3.3 Process Air

1. Design process air systems (diffusers and blowers) to meet airflow requirements for the maximum day demand as determined by process modeling.
 - 1.1 Provide sufficient installed blower capacity to meet the design airflow with the largest unit out of service.
2. Process air systems must also be designed for the lowest process air demand. Process modeling and calculations should be performed to determine the minimum air requirement to maintain treatment performance and tank mixing.
 - 2.1 Provide blowers with sufficient turndown, or include jockey blowers as required, to deliver the minimum airflow within the operating range of the equipment.
3. Process blowers must be selected such that a rise-to-surge margin of 15% is maintained for all operating conditions.
4. Where possible, process blowers should have individually piped air inlets. Shared headers for suction piping are discouraged.
5. Select process air blowers based on energy efficient solutions. The preferred technologies are as follows:
 - 5.1 Single stage centrifugal with dual point control or high-speed turbo blowers for main process systems.
 - 5.2 Hybrid or positive displacement blowers for other systems such as channel aeration.
6. Control valve shall be sized such that the range of airflow from minimum mixing to the maximum day process demand is within the controllable range (30 to 70% open) of the valve. In most cases, control valves will be 1-2-line sizes smaller in diameter than the adjacent piping. Designer to determine necessary control valve size and any reduction in line size to ensure adequate control.
7. Provide all instrumentation and control hardware as needed to maintain efficient control of the process air system to meet all process performance objectives.

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- 7.1 Blowers shall operate to meet a pressure set-point, which may be varied as required to optimize control valve positions. Where multiple blowers are installed, the control system shall stage blowers on and off based on the most efficient combination to maintain the process set-point.
- 7.2 Process control valves will throttle air from the main header to meet a DO set-point in the tank. Provide a tuned PID control loop to optimize the overall process control.
- 7.3 The control system will monitor all control valve connected to a header system and vary the pressure set-point such that one valve is always as close to 100% open as possible.

4.3.4 Foul Air Collection and Treatment

1. Acceptable technologies for foul air treatment are as follows:
 - 1.1 Carbon scrubbers may be used for room air and process air sources that are low strength and high volume.
 - 1.2 Biofilters may be used for process air sources under 25 ppm H₂S.
 - 1.3 Biotrickling filters followed by a biofilter may be used for higher strength process air sources.
2. Foul air ductwork materials shall be as follows:
 - 2.1 316L stainless steel for indoor ductwork.
 - 2.2 FRP for outdoor ductwork.
3. Foul air ductwork must be designed with adequate slope to prevent build-up of condensate, along with drainage of condensate back to the treatment plant process.
4. All drains on foul air systems must include P-traps with adequate trap depth based on the design pressure.
5. All fans shall be designed with a minimum rise to surge of 15%.
6. Foul air fans, except inline booster fans, shall be installed downstream of treatment where possible. Fan materials shall be FRP or 316L stainless steel.
7. Discharge stacks shall be FRP and include vortex shedding where required. Stack height shall be determined based on a dispersion modeling study. Ensure exit velocities prevent ice formation during winter months.
8. Foul air systems shall be balanced by a qualified balancing agent to meet the design airflows. The balancing agent shall issue a report indicating the measured airflows on each branch, methodology for measurement, performance data for all fans, and positions of balancing dampers.

4.3.5 Compressors

1. Place compressor as close as possible to the suction source.
2. Provide dryers as needed for compressed air to meet the requirements of actuators, instruments, etc. Where acceptable given the equipment that is serviced, utilize refrigerating dryers. If a lower dewpoint is required than may be provided with a refrigerating dryer, then a desiccant dryer is acceptable.
3. For continuous flow application, provide rotary screw compressors sized based on the range of airflows. Select rotary screw compressors such that the operating and idle times are within the manufacturer's allowable range. Where larger turndown is needed, provide a unit with a VFD.

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4. For intermittent flow applications, such as the use of air tools, provide a reciprocating compressor.
5. Top suction and discharge lines should be routed to provide clearance for overhead maintenance requirements, or should be made up with removable spool pieces.

4.4 Conveyors

1. Provide shaftless conveyors for municipal wastewater screenings, sludges, etc. Dewatered sludge conveyors may be shafted or shaftless in accordance with the manufacturer's recommendation.
2. Conveyor materials shall be as follows:
 - 2.1 Screw: Carbon steel
 - 2.2 Cover, trough and hoppers: Stainless steel
 - 2.3 Lining: UHMWPE
3. Provide inspection hatches in the cover of sufficient size for operators to identify and clear clogs, and cut any material stringy material winding in the screw.
4. Conveyors must include a safety pull switch, motion sensor, and motor overload protection.
5. Screenings conveyors shall include 75 mm drains, including one at the low end of a sloped trough, and additional drains along the length of the trough as required.
6. Spiral screw sections for wastewater screenings must be connected without any protruding hardware, which can cause winding of stringy materials within the screw.
7. Spiral screw shall have a minimum 300 mm Brinell hardness peripheral edge, equal to 30% of the cross section of the spiral.

4.5 Piping

1. Ensure that all piping provides sufficient head clearance, is not a tripping hazard, or a barrier to equipment access. If this is unavoidable, provide proper warning signs, barriers, other protection, or alternate routes.
2. Care shall be taken to make sure piping is not directly above any electrical equipment or equipment which requires lifting for maintenance, removal, or repair.
3. In general, it is preferred to place piping close to walls from which it can be readily supported.
4. If piping must be near a wall but not supported from it, maintain a minimum clearance of 600 mm between the outermost pipe flange and the wall.
5. For purging of air from pipelines, provide manual vent valves at high points of all pipelines carrying liquids and pipes that must be hydrostatically tested.
6. For drainage of pipelines, provide manual drain at the low points of all pipelines carrying liquids and pipes that must be hydrostatically tested.
 - 6.1 Drain valves shall be as close as possible to the bottom of the pipe. Minimize the drop leg length.
 - 6.2 Drain valves should be provided between each pair of isolation valves on pipelines.
 - 6.3 Drains for clear liquids shall be 25 mm diameter or larger and drains for solids bearing liquids shall be 50 mm diameter or larger. Increase drain diameter to one-line size

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larger than the size of solids present in the flow. Increase drain diameter from the sizes specified above to ensure draining of pipeline does not exceed 1 hour.

7. For sewage and sludge pipelines, provide flushing connections at each side of mainline and branch shut-off valves, pump suction valves, and discharge isolation valves.
 - 7.1 Flushing water connections shall be permanently piped for points that will be flushed at least once per month.
 - 7.2 Ensure that appropriate valve isolation is provided to allow for flushing flexibility.
 - 7.3 Orient flushing point connections as appropriate to direct the flushing flow.
8. Scum pipes shall be as short and as straight as possible and provided with access points for mechanical cleaning devices or high-pressure cleaning. Include flushing water connections on either end to flush/ back flush scum piping.
 - 8.1 Orient cleaning access points to facilitate cleaning operations at 45° angle maximum (30° preferred).
9. Ensure adequate space is available for installation of pipe supports and seismic bracing.
10. Provide flexible connections or pipe couplings where appropriate to facilitate assembly and disassembly of piping and connections to equipment.
11. Show locations of pipe anchors and expansion joints on the drawings.
12. Install reducers on the suction side of pumps flat-on-top to prevent air or gas entrapment.
 - 12.1 Exception: Install reducers for sand ballasted systems flat-on-bottom to prevent solids accumulation.
13. Wall penetrations shall be perpendicular to the wall. Provide a puddle flange and a flanged end on both sides of cast-in-place concrete wall penetrations for new construction. Where required, provide cored penetrations with Link-Seal or double Link-Seal as appropriate for the installation.
14. Provide appropriate valve isolation such that any pipe segment may be taken out of service without affecting other pipe segments.
 - 14.1 Provide valves on branches as close to the main header as possible.
15. Sewage and sludge service check valves to be installed on horizontal pipes only. To prevent the accumulation of solids on the downstream side of the flapper, do not install swing check valves in vertical piping runs.
16. Provide a coupling or dismantling joint within four pipe diameters of actuated valves and flow meters for easy disassembly. If placing a coupling or pipe joint within 4 pipe diameters results in flow disturbances that affect flow meters or other inline devices, provide sufficient additional straight length in accordance with the device manufacturer's installation requirements.
17. Provide thrust restraint or anchors designed by the Engineer for sleeves and other couplings that are not self-restraining.
18. Provide adequate space for valve and gate actuators.
19. Provide adequate clearance for rising stem valve and gate operators.
20. Provide sufficient straight pipe runs on the upstream and downstream side of all instrumentation in accordance with the manufacturer's installation requirements or industry practice.
21. Where required, provide permanent access platforms for actuated modulating valves. Temporary ladders or lifts are unacceptable.

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22. Coordinate with other disciplines to ensure no conflict between piping and other components or the Infrastructure such as cable tray, ducting, sprinkler systems, lighting, etc.

4.6 Heat Exchangers

1. Shell-and-tube heat exchangers shall have a clearance equal to the bundle length plus 1.5 m to allow for tube removal.
2. Provide 300 mm clearance around flanges to the nearest obstruction.

5 LIFTING AND EQUIPMENT REMOVAL

5.1 General Requirements

1. For any and all equipment that requires lifting and equipment removal, the designer is responsible a comprehensive design that provides the capability to maintain, lift, and remove all equipment. The requirements of this section shall apply to all equipment directly or indirectly connected to a device that requires energy to operate and all other equipment requiring service at intervals less than ten years.
 - 1.1 Designs that do not allow for equipment removal with a single lifting device shall be submitted for review and approved by the City.
 - 1.2 Provide a lifting plan to the City identifying the proposed lifting and equipment removal procedures of each piece of equipment.
2. Ensure all applicable equipment is provided with lifting eyes or other appropriate means to connect a lifting device without detriment to the equipment.
3. All lifting devices, components and anchorage points shall be labelled with applicable Safe Working Load and tag lifting devices in accordance with the WWD Identification Standard.
4. All lifting devices shall be positioned or installed in such a way as to reduce the risk of:
 - 4.1 equipment or load striking a person; or
 - 4.2 loads drifting, falling freely, or being unintentionally released and minimizing the number of lifts required
 - 4.3 Reduce unsafe loading practices such as off-centre or off-balance loading
5. Lifting equipment should be installed so as to not lift an item of equipment or load over and across areas occupied or uncontrollably accessed by persons.

5.2 Manual Lifting

1. All manual lifting shall comply with:
 - 1.1 Manitoba Workplace Safety and Health Regulation MR217/2006
 - 1.2 NIOSH Work Practice Guide For Manual Lifting
2. In no case shall manual lifting be permitted if more than two people are required and the mass to be lifted exceeds 23 kg (50 lb)

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5.3 Portable Lifting Devices

1. Portable lifting devices may be used for equipment components weighing less than 1,000 kg.
 - 1.1 Portable lifting devices are not acceptable for the regular movement of chemicals or other consumables without approval of the City.
2. Where portable lifting devices are proposed, ensure that appropriate clearances and access is provided around the equipment to enable a controlled movement of the equipment from its installed position to its off-loading position.
 - 2.1 Travelling or slewing motion of the load shall be at a speed such that it does not produce a pendulum motion during the lift and cause shifting of the load. It shall also be free of pinching points.
3. Portable lifting devices may include:
 - 3.1 Moveable gantry cranes;
 - 3.2 Portable davits with fixed bases;
 - 3.3 Hand-operated hoists (i.e. chain hoist) with permanent attachment points;
 - 3.4 Engine hoists
4. Where moveable gantry cranes or engine hoists are proposed, ensure adequate access to the equipment and provide a non-corrosive storage location for the portable gantry crane or engine hoist. Show the moveable gantry crane or engine hoist in the proposed storage location on the drawings.
 - 4.1 Moveable gantry cranes and engine hoists are not acceptable for outdoor lifting without approval of the City.
5. Where portable davits are proposed, ensure that an engineered davit base is included in the design.
 - 5.1 Floor-mounted davit bases shall be flush with the floor unless it can be proven that there the davit base will not cause a tripping hazard.
 - 5.2 Davit bases shall have a removable cover prevent accumulation of grit and debris in the recess when it is not in use.
 - 5.3 All davit bases and their operating radii shall be shown on the drawings.
 - 5.4 Davit basis shall be constructed of material suitable for the environment.
 - 5.5 Ensure compatibility of appropriate davits and davit bases on site.
 - 5.6 Where multiple staged lifts will be required, provide a second lifting attachment point on the davit arm.
 - 5.7 Floor davit bases shall be engineered and sealed by a professional engineer.
6. Where hand-operated hoists are proposed, ensure that an engineered attachment point is included in the design.
 - 6.1 Ensure all lifting points are reasonably accessible, considering the frequency of maintenance.
 - 6.2 Where multiple lifts will be required, provide a second lifting attachment point.
 - 6.3 All lifting points shall be shown on the drawings.
 - 6.4 Lifting eyes and other attachment points shall be constructed of material suitable for the environment.
 - 6.5 Lifting eyes and other attachment points shall be engineered and sealed by a professional engineer.

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7. The use of rented boom cranes or spider cranes shall only be considered for maintenance operations with an expected frequency of greater than once in five years.
8. Provide all portable lifting devices required for the design.
 - 8.1 The designer shall coordinate with City Operations to determine existing portable lifting devices and the practicality of using them for any new and upgraded areas. If existing devices are deemed unusable or otherwise insufficient, provide additional lifting devices.

5.4 Permanent Lifting Equipment

1. Provide permanent motorized hoists, monorails, or cranes where:
 - 1.1 The weight of any piece of equipment in its entirety, or any of its removable components exceeds 1,000 kg;
 - 1.2 Lift frequency for normal operation or maintenance may exceed bi-weekly; and
 - 1.3 Lifting is a normal operating procedure, regardless of weight, (example: regular movement of polymer bags).
2. All motorized hoists, monorails, or cranes are required to maintain and hold the load during a power lift.

6 PUMPING SYSTEMS

6.1 Pump Types and Applications

6.1.1 Pumps

1. Where multiple parallel units are provided, ensure the drive orientation and the rotation direction is identical to minimize spare part inventory. Exceptions shall be approved by the City.
2. To the extent possible given any footprint limitations, comply with the HI 9.6.6 standard for the layout of piping and fittings around pumping equipment.
3. For sludge pumping, simplify the discharge piping as much as possible to minimize the risk of clogging including:
 - 3.1 Minimize the number of bends
 - 3.2 Use long radius bends when bends are required
 - 3.3 Use the smoothest pipe materials/linings available for the application
 - 3.4 Use the largest practical pipe diameter (minimum 100 mm)
 - 3.5 Provide regularly spaced flushing taps in accordance with Section 4.4.
4. Top suction and discharge lines should be routed to provide clearance for overhead maintenance requirements, or should be made up with removable spool pieces.

6.1.2 Centrifugal Pumps - General

For high flows at low to moderate heads, centrifugal pumps are preferred over positive displacement pumps, unless the fluid's characteristics dictate otherwise.

In general, closed impellers shall be used for pumping clear and reasonably clear fluids, while open impellers shall be used for pumping sludges and slurries.

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1. Non-Clog Dry Pit Centrifugal Pumps

- 1.1 Use non-clog dry pit centrifugal pumps for pumping typical process liquids, sludges and slurries.
 - 1.1.1 Use impellers and pump casings made of hardened alloy steel for increased wear resistance for very abrasive commodities, such as grit slurry.
 - 1.1.2 Use screw-type impellers for return activated sludge, or where steeper performance curves, higher efficiencies, and low shear is required.
 - 1.1.3 Use chopper type pumps with sharpened vanes rotating against a cutter bar in the pump intake where risk of plugging of downstream piping exists, such as for scum and fermenter sludges.
 - 1.1.4 Use recessed impeller pumps for grit slurries and primary sludge.
 - 1.1.5 Standard impellers may be used for other applications.
 - 1.1.6 Direct driven horizontal mounting is preferred where space is available. Belt driven horizontal mounting or vertical mounting is acceptable where space is limited.
 - 1.1.7 Exceptions shall be reviewed and approved by the City.

2. Submersible Non-Clog Pump

- 2.1 Minimize the use of submersible pumps for raw sewage, effluent, and sump pumps. Limit the use of submersible pumps to sump pit locations. Exceptions can be reviewed and approved by the City of Winnipeg.
- 2.2 When pumping process fluids that may contain screenings, where the pump discharge is less than 100 mm diameter, provide a cutter impeller.
- 2.3 When pumping process fluids that may contain screenings, where the pump discharge is 100 mm or greater, the Flygt N-type impeller or a screw impeller is preferred.
- 2.4 Drywell mounted pump motor cooling shall be by circulation of a suitable liquid through a cooling jacket surrounding the motor housing. Using the pumped media (if sewage) is discouraged.
- 2.5 Wetwell mounted pump motor cooling shall be by virtue of the motor being submerged in the fluid.

3. Horizontal End-Suction Centrifugal Pumps

- 3.1 Use end-suction centrifugal pumps for flushing water applications.
- 3.2 Use FRP (or other suitable corrosion-resistant or chemically compatible non-ferrous material) pumps for chemical transfer.

6.1.3 Vertical Turbine Pumps

1. Use vertical turbine pumps for pumping clear or reasonable clear water at high pressure.
2. Vertical turbine solids handling pumps may be used for screened raw sewage.

6.1.4 Vertical Mixed Flow or Axial Flow Pumps

1. Use vertical mixed flow or axial flow pumps for pumping treated effluent or mixed liquor.

6.1.5 Submersible Propeller Pumps

1. Use submersible axial flow propeller pumps for pumping high volumes of clear or reasonably clear water (free of stringy or fibrous material) at low heads.

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2. Use horizontal submersible axial flow propeller pumps for pumping mixed liquor.

6.1.6 Positive Displacement Pumps - General

Use positive displacement for low to medium flows of viscous fluids rates at low to high heads, or where precise or constant flow rate is required.

1. Progressive Cavity Pumps
For pumping thick sludges, such as thickened waste activated sludge, and for liquid polymer transfer and feed.
2. Rotary Lobe Pumps
For pumping scum and sludge. When pumping primary sludge, mixed sludge, thickened primary sludge or digested sludge, a grinder on the suction side of the pump should be provided to minimize the chance of the close-fitting rotors binding.
3. Peristaltic (Hose) Pumps
For very steady non-pulsating flow of chemicals and sludges.
4. Diaphragm Metering Pumps
For precise metering of chemicals or other commodities.

6.2 Pump Construction

6.2.1 Pump Shaft Sealing

1. Generally, pumps shall be furnished with mechanical seals, not packing.
2. Mechanical seals water piping shall include solenoids that open when the pump is operated, a Y-strainer, and a combined flow switch, rotameter and pressure gauge instrument such as the John Crane Safeunit or the ESKO ESF.
3. Double seals shall be considered for sludge and chemical services where the shaft cannot be sealed with the pumped fluid or where contamination of the pumped fluid with the seal fluid would be unacceptable. Where double mechanical seals are used, drains must be located near the pump.
4. Single mechanical seals are acceptable for general liquid services and sludges < 2% solids.
5. Where available and appropriate for the application, oil lubricated seals shall be considered in order to minimize water consumption.
6. Mechanical seals shall be high quality, split, cartridge type.
7. For sludge and chemical pumps with a gearbox, provide a seal that has an open cavity from the gearbox.
8. Where the pumped fluid is 5 percent solids by weight or higher, both seal faces shall be hard. Otherwise, a hard-soft face combination shall be specified.
 - Acceptable hard seal face materials include sintered or reaction bonded silicon carbide, or graphitized silicon carbide.
 - Acceptable soft seal face material is carbon-graphite.

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6.2.2 Bearings

1. In general, use grease lubricated ball and roller type bearings, both guide and thrust.
2. Grease lubricated fittings shall be included with grease addition and relief fittings.
3. For large equipment, consult the manufacturer for specific lubrication requirements.

6.2.3 Shaft Couplings

1. For pumps which carry their own thrust load, use spring grid or gear type flexible shaft couplings.
2. For pumps which transmit the impeller thrust to the motor bearings, such as vertical turbine pumps, use spacer couplings.
3. Vertical turbine pumps with hollow-shaft motors shall be furnished with non-reverse ratchet type couplings to protect the pump and motor against backspin during shutdown and power failure.
4. Provide OSHA-approved shaft and coupling guards for all rotating equipment.

6.2.4 Materials

1. Pump materials shall be compatible for the particular service.
2. For water and sewage pumps, the following materials are preferred:
 - 2.1 Volute: Cast or Ductile iron
 - 2.2 Impeller: Cast or ductile iron, or stainless steel where required for the service
 - 2.3 Wear ring: Stainless steel
3. Certain applications may require special materials for corrosion, chemical, or abrasion resistance.

6.3 Hydraulic Design

6.3.1 Pump Selection and Hydraulic Calculations

1. Provide hydraulic calculations for all pump applications.
2. Develop system curves for both the minimum head condition (minimum static head and friction loss) and the maximum head condition (maximum static head and friction loss), from the minimum required flow to the maximum required flow, to establish the required operating range of the pump.
 - The system curves shall be superimposed on the performance curves of the candidate pumps to ensure that the required operating range falls within the manufacturer's recommended allowable operating region of the pump.

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3. Provide a pump selection that optimizes efficiency over the range of pump operating points, with consideration of the following:
 - Where possible, the required operating range shall be within the POR per the *ANSI/HI 9.6.3 Guideline for Operating Regions* standard.
 - The average operating condition should be as close to the BEP as practical.
 - In parallel pumping systems with significant dynamic losses and a wide range of operating flows, select pumps that operate to the left of the BEP at their maximum design condition with all pumps in service. Where dynamic losses are insignificant and the system curve is flat, select pumps that operate to the right of the BEP at the maximum design condition.
 - Avoid selecting pump operating points near the extremes of the performance curve to prevent excessive pump shaft radial loading, reduced bearing and seal life, and shaft failure.
4. Provide adequate performance overlap for systems with parallel duty pumps. Ensure proper pump sequencing to allow smooth transition and avoid flow surges when starting and stopping lag and stand-by pumps.

6.3.2 Net Positive Suction Head

1. Suction lines shall be as short and straight as possible.
2. The design shall provide adequate NPSHA, plus a margin of safety, relative to the NPSHR/NPSH3 provided by the manufacturer.
3. NPSH calculations for centrifugal and vertical pumps shall comply with HI standard *ANSI/HI 9.6.1 Centrifugal and Vertical Pumps for NPSH Margin*.

6.3.3 Sump and Wet Well Design

1. Use HI standard *ANSI/HI 9.8 Pump Intake Design*, to design sumps and wet wells to ensure pump suction submergence, approach velocities, and other relevant parameters are satisfactory.
 - 1.1 Where the HI 9.8 standard cannot be met, physical modeling should be considered. Present anticipated cost and schedule for modeling, and the risks of not modeling to the City for consideration.
2. Provide sufficient wet well volume for system control stability. Where feasible, use the following general guidelines:
 - 2.1 Where continuous level control is required, provide enough wet well surface area to limit rising or falling velocity to a maximum 300 mm per minute.
 - 2.2 For constant speed pumps, provide sufficient wet well volume to prevent a pump cycling (starting) more frequently than the limits of its drive motor (consult manufacturer). Refer to the HI 9.8 Appendix B for a methodology for calculating sump volume.
 - 2.3 Install level measurement devices in the most quiescent region of the well (low turbulence, waves, or vortices) to avoid widely fluctuating or unstable level signals. A stilling well may be required.

7 STORAGE TANKS

7.1 Material Selection

1. Tank materials must be compatible with the commodity that is to be stored. The material must not corrode or deteriorate over time. Acceptable tank materials are listed in Table 7-1. Other materials require approval of the City.
2. Typical materials for storage tanks for process applications shall include:
 - Concrete
 - Stainless steel
 - Steel (rubber lined, plastic lined)
 - FRP
 - HDPE
 - Ductile-iron (cement lined, glass lined)

Table 7-1 : Preferred Tank Materials

Application	Acceptable Material of Construction
Ferric Chloride – up to 39%	FRP
Scum	Reinforced concrete
Sludge	Reinforced concrete
Sodium Bisulphite – 38%	FRP
Sodium Hypochlorite – 12%	FRP
Sodium Hydroxide – 50%	FRP
Wastewater	Reinforced concrete

Note: If designer is proposing other materials not in Table 7-1. Submit approval to City Project Manager.

7.2 Tank Features

1. If the tank is too small to enter, provide hand-holes for inspection and cleaning.
2. Otherwise, provide a permanent means to enter the tank for periodic inspection.
3. Tank entry ports shall comply with health and safety standards for size and function.
 - Tanks which require periodic inspections shall be provided with side and top entries.
 - In general, openings shall be minimum 600 mm in diameter with a bolted cover and gasket.
 - Where possible, equip access covers with davits or hinges with room to fully open the hatch, especially if the pressure rating of the vessel dictates a heavy cover, or if the cover is inconvenient to unbolt and refasten each time.
4. Provide tank bottoms with slight slope toward a drain connection.
 - Place the drain nozzles as close to the tank floor as possible.

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- Place fabricated flat bottom tanks on housekeeping pads with full bottom support.
 - Where necessary, tank pads shall be blocked out at the location of the drain nozzle to allow room for flanging drain piping to the nozzle.
5. Atmospheric tanks shall be equipped with a vent line, routed to the outdoors where necessary, and fitted with an insect screen. Size vent lines properly to prevent tank collapse during pump out or drainage, or over-pressurizing the tank during filling or purging.
 6. Where feasible or required by code, equip tanks with an overflow line.
 - Direct the overflow to a plant drain line, or to a containment system where it can be safely handled.
 - When two tanks (containing the same commodity) are in parallel, combine the overflow lines such that one tank will first overflow into the second tank before it overflows to drain or to the containment system.
 7. Provide spectacle blinds to isolate out-of-service tanks.
 8. Provide ladders and platforms where necessary to access tank man ways, inspection ports, level instruments, relief valves, and other tank accessories.
 - Design platforms and ladders to meet Manitoba's Workplace Safety and Health Act regulations, they shall be suitably sized for their proposed purpose.
 - Ensure attachments are made to the tank to securely hold platforms and ladders in place.
 - Locate level instruments, relief valves and other items requiring regular maintenance near the edge of the tank so that these items can be accessed directly from the platform and to avoid walking on the top of the tank.
 9. Provide chemical tanks with WHMIS labels indicating the tank capacity, the chemical to be stored and its specific gravity.
 10. Ensure secondary containment is provided for each chemical. If different adjacent chemicals can be mixed with no adverse effects, a common containment area can be used.

8 PIPING SYSTEMS

8.1 General Requirements

1. Process mechanical piping includes all piping directly associated with any and all treatment processes. The majority of process mechanical piping shall be located within buildings, tunnels, and galleries.
2. Coordinate concrete encased piping with the structural engineering discipline and buried process mechanical piping with the civil engineering discipline to ensure proper design for earth loads and traffic loads.

8.1.2 Code Considerations

1. Select pipe materials carefully to ensure that they are suitable for the service intended and meet the applicable code requirements.
2. Comply with the following design codes:
 - 2.1 ASME B31.3 – Process Piping

- 2.2 API 610 Nozzle loads
 - 2.2.1 If available, manufacturer's allowable nozzle loading shall be used in lieu of API 610.
 - 2.2.2 Upon confirmation with the manufacturer or approval by a Professional Engineer, allowable loads within API 610 may be doubled.
- 2.3 CSA/ANSI B149.6:20 – Code for digester gas
- 2.4 HI 9.6.6 – Pump Piping
 - 2.4.1 Where space is not available to meet this standard, deviations may be acceptable if approved by a Professional Engineer.

Pipe Flow Velocities

1. In general pipelines shall be sized to limit velocities as shown in Table 8-.

Table 8-1: Pipe Flow Velocities

Type	Velocity
Gravity	<ul style="list-style-type: none"> • an average velocity of 1.2 to 1.5 m/s, • a minimum velocity of 0.6 m/s (to prevent settling of solids); • a maximum velocity of 2.4 to 2.7 m/s (to minimize erosion and head loss).
Pressure	<ul style="list-style-type: none"> • an average velocity of 1.5 to 3.0 m/s, • a minimum velocity of 0.6 to 0.9 m/s; and • a maximum velocity of 3.0 to 4.5 m/s. • Refer to the HI Standard 9.6.6 for detailed requirements.
Process Air	<ul style="list-style-type: none"> • 6 to 9 m/s for sizes 75 mm diameter and smaller, • 9 to 15 m/s for sizes 100 to 250 mm, • 15 to 19 m/s for sizes 300 to 600 mm; and • 19 to 33 m/s for sizes 750 mm and larger.
Foul Air	<ul style="list-style-type: none"> • Design for max 5 mm of pressure drop per 30 m of duct

8.3 Thermal Expansion and Flexibility

1. Thermal expansion and contraction movement shall be calculated with consideration of the pipe length, material properties, and range of temperatures that the piping will be exposed to in operation.
2. In general, avoid expansion joints, couplings, or compensators where the calculated movement is within the allowable flexure and allowable stress of the pipe material, and where the support system does not hinder movement.
3. Determine the allowable flexure and stress range in accordance with ASME B31.3 unless alternate piping codes are required by local authorities.

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4. Limit loads at equipment nozzles to within allowable limits as provided by the Manufacturer, or indicated in the API 610 standard. Allowable nozzle loads in API 610 may be doubled if approved by a Professional Engineer.
5. Develop details regarding piping expansion and flexibility during detailed design.
6. Where expansion joints or couplings are part of the piping system design, the pipe support system shall be designed and detailed as necessary to include pipe anchors to restrain and resist thrust expansion joints, pipe guides adjacent to expansion joints and rolling or sliding supports to allow movement of the pipe.
7. Anchor loads for piping with expansion joints shall be calculated to determine if special structural design is required for the structural attachment, or if a special design is required for the anchor attachment to the pipe.
8. The following expansion joint types should be used for process piping:
 - 8.1 Liquid service without abrasive materials: Single arch non-metallic spool type (Garlock 204, Proco 231, or equal)
 - 8.2 Liquid service with abrasive materials, or >2% sludge service: Single arch non-metallic spool type with filled arch (Garlock 204, Proco 231FA, or equal) or spherical molded type (Garlock Style 8100, Proco 240, or equal)
 - 8.3 Process air: Metal bellows expansion joint (Flextech, Senior Flexonics, or equal)

8.4 Pipe Supports

1. Under a design-bid-build contracting strategy, the contractor shall not be expected to perform any design for pipe supports for piping 600 mm and larger. The designer shall provide a comprehensive design for the pipe supports including:
 - 1.1 Structural design for secondary pipe support secondary structures.
 - 1.2 Details for mechanical pipe supports, referencing MSS SP-58 where applicable.
 - 1.3 Locations of all supports on the drawings and 3D model as applicable. Mechanical pipe supports may be called out by annotation, but all structural elements must be detailed.
 - 1.4 Comprehensive structural and mechanical design.
 - 1.5 Design for restraint of thrust forces, including those generated by flexible couplings and untied expansion joints.
 - 1.6 Receive from the contractor and review pipe support shop drawings during construction.
2. Under a design-bid-build contract, the piping support calculations and design for piping smaller than 600 mm diameter may be assigned to the contractor provided the work is performed by a professional engineer. Notwithstanding, the designer (eg. consultant), the engineer shall:
 - 2.1 Provide standard details for pipe supports, referencing MSS SP-58 where applicable.
 - 2.2 Design for restraint of thrust forces, including those generated by flexible couplings and untied expansion joints.
 - 2.3 For each piping run, indicate if piping is to be supported from the ceiling, wall, or floor. Coordinate with the structural discipline to ensure the structure can support the piping load.
 - 2.4 Receive from the contractor and review pipe support shop drawings during construction.

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3. Ensure that pipe supports for plastic pipes meet the requirements of all applicable manufacturer and industry guidelines.
 - 3.1 Ensure saddle-type supports of the appropriate width are provided.
 - 3.2 Ensure appropriate support spacing.
 - 3.3 Where required, provide load shields designed to the manufacturer's standard.
4. The style and placement of supports shall consider future maintenance and operations that may require removal and replacement of piping and valves.
5. Specify channel-type support systems for small diameter (<75mm) piping.
 - 5.1 Specify corrosion-resistant alloy and FRP for damp and corrosive areas.
6. Provide sway struts and braces, or adequate line stops and guides as required to restrain piping seismic forces as required by the Manitoba Building Code for post disaster structures.
7. Follow ASME standards for piping that requires registration with the Office of the Fire Commissioner – Inspection and Technical Services Manitoba.

8.5 Thrust Restraint

1. Provide thrust restraint by means of pipe anchors, tie rods, and restrained joints.
2. Provide expansion joints with extension limiting rods to protect the bellows from over extension.
3. Thrust tie and welded lug assemblies for steel pipe shall be by standard detail.
4. Provide thrust restraint for buried pipe by proprietary restrained joints or individually restrained joints with tie rod assemblies.
5. Where soil bearing pressure is adequate, thrust restraint may be by concrete thrust blocks. However, avoid where future nearby excavations may compromise a thrust block's restraining ability.

8.6 Piping Identification

1. All piping shall be properly identified with permanent labels indicating the contents and direction of flow, in accordance with the City's standards.
2. Refer to the City of Winnipeg Water and Waste Department Identification Standard related to piping.
3. Refer to the WSTP Paint Colour Standard for pipe colours.

9 VALVES

9.1 Manually Operated Valves

1. Provide hand wheel operators for manual valves 200 mm in diameter and larger.
2. Provide valve position indicator visible from the position of operation.
3. Provide wrench levers operators for quarter-turn valves (plug, butterfly, and ball) smaller than 200 mm.
4. Operator force shall not exceed 177 N under any operating condition, including initial breakaway. Provide gear reduction operator when force exceeds 177 N.

5. Install manually operated valves within easy reach (within 2,000 mm of the operating floor).
6. Where valves cannot be installed within 2,000 mm of the operating floor, provide chain wheel operators having chains extending to within 1,200 mm of the floor.
 - 6.1 Chain wheels shall include safety cable
 - 6.2 Provide chain bucket for chain storage in congested areas
7. Provide buried valves with square head operating nuts, extension stems, and valve boxes at grade. Gate valves shall generally be the rising stem type; use non-rising stems only where space is limited. Ideally, locate valves with access inside of buildings for operations and maintenance or if outside easily accessible.

9.2 Power-Actuated Valves

1. Power-actuated valves shall be installed where required for, based on automatic process control. Additionally, power actuators shall be provided for the following applications:
 - valve operation is required at least once per shift.
 - quick valve operation may be required because of an emergency.
 - slow valve operation may be required to prevent water hammer.
 - large valves (>600 mm) where manual operation would be cumbersome.

9.2.1 Electric Actuated Valves

1. In general, provide electric motor operators with manual override for power-actuated valves, for both open-close service and modulating service.
2. Small open-close valves for clean water service (50 mm and smaller) shall be solenoid operated. Provide motorized ball valve for small open-close valves otherwise.
3. In general, 120V single-phase actuators shall be used for valves 50 mm and smaller; 600V three-phase actuators shall be used for valves 100 mm and larger.
4. Use the City's standardized actuator vendor.
5. Ensure the running and breakaway torque safety factors ratings are appropriate for the specific valve type and service. Actuators shall be rated at least twice the valve operating torque, or twice the breakaway torque, whichever is greater, unless it can be proven, in writing, that a lower safety factor is sufficient. Minimum safety factors for clean fluid applications are as follows:

5.1	Butterfly Valves:	1.3 (with proof)
5.2	Eccentric Plug Valves:	1.5 (with proof)
5.3	Gate Valve:	1.5 (with proof)
5.4	Sluice and Slide Gates:	2.0 (no exceptions)
6. Ensure actuator duty rating is greater than the worst operating case.
7. Ensure solid-state modulating actuators are specified for control applications.
8. Ensure the actuators are rated for the installation location (eg. area classification, outdoor, etc.).

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9.2.2 Pneumatic Operated Valves

1. Pneumatic operated valves shall be limited to the following applications:
 - 1.1 fast opening or closing of the valve is required for process control;
 - 1.2 failsafe valve operation is required;
 - 1.3 Retrofits of existing installations; or
 - 1.4 Other special applications as approved by the City.
2. Pneumatic actuators shall comply with AWWA C541 and shall include air sets, exhaust mufflers, speed controls, pilot solenoids, and safety-vented isolation valves.
3. Provide zero-bleed energy efficient positioners unless air bleed is needed for the service conditions.

9.3 Control Valves

These general guidelines shall be followed for control valve sizing:

1. The appropriate valve flow characteristic (quick opening, linear, equal percentage, modified parabolic) shall be selected based on the application (pressure relief, pressure control, flow control, level control) and the proportion of total system head loss available as pressure drop across the valve.
2. The turndown ratio (the ratio of maximum to minimum flow) shall not exceed 5:1.
3. The required valve operating range shall be maintained within 15 to 80 percent of the maximum flow coefficient (C_v) for optimum control. Valves shall be sized to pass the maximum flow at minimum pressure drop with the valve operating at not more than 80 percent of maximum capacity.
4. In a throttled constant-speed pump system, the pressure drop across the valve at maximum flow shall be at least 40 percent of the system total frictional loss (including the control valve) when the system static head exceeds 70 of the total dynamic head (TDH), at least 30 percent when the static head is 50 to 70 percent of the TDH, and at least 20 percent when the static head is less than 50 percent of the TDH.
5. In a system where static pressure or head moves liquid from one vessel to another, the pressure drop across the valve at maximum flow shall be at least 10 percent of the system static pressure or 40 percent of the system total frictional loss (including the control valve), whichever is greater.
6. In all cases, the valve shall be at least 10 percent open at the maximum throttling (minimum flow at maximum pressure drop) position. The preferred minimum opening is 15 percent.

9.4 Check Valves

1. Check valves shall be installed on all pipes where passive backflow prevention is not present and where backflow is not desired.
2. The standard for most wastewater process commodities is a swing flex check valve, complete with position indicator and backflow actuator. Alternate acceptable options are swing check valves or actuated plug valves for liquid service. Ball check valves are acceptable as an alternative for sludge or scum service.
3. The standard for process air check valves is a double leaf check valve.

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4. Install check valves on pump or blower discharges upstream of the isolation valve.
5. Check valve alone is not sufficient for isolation.

9.5 Valve Installation

1. Valve Orientation
 - 1.1 Valves shall be installed with the operating mechanism either vertically upward or horizontal (never vertically downward).
 - 1.2 Limit installation at an inclined angle above the horizontal to situations where interference must be avoided.

10 GATES AND STOP LOGS

10.1 Gates

1. Slide gates shall be used to isolate flow in tanks and channels.
2. Ensure slide gates meet AWWA C561, Standard for Fabricated Stainless-Steel Slide Gates. Allowable leakage rates shall be the allowable leakage rate specified in AWWA C561.
3. In tanks, the gates shall be wall-mounted with an elastomeric gasket between the gate frame and the concrete wall.
4. Provide thimble for pipe penetrations into tanks that are isolated with slide gates.
5. In new channels, the gate frame shall be embedded in the walls and floor of the channel such that the gate invert is flush with the channel bottom and the gate opening is equal to the full width of the channel. In existing channels, the gates frames shall be surface mounted.
6. Gates located near the operating floor level shall generally be the self-contained type, with the gate operator mounted on a yoke attached to the gate frame. Self-contained gates shall be fully assembled and tested at the factory, and the gate operator thrust loads shall be transferred entirely to the gate frame rather than to the concrete structure. Gates located well below the operating level shall generally be the non-self-contained type with extension stems and pedestal mounted operators.
7. Where self-contained gates are used, provide a top yoke design that allows the removal of the slide without also removing the gate frame.
8. Manually operated gates shall be equipped with geared crank type operators, either yoke or pedestal mounted. The crank shall be removable for attachment of a portable electric drill operator. Power operated gates shall be provided for the following applications:
 - process control requires remote automated operation of the gate.
 - gate operation will be required more than once per week.
 - rapid response to an emergency condition may be required.
 - gates with a vertical lift of 1,800 mm or greater.
 - gates with a nominal area of 3.24 m² or greater.
9. Power-operated gates shall be equipped with electric motor operators with a manual override.
10. Use rising stem gates wherever possible to minimize the opportunity for fouling of the threads. Do not use non-rising stems for modulating gates.

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11. In applications with abrasive grit, use cast iron or stainless-steel sluice gates with a wedging action at the point of gate closure to provide sealing.
12. Gates shall be 316L stainless steel.
 - 12.1 Pickle and passivate all welds for fabricated gates.
13. Use of stoplogs for flow isolation is discouraged, except in cases where the need to close or open a conduit is infrequent (less than once per year). The City shall decide the acceptable level of "infrequent" for each case where stoplogs are proposed.
14. Provide stoplogs as a means to isolate gates for when gates need maintenance or replacement.

10.2 Stop Logs

1. Where stop logs are used, provide heavy-duty stop logs rated for the head applied.
2. In new channels, the stop log guide channels shall be embedded in the walls and floor of the channel such that the stop log invert is flush with the channel bottom and the stop log opening is equal to the full width of the channel. In existing channels, the stop log guide channels shall be surface mounted.
3. As much as possible, standardize the width and height of the stop logs to allow interchangeable use in multiple locations.
4. Leakage rate for stop logs not to exceed 0.62 L/min per metre of wetted seal perimeter.
5. Aluminum stop logs may be used, provided they are not normally installed. If stop logs are normally installed, use 316L stainless steel.
6. Provide 316L stainless steel stop log guide channels.
7. Pickle and passivate all welds for fabricated stop logs (if applicable) and stop log guide channels.
8. For each set of stop logs, provide a lifter capable of installing and removing all stop logs of the same width whether they are installed or at the operating floor level.
 - 8.1 Provide the lifter with lifting hooks designed to engage the slots in the top of the stop logs.
 - 8.2 Provide a lanyard release.
 - 8.3 Lifter shall be constructed of stainless steel and fitted with ultra high molecular weight polyethylene guide bars and stainless-steel fasteners.
9. Provide mechanical lifting device to assist with stop log installation and removal. Ensure sufficient head room is provided.
10. For each set of stop logs, provide a stop log storage rack.
 - 10.1 Show the stop log storage rack on the process drawings and ensure sufficient clearance to allow movement of the stop logs from the rack to the installation location.
 - 10.2 Storage racks shall be located in the same room that the stop logs will be installed, unless otherwise approved by the City.
 - 10.3 Aluminum storage racks may be acceptable, provided aluminum is suitable for the atmosphere in the room. If not, use 304L stainless steel.
 - 10.4 Where manual lifting of the stop logs is not permitted by Section 5.2, provide a mechanical lifting system to move the stop logs from the storage rack to the installation location.

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11 SAMPLING

1. Provide automatic composite samplers where repeated regular sampling is required for process monitoring and adjustment, or for regulatory reporting and compliance, unless composite sampling is not suitable for the parameter being measured (eg. bacteria sampling in final effluent).
2. Automatic samplers shall take representative samples and store them in a dedicated refrigerator.
3. Sample volume and frequency of sampling shall be adjustable by an operator.
4. Provide a recirculation pump and pipe to draw the subject liquid near the sampler for sampling and then return it to the original location.
5. Provide instrument air for operation of the samplers from either the building instrument air line or a dedicated oil free compressor complete with moisture removal and air filtration. Refer to Section 4.3.5.
6. Sentry ISOLOCK is the preferred sampler and is used at numerous sampling points. However, the City has not standardized Sentry ISOLOCK therefore the product cannot be sole sourced, without prior approval per Section 3.12.2, but should be a named manufacturer in the specifications.

12 SERVICE LIFE

1. Mechanical and electrical equipment: 20 years
2. Process piping (other than buried): 20 years
3. Buried piping: 60 years

13 DESIGNER RESPONSIBILITIES

13.1 General

1. Responsibility for deliverables
 - 1.1 All drawings, specifications, and other deliverables related to a design are the responsibility of the designer.
2. Ensure all process mechanical deliverables are sealed by a qualified professional engineer.
3. Completeness of drawings:
 - 3.1 All drawings shall be comprehensive in nature to allow for effective use in construction.
 - 3.2 BIM projects shall be complete to Level of Detail (LOD) 300 as defined by the BIM Forum
4. Update of existing drawings:
 - 4.1 If the project is an addition, expansion, upgrade, or modification to an existing site or facility, existing drawings may require updating. Coordinate with the City to understand the specific requirements. Typical requirements include:
 - Updating existing building floor plans and layouts.
 - Updating P&ID drawings.
 - The update of detail drawings for existing works is not expected or required.

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5. Design reviews:
 - 5.1 Issue design documents for review at intervals agreed to in advance with the City.
 - 5.2 Incorporate all WSTP comments into the design. Where a WSTP comment is not accepted by the designer, provide justification to the City Project Manager.
6. As-Built Drawings:
 - 6.1 Update all process mechanical deliverables to “as-built” status at the end of the project. The “as-built” documents shall incorporate contractor mark-ups and alterations arising from: inspections, change orders; RFIs; and other communication between the Contractor and the designer.
 - 6.2 Unless otherwise specified by the City and agreed to by the designer, as-built drawings will not be sealed (otherwise known as record drawings).
7. Third Party Consultants:
 - 7.1 Expertise and assistance may be required from external third-party specialized consultants.
 - 7.2 The designer shall assume responsibility for monitoring the activities and progress of each third-party consultant.
 - 7.3 It is the responsibility of the design engineer to ensure that the deliverables follow all City standards and guidelines.
 - 7.4 QA/QC procedures of the third-party consultant must be equivalent to that of the prime consultant.
8. Site Visits:
 - 8.1 The designer is responsible for ensuring that a sufficient number of site visits occur to facilitate the understanding of specific field conditions or status of existing facilities and buildings.
9. Demolition Requirements
 - 9.1 It is generally required that the designer assume responsibility for demolition works associated with the work. Clearly indicate all demolition requirements on the drawings and in the specifications.
 - 9.2 Minor demolition (pipe removal and realignments etc.) may be shown on the relevant construction drawing. Where demolition is extensive (entire buildings, processes, etc.), create dedicated demolition drawings.

13.2 Drawings

The drawings indicated in this section are minimum requirements for new construction, unless otherwise approved by the City.

13.2.1 General Requirements

1. Provide scale bar on all scaled drawings to allow for measurement takeoff and avoid confusion regarding scale, regardless of the format or size reproduction of the document.
2. Show a north arrow on all plan drawings.

13.2.2 Legend

1. Requirement

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- 1.1 Provide a legend drawing showing the symbols and abbreviations used. Coordinate re-use of any existing legend drawings with the City.
2. Content
 - 2.1 Ensure that the legend is consistent with the City's practices. Symbols shall be consistent with the P&IDs.
3. Format:
 - 3.1 Produce drawings in ANSI D format.

13.2.3 Process Flow Diagrams (PFDs)

1. Requirement
 - 1.1 Provide PFDs for the complete process system. The PFDs shall show all major equipment and flow streams.
2. Content
 - 2.1 PFDs shall depict all major equipment and piping.
 - 2.2 Provide PFD for the entire project.
 - 2.3 All equipment shall be fully identified as per the City WWD Identification standard.
 - 2.4 Show major control valves and gates. Isolation valves and gates are not typically shown.
3. Format
 - 3.1 Produce drawings in an ANSI D format.

13.2.4 Process and Instrumentation Diagrams (P&IDs)

1. Requirement
 - 1.1 Provide P&IDs for the complete process system, including all auxiliary services.
2. Content
 - 2.1 All equipment, piping, valves, and instruments.
 - 2.2 All automation and control components.
 - 2.3 All process flow rates.
 - 2.4 All instrumentation ranges.
 - 2.5 All hardwired equipment interlocks.
 - 2.6 All local control panels.
 - 2.7 Motors and the associated starter.
 - 2.8 Communication signals to SCADA / PCS.
 - 2.9 All major hardware and software control loops.
3. Format
 - 3.1 Produce drawings in an ANSI D format.
 - 3.2 The P&IDs shall be in a format compliant with the City WWD Identification Standard and ISA 5.1.

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13.2.5 Hydraulic Profiles

1. Requirement
 - 1.1 Provide a comprehensive set of hydraulic profile drawings for all major flow paths, including process bypass. In general, any one profile should be shown on a single sheet. If multiple sheets are required, the last water elevation on the sheet n shall be duplicated as the first water elevation on sheet $n + 1$ to facilitate readability.
2. Content:
 - 2.1 Vertical scale may be exaggerated to accentuate the elevation differences. The horizontal is generally not to scale.
 - 2.2 The water elevation for each process and flow path shall be shown, at minimum, for:
 - 2.2.1 Peak wet weather flow (PWWF)
 - 2.2.2 Max day flow (MDF); and
 - 2.2.3 Average daily dry-weather flow.
 - 2.2.4 If a flow other than the three above is critical to the operation of some reactor or channel (eg. minimum flow), also show the profile for this condition.
 - 2.3 All weir and flume elevations.
 - 2.4 All tank, conduit, and channel elevations.
 - 2.5 All pipe diameters.
 - 2.6 Maximum and minimum control elevations in pumping wet wells and other variable elevation processes.
 - 2.7 Design flood elevations
3. Format:
 - 3.1 Produce drawings in an ANSI D format.

13.2.6 Process Plan Overview Drawings

1. Requirement
 - 1.1 Where Process Plan Drawings (see 13.2.7) may only show a portion of the process, Process Plan Overview Drawings are required to show the complete floor elevation for all floors with major equipment, including the roof if equipment is located there.
2. Content:
 - 2.1 Arrangement of all major equipment and piping.
 - 2.2 Annotations with tagging for equipment.
3. Format:
 - 3.1 Produce drawings in ANSI D format.
 - 3.2 Provide a scale bar to allow for scale takeoffs.
 - 3.3 Scale:
 - 3.3.1 Recommended: 1:100 – 1:150
 - 3.3.2 Maximum: 1:200
 - 3.3.2.1 The maximum scale is only permissible in instances where there is limited equipment and piping detail to show.

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13.2.7 Process Plan Drawings

1. Requirement
 - 1.1 Process plan drawings are required for every floor elevation, including the roof if equipment is located on the roof.
2. Content:
 - 2.1 Arrangement of all process equipment, including all piping.
 - 2.2 All pipe supports for all piping 600mm and larger.
 - 2.3 All equipment and valves.
 - 2.4 All field instruments should be indicated.
 - 2.5 Pipe elevations, measured in geodetic elevation at the centreline.
 - 2.6 Annotations with tagging for piping, valves and equipment.
3. Format:
 - 3.1 Produce drawings in ANSI D format.
 - 3.2 Provide a scale bar to allow for scale takeoffs.
 - 3.3 Scale:
 - 3.3.1 Recommended: 1:50
 - 3.3.2 Maximum: 1:100
 - 3.3.2.1 The maximum scale is only permissible in instances where there is limited equipment and piping detail to show.

13.2.8 Process Section and Detail Drawings

1. Requirement
 - 1.1 Provide process section and detail drawings to completely make clear the required installation of the process systems.
2. Content
 - 2.1 Clearly identify all materials of construction.
 - 2.2 Clearly show all dimensions.
 - 2.3 All pipe supports for all piping 600mm and larger.
 - 2.4 All equipment and valves complete with identification.
 - 2.5 Annotations with tagging for piping, valves, and equipment.
3. Format:
 - 3.1 Produce drawings in ANSI D format.
 - 3.2 Scale:
 - 3.2.1 Recommended: 1:50
 - 3.2.2 Maximum: 1:100

13.2.9 Piping Support Detail Drawings

1. Requirement
 - 1.1 Provide drawings to clearly identify the required piping support installation.

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- 1.1.1 Typical details shall be provided for pipes < 600 mm. The Contractor shall provide sealed shop drawings for all pipe supports < 600 mm.
- 1.1.2 Complete comprehensive design shall be provided for all pipes >= 600 mm.

2. Content

- 2.1 Clearly identify all materials of construction.
- 2.2 Clearly show all dimensions.
- 2.3 Indicate references to MSS SP58 where applicable.
- 2.4 Coordinate with the structural discipline as required.

3. Format:

- 3.1 Produce drawings in ANSI D format.
- 3.2 Scale:
 - 3.2.1 Recommended: 1:25
 - 3.2.2 Maximum: 1:50

13.2.10 Equipment Installation Detail Drawings

1. Requirements

- 1.1 Provide equipment installation detail drawings as applicable to provide the contractor with sufficient information to bid the work and meet the requirements of the project.

2. Format:

- 2.1 Produce drawings in ANSI D format.
- 2.2 Scale:
 - 2.2.1 Recommended: 1:25
 - 2.2.2 Maximum: 1:50

13.2.11 3D Model

- 1. 3D models and associated drawings are not mandatory for all projects, but where 3D design is required by the City, or proposed by the Consultant, this section shall be complied with in its entirety. 3D models shall be used for all major capital projects.
- 2. The 3D model shall include pipework, ductwork, and equipment for all disciplines to fully represent the entire facility.
- 3. 3D models should be completed to Level of Detail (LOD) 300 per the BIM Forum.
- 4. In addition to the 3D model provide:
 - 4.1 3D elevation and section drawings to convey the complete process configuration.
 - 4.2 3D detail drawings for areas with interdisciplinary coordination requirements.
- 5. 3D Models will be hosted on Autodesk Construction Cloud (ACC).

13.2.12 Coordination with Other Disciplines

1. Structural and Architectural

- 1.1 Ensure that openings for equipment, pipework, and other openings are coordinated with and shown on the structural and architectural drawings.
- 1.2 Ensure all equipment weights are coordinated with the structural design.

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- 1.3 Where new equipment is installed on an existing floor/roof, the engineer is responsible for coordinating the appropriate structural review to ensure that the weight of the equipment is supported. Upgrade the existing structure as required.
- 1.4 Where new penetrations are made to an existing structure, ensure that structural elements are not affected. Coordinate the appropriate structural review and upgrade as required.
 - 1.4.1 Where penetrations are made through reinforced concrete, care should be taken during the design planning and construction stages to minimize the cutting of reinforcement.
 - 1.4.2 Where penetrations are made through the roof, provide details for continuity of the roofing membrane.
- 2. Building Mechanical, Electrical, Instrumentation
 - 2.1 Undertake clash resolution as part of design to confirm that all piping, cable trays, and ducts are clash free unless field run.
 - 2.2 Review all electrical clearances (cable tray, panels, etc.) are in accordance with the Canadian Electrical Code (CEC).
 - 2.3 Coordinate all instrument locations and confirm that instruments are accessible for maintenance, are installed per the manufacturer's guidelines, and are readable where applicable.

13.3 Other Documents

13.3.1 Equipment List

- 1. Requirements
 - 1.1 Provide a comprehensive equipment list.
 - 1.1.1 It is preferred if the list is organized into a separate document for each process area (area code).
- 2. Content
 - 2.1 Include:
 - 2.1.1 Equipment Identifier
 - 2.1.2 Equipment Description
 - 2.1.3 P&ID
 - 2.1.4 Location
 - 2.1.5 Motor Size
 - 2.1.6 Voltage
 - 2.1.7 Starter Type
 - 2.1.8 Phase
 - 2.1.9 FLA
 - 2.1.10 Other information as applicable.
- 3. Format:
 - 3.1 Produce equipment lists in Microsoft Excel format.

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13.3.2 Valve List

1. Requirements
 - 1.1 Provide a comprehensive valve list.
 - 1.1.1 It is preferred if the list is organized in a master list that can be sorted as process area, valve type, size, etc.
 - 1.2 Include gates and stop logs in the valve list.
2. Content
 - 2.1 Include:
 - 2.1.1 Valve Identifier
 - 2.1.2 Valve Description
 - 2.1.3 Valve Type
 - 2.1.4 Actuator
 - 2.1.5 P&ID
 - 2.1.6 Specification / Datasheet
 - 2.1.7 Location
 - 2.1.8 Service
 - 2.1.9 Other information as applicable.
3. Format:
 - 3.1 Microsoft Excel format.

13.4 Design Calculations

1. As a minimum, provide the following list of process mechanical design data and calculations:
 - Pump Hydraulic Calculations
 - Hydraulic profile calculations.
 - Aeration calculations
 - Mass balances
 - Foul air flow and loading calcs
 - HI compliance calcs
2. At the agreed to design review milestones, submit draft design calculations to the City.
3. Provide final calculations, updated to include any modifications during design and construction, as part of the as-built package.