

Contract for: **Wastewater Treatment Facility**

Between: **English River Enterprises Property
Management LP**

And: **Wright Construction Western Inc.**

Project: **7603-002-00**

Contract Date: **January 15, 2021**

Volume: **2 of 6**

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1. GENERAL

1.1 INTENT

- .1 The work in this section to include, but not necessarily be limited to the following:
 - .1 Supply, installation, connection and calibration of all instruments as listed in Section 13312.
 - .2 Valves, flow meters and other in-line instruments supplied and connected in this section to be installed in Division 15.
 - .3 Shipment of instrumentation components to the control and instrument panel manufacturer where applicable.
 - .4 Supply, installation and connections of all cable, conduit and wiring for the control and instrumentation systems.
 - .5 Supply, installation and connection of control panels.
 - .6 Installation and connection of Programmable Logic Controller.
 - .7 Commissioning of all instruments as described in Section 01810.

1.2 SHOP DRAWINGS

- .1 Submit the following items:
 - .1 Field Instruments listed in section 13312
 - .2 Programmable Logic Controls and Computers section 13317
 - .3 Radio Equipment listed in section 13318
 - .4 Control Panels
 - .5 Control relays
 - .6 Rail-mount terminals
 - .7 Rail-mount fuse holders
 - .8 Power Supplies
 - .9 Selector Switches and Push Buttons
 - .10 Uninterruptable Power Supplies
- .2 Shop drawings to indicate (where applicable):
 - .1 Instrument tag numbers(s)
 - .2 Available range
 - .3 Materials of construction
 - .4 Wetted materials
 - .5 Accuracy
 - .6 Rating of enclosure
 - .7 Other details listed on the Instrument Specification Sheet
 - .8 Detailed wiring/interconnection diagrams with terminal labels

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- .9 Complete product part numbers for each piece of equipment
- .10 Any additional information requested by Owner or Owners representative

2. PRODUCTS

2.1 SPARE PARTS

- .1 Provide the following spare parts loose in each control panel:
 - .1 Five bulbs of each type used where bulb is incandescent.
 - .2 Ten fuses of each type and rating used.
 - .3 Two control relays and bases of each type used.
 - .4 One rail-mount circuit breakers of each type used.
 - .5 Two push-button and selector switch contact blocks of each type used.
 - .6 Ten pass through terminals of each type
 - .7 Two fused terminals of each type

3. EXECUTION

3.1 INSTRUMENT TAGGING

- .1 Provide each instrument with a tag stamped or engraved with the Instrument number.
- .2 Tags to be done in accordance with specifications described in section 16075.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Owners Representative.
- .4 Affix tags to instruments with nylon tie-wraps or adhesive. Do not use adhesive on curved surfaces.
- .5 All tags on existing equipment are to be removed. New tags are to be attached to all existing equipment, with new lettering and numbering as specified in the drawings.

3.2 COMMISSIONING

- .1 Commission all instruments as described in Section 01810
- .2 Retain the services of the equipment Manufacturers Technical Representative as required as described in Section 13312
- .3 Upon completion of construction, all circuits are to be operational and all instruments operating within manufacturer's specifications.
- .4 Prior to notifying Owner's Representatives Commissioning Team to begin commissioning activities, verify all PLC inputs, and outputs, and complete Record Drawings as described in this section.

- .5 Electrical controls, circuits and systems shall be tested by trial operation of control equipment after all wiring is completed to see that each interlock and control function operates in accordance with the contract drawings and the description of operation for the equipment. Where field conditions prevent actual equipment functioning during testing, the contractor shall simulate the intended operating condition in the associated control circuits.
- .6 The contractor shall locate the cause of any malfunction and make the necessary wiring and / or equipment changes or corrections to obtain the particular systems intended operation as defined by the contract drawings. Such changes shall be included in the test report.
- .7 Control Panels shall be operated through all design functions. This shall include remote operation of all equipment and actuation of alarms and indicating devices according to design requirements.
- .8 Complete operation tests shall be given to all relays, and control devices to show that the equipment performs all design functions and meets design and procurement specifications.
- .9 During start-up, assist Commissioning Team in debugging system operation and correct any deficiencies and omissions which appear.

3.3 RECORD REPORTS

- .1 During each of the aforementioned tests, the electrical contractor shall maintain a comprehensive set of test reports defining the specific condition in which the apparatus is left, after it has been given approval for use in its indented service. The completed report shall become the property of the Owner.
- .2 A check list type report for each individual item of all electrical equipment listed in Division 13, should be headed with but not limited to the following identification data, defining:
 - 1 Equipment Name
 - 2 Item Tag Number
 - 3 Manufacturer
 - 4 Type of Class
 - 5 Application
 - 6 Plant Location
 - 7 Voltage Rating
 - 8 Date of Test
 - 9 Ambient Conditions
 - 10 Testers Signature
- .3 Among the specific requirements of testing to determine the equipment's operation condition relative to that particular apparatus, all items shall be visually inspected and evaluated on the report as to its general condition both exterior and interior.

- .4 The forms used for testing and startup shall be similar (contain the same information) to the sample form indicated below. MPE can provide template documents upon Contractors request.



Instrumentation Equipment Startup Startup

Parameter Input and Checklist

TAG

Project: _____ Job Number: _____ Date: _____ MPE Onsite Rep: _____	Project Manager: _____ Resident Engineer: _____ Contractor Rep: _____ Manufacturer Rep. _____
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Print Name

Instrumentation Information:

Tag Number: _____	Transmitter: <input type="checkbox"/>	Receiver: <input type="checkbox"/>	
Manufacturer: _____	Communication: _____	Digital: <input type="checkbox"/>	
Model Number: _____		Analog: <input type="checkbox"/>	HART: <input type="checkbox"/>
			4-20mA: <input type="checkbox"/>
Serial Number: _____	4 Wire: <input type="checkbox"/>	2 Wire: <input type="checkbox"/>	
Voltage: _____			

Analog Input Parameters:

Device Units: _____

Device Span: _____

Signal Value Minimum _____	➡	Span Value _____	Actual Test: <input type="checkbox"/>
			Simulated Test: <input type="checkbox"/>
Signal Value Maximum _____	➡	Span Value _____	Actual Test: <input type="checkbox"/>
			Simulated Test: <input type="checkbox"/>

Comments: _____

Analog Input Meets Specification: Yes: ☐ No: ☐

Analog Output Parameters:

Device Units: _____ Device Span: _____	<table style="width: 100%; border-collapse: collapse; font-size: x-small;"> <thead> <tr> <th colspan="6">HMI Alarms (Completed by Programmer)</th> </tr> <tr> <th>Alarm</th> <th>Required</th> <th>Set Point</th> <th>Confirmed</th> <th>Reset</th> <th>HMI Tag</th> </tr> </thead> <tbody> <tr> <td>High High</td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> </tr> <tr> <td>High High</td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> </tr> <tr> <td>Low</td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> </tr> <tr> <td>Low Low</td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> <td style="text-align: center;"><input type="checkbox"/></td> <td style="text-align: center;"><input type="checkbox"/></td> <td></td> </tr> </tbody> </table>	HMI Alarms (Completed by Programmer)						Alarm	Required	Set Point	Confirmed	Reset	HMI Tag	High High	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		High High	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		Low	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>		Low Low	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	
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Span Minimum _____	➡	Signal Value _____	Actual Test: <input type="checkbox"/>
			Simulated Test: <input type="checkbox"/>
Span Maximum _____	➡	Signal Value _____	Actual Test: <input type="checkbox"/>
			Simulated Test: <input type="checkbox"/>

Comments: _____

Analog Output Meets Specification: Yes: ☐ No: ☐

Digital Input Parameters:

Digital Signal 1:	Active: <input type="checkbox"/>	High: <input type="checkbox"/>	Set Point High: _____	Power to Open: <input type="checkbox"/>
	Passive: <input type="checkbox"/>	Low: <input type="checkbox"/>	Set Point Low: _____	Power to Close: <input type="checkbox"/>
	Pulse: <input type="checkbox"/>	Pulse Width: _____		Power Fail Status Description: _____
Description:	_____			_____
	_____			_____
Digital Signal 2:	Active: <input type="checkbox"/>	High: <input type="checkbox"/>	Set Point High: _____	Power to Open: <input type="checkbox"/>
	Passive: <input type="checkbox"/>	Low: <input type="checkbox"/>	Set Point Low: _____	Power to Close: <input type="checkbox"/>
	Pulse: <input type="checkbox"/>	Pulse Width: _____		Power Fail Status Description: _____
Description:	_____			_____
	_____			_____
Other Digital Signals:	_____			

Digital Input Meets Specification:	Yes <input type="checkbox"/>	No <input type="checkbox"/>		

Digital Output Parameters:

Digital Signal 1:	Active: <input type="checkbox"/>	High: <input type="checkbox"/>	Set Point High: _____	HMI Alarms (Completed by Programmer)	
	Passive: <input type="checkbox"/>	Low: <input type="checkbox"/>	Set Point Low: _____	Required: <input type="checkbox"/>	HMI Status _____
	Pulse: <input type="checkbox"/>	Pulse Width: _____		Alarm on High: <input type="checkbox"/>	Required: <input type="checkbox"/>
	Continuous: <input type="checkbox"/>			Alarm on Low: <input type="checkbox"/>	On: <input type="checkbox"/>
				Reset: <input type="checkbox"/>	Off: <input type="checkbox"/>
Description:	_____			HMI Tag	_____

Digital Signal 2:	Active: <input type="checkbox"/>	High: <input type="checkbox"/>	Set Point High: _____	HMI Alarms (Completed by Programmer)	
	Passive: <input type="checkbox"/>	Low: <input type="checkbox"/>	Set Point Low: _____	Required: <input type="checkbox"/>	HMI Status _____
	Pulse: <input type="checkbox"/>	Pulse Width: _____		Alarm on High: <input type="checkbox"/>	Required: <input type="checkbox"/>
	Continuous: <input type="checkbox"/>			Alarm on Low: <input type="checkbox"/>	On: <input type="checkbox"/>
				Reset: <input type="checkbox"/>	Off: <input type="checkbox"/>
Description:	_____			HMI Tag	_____

Other Digital Signals:	_____				

Digital Output Meets Specification:	Yes <input type="checkbox"/>	No <input type="checkbox"/>			

Instrumentation Ready for Service:Yes: ☐ No: ☐

Test Equipment Used:	Model: _____
	Serial No.: _____
Comments:	_____

Attachments:	_____

Onsite Rep:	_____

Print Name Signature Date

END OF SECTION

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1. GENERAL

- .1 Not Applicable.

2. PRODUCTS

2.1 WIRE AND CABLE

- .1 Wire for 120 VAC control signals to be as specified in Division 16, except that control wiring within cabinets shall be minimum #18 AWG.
- .2 All control wires shall be color coded as follows:

Less than 50VDC Positive - Red
Less than 50VDC Positive - Blue
50VDC and greater Positive - Violet, Purple or Pink
50VDC and greater Negative - Yellow

120VAC Hot - Black
120VAC Neutral - White
240VAC Hot - Black
120/240VAC Hot - Black and Red
240VAC Neutral - White
208VAC Hot - Red, Black, Blue
208VAC Neutral - White

Ground – Green
Reserved – Brown
Reserved – Orange
Reserved – Gray

- .3 Wire for 24 VDC analog instrument signals to be stranded copper, AWG 18, foil or braided shield, 300V rating.
- .4 All control and instrumentation cables not in control cabinets shall be protected via interlocked galvanized steel or RPVC Conduit or aluminum armour with PVC Coating.

3. EXECUTION

3.1 TERMINATION OF CONDUCTORS

- .1 Where spare conductors are pulled into an instrument or junction box where spare terminals are not provided, tie back spare conductors.
- .2 Where spare conductors are pulled into a control panel, provide spare terminals and terminate all conductors.

- .3 The conductor and conduit schedules are intended to show the majority of the power and instrument runs. Supply, Install and connect all cables and conduit for the control instrumentation and power system to provide a complete and functional system.

3.2 CABLE LABELING

- .1 Label each cable where it enters a panel or instrument with double zip tied engraved lamacoid labels. See section 16075 for electrical identification.
- .2 Write on labels are not acceptable.
- .3 All teck control cable is to have an outer jacket colour as follows:
 - .1 Instrumentation and control cable – Grey
 - .2 Power cable - Black
 - .3 Ethernet Network cable (Cat5e or Cat6) - Blue

3.3 CONDUCTOR LABELING

- .1 Conductors to be labeled at each end by slip-on plastic tags Wieland type Z5 or Weidmuller type Z or by machine-printed heat-shrink labels.
- .2 Write on Labels are not acceptable.

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 All field instruments required including:
 - 1. Magnetic Flow Meters
 - 2. Pressure Switches
 - 3. Level Pressure Transducers
 - 4. Ultrasonic Level Transmitters
 - 5. Level Switches
 - 6. Compact Conductive Level Switch
 - 7. Conductivity Level Switches
 - 8. Electro-Pneumatic Positioners
 - 9. General Purpose 2-Way Solenoid Valves
 - 10. Piloting Solenoid Valves – Locally Mounted
 - 11. Weight Indicating Transmitters
 - 12. Gas Analyzer and Transmitters
 - 13. Visual Signaling Device (External Device)
 - 14. Smoke Detectors
 - 15. Heat Detectors
 - 16. Temperature Transmitter

1.2 RELATED SECTIONS

- .1 Division 15 - Mechanical, all sections.
- .2 Division 16 - Electrical, all sections.

1.3 UNIFORMITY OF INSTRUMENTS

- .1 Instruments of one manufacturer to be used throughout to the extent practical. Variations will be permitted only where the major supplier cannot supply a particular instrument as specified.
- .2 Note that where the specifications specify a variety of instrument manufacturers, these are to establish standards of quality.
- .3 All instruments must be CSA approved and meet all applicable industry standards and codes.

1.4 DRAWINGS AND DESIGN

- .1 The drawings are intended to show the major details of the controls and instrumentation work but it is the Contractor's responsibility to examine the electrical, mechanical, structural and architectural drawings before beginning the work and report to the Owner's Representative any discrepancies or interferences which may occur.

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- .2 Control and instrumentation system layouts shown on the drawings are generally diagrammatic and the locations of equipment are approximate. Exact routing of conduits, cables, wiring, tubing and air headers to be governed by the mechanical, structural and architectural conditions which prevail.
- .3 The Owner's Representative reserves the right to change the location of any piece of equipment without extra payment therefore, providing only that the change is requested before installation and that the new location is within 1.5 meters of the original location.

1.5 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings.
- .2 Indicate:
 - .1 Instrument manufacturer's name, type, model, year, and serial number.
 - .2 The manufacturer's specifications for each instrument.
 - .3 Outline and arrangement drawings.
 - .4 Cross-sectional drawings.
 - .5 Materials of construction.
 - .6 Available range and accuracy.
 - .7 All other pertinent product information and data.

1.6 OPERATION & MAINTENANCE DATA

- .1 Provide operating & maintenance data for incorporation into the - Operation and Maintenance Manual.
- .2 Data to Include:
 - .1 Manufacturer's name, type, model year, capacity and serial number.
 - .2 Details on operation, servicing and maintenance.
 - .3 As-built wiring diagrams.
 - .4 Available range, accuracy and rating information of instrument.

1.7 TAGGING

- .1 Provide each instrument with a tag stamped or engraved with the equipment number.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lametoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

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1.8 MATERIALS

- .1 All materials to be new, free from defects and conforming to applicable reference standards.
- .2 All materials, linings and coatings in contact with water to be NSF approved for potable water.
- .3 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.

2. PRODUCTS

2.1 GENERAL

- .1 Manufacturer and Supplier
 - .1 All instruments shall be of a manufacturer/supplier with service facilities in Saskatoon, Saskatchewan.
- .2 Serial Numbers and Nameplates
 - .1 Each piece of equipment shall be stamped with a serial number, prior to shop performance testing.
 - .2 Each piece of equipment shall be provided with a substantial steel or brass nameplate attached to the unit, clearly inscribed with the manufacturer's name, year of manufacture and the principal rating data.
- .3 Painting
 - .1 Paint all equipment where applicable to appropriate sections in Division 9.
- .4 Instrument Isolation Valves
 - .1 Where needed to isolate equipment, provide instruments with block valves, block and bleed valves, or 3-valve manifolds at the discretion of the Engineer.
 - .2 Use 316 stainless steel valves on stainless steel and carbon steel piping, bronze body valves on copper piping, and PVC ball valves on PVC piping.
- .5 Instrument Description
 - .1 All instruments are given a description "Tag #". The Tag # refers to the description relative to the P & I drawings and mechanical drawings for reference.

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2.2 MAGNETIC FLOW METERS

.1 General

- .1 All meters within this subsection shall be provided by the same manufacturer.
- .2 The flow indicating transmitter shall be suitable, in all respects, for use with specified application.
- .3 The flow indicating transmitter shall be suitable for use with the specified flow and accuracy. Supplier to verify sizing based parameters listed in this specification.

.2 Applicable Equipment: FIT 2101, FIT 5155, FIT 7120, FIT 7320

.1 Liquid Type:

- .1 Raw Sewage: FIT 2101
- .2 Effluent: FIT 5155
- .3 Polymer Solution: FIT 7320
- .6 Alum Solution: FIT 7120

.2 Size:

- .1 2mm: FIT 7120
- .2 50mm: FIT 7320
- .3 75mm: FIT 2101, FIT 5155,

.3 Location:

- .1 Headworks Room: FIT 2101,
- .2 Pump Room: FIT 5155
- .3 Treatment Area: FIT 7320, FIT 7120

.4 Acceptable Suppliers:

- .1 ABB
- .2 Endress & Hauser

.5 Operating Conditions:

- .1 Temperature: 1 to 25 degree C
- .2 Flow Rates: FIT 2101, FIT 5155
 - .1 Max: 15 L/sec
 - .2 Min: 0 L/sec
- .3 Flow Rates: FIT 7320
 - .1 Max: 8.3 L/min
 - .2 Min: 0 L/s
- .4 Flow Rates: FIT 7120
 - .1 Max: 5 L/hr
 - .2 Min: 0.36 L/hr

.6 Specified materials:

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- .1 Pressure Rating: 1034 kPa
- .2 Body Material: Carbon Steel
- .3 Mounting: ANSI 125 Flange
- .4 Liner material: to suit service
- .5 Electrode: to suit service
- .7 Transmitter:
 - .1 Output:
 - .1 4-20 mA
 - .2 Pulse output
 - .3 Hart Digital Communication Protocol
 - .2 Power: 120 VAC
 - .3 Accuracy: 1% of full span
 - .4 Output meter scale: LCD
 - .5 24 VDC Active and Passive Pulse Boards
 - .6 Calibration Range:
 - .1 0 to 20 l/sec: FIT 2101, FIT 5155
 - .2 0 to 10 l/min: FIT 7320
 - .3 0 to 5 l/hr: FIT 7220
- .8 Units:
 - .1 Flow Rate: As indicated above
 - .2 Totalizer: L or m³
- .9 Totalizer Location:
 - .1 Remote: FIT 2101, FIT 5155, FIT 7120, FIT 7320
 - .2 Integral: N/A
- .10 Accessories:
 - .1 PC configuration soft ware for instrument setup
 - .2 Cabling required for remote indicators and totalizers.
 - .3 Grounding Rings as per manufacturer's recommendations
- .11 Tag #'s: FIT 2101, FIT 5155, FIT 7120, FIT 7320

2.3 PRESSURE SWITCHES

- .1 Applicable Equipment: PSL 3131
 - .1 Liquid Type:
 - .1 Plant Service Water: PSL 3131
 - .2 Location:
 - .1 Rotary Drum Thickener: PSL 3131
 - .3 Specified Equipment: PSL 3131
 - .1 Manufacturer: Mercoid Dwyer or approved equal

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- .2 Type: SPDT snap-action switch with adjustment dead band
- .3 Model: DA Series - 7041-153-6E
 - .1 Operating Range: 0 – 100 psig
 - .2 Set Point:
 - .1 PAL: 35 psig
 - .3 Enclosure
 - .1 NEMA 4X
 - .2 Water proof
 - .4 Electrical Connection: 1/2"
 - .5 Process Connection: 1/4" NPT
 - .6 Sensing System: 316 SS Bourdon Tube
 - .7 Accessories: All connections as required.
 - .8 Vertical Mounting
 - .9 82 degrees Celsius temperature limit
- .5 Accessories: All connections as required.
- .6 Tag #'s: PSL 3131

2.4 LEVEL PRESSURE TRANSDUCERS

- .1 The level pressure transducer shall be suitable, in all respects, for use with specified application.
- .2 Applicable Equipment: LT 1126, LT 8126
 - .1 Liquid Type:
 - .1 Raw Wastewater: LT 1126
 - .2 Treated Effluent: LT 8126
 - .2 Location:
 - .1 Wetwell: LT 1126
 - .2 Effluent Chamber: LT 8126
 - .3 Specified Equipment: LT 1126, LT 8126
 - .1 Manufacturer: Endress + Hauser or approved equivalent
 - .2 Model: Deltapilot M FMB52
 - .3 Required Measurement Range: 0 to 10 meters
 - .4 Approval: CSA C/US General Purpose
 - .5 Display, Operation: LCD, push button on display/electronics
 - .6 Housing: F31 Alu, Glass window
 - .7 Sensor Range: 1000mbar/100kPagauge, 10mH2O
 - .8 Reference Accuracy: Standard
 - .9 Calibration; Unit: Customized level; see additional spec.
 - .10 Probe Connection: FEP cable
 - .11 Process Connection: 3" 150lbs RF, 316/316L flange ANSI B16.5
 - .12 Membrane Material: AlloyC

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- .13 Fill Fluid: Synthetic oil, FDA
- .14 Seal: None, cell welded
- .15 Power: Loop powered 2-wire - 24 vdc unit
- .16 Output: 4-20 mA HART
- .17 Electrical Connection: ½ NPT Male c/w IP66/68 NEMA4X/6P
- .18 Cable Length:
 - .1 10 m (30 ft) - to be confirmed by Contractor
- .19 Accessories:
 - .1 Full Lightning Protection

- .4 Tag #'s: LT 1126, LT 8126

2.5 ULTRASONIC LEVEL TRANSMITTERS

- .1 Applicable Equipment: LIT 1126, LIT 8126, LIT 3226
 - .1 Liquid Type:
 - .1 Raw Wastewater: LIT 1126,
 - .2 Treated Effluent: LIT 8126,
 - .3 Sludge: LIT 3226
 - .2 Location:
 - .1 Wetwell: LIT 1126
 - .2 Treated Effluent Chamber: LIT 8126
 - .3 TWAS Storage: LIT 3226
 - .3 Mounting:
 - .1 As indicated on standard details and Contract Drawings
 - .4 Specified Equipment: LIT 1126, LIT 8126, LIT 3226
 - .1 Manufacturer: Endress + Hauser or approved equivalent
 - .2 Sensor:
 - .1 Model: Prosonic FDU91
 - .2 Type: Ultrasonic
 - .3 High degree of chemical resistance against aggressive media such as acids and alkali
 - .4 Integrated temperature sensor for automatic adjustment of sonic travel time
 - .5 Reinforced self-cleaning design
 - .6 Mounting: G 1" thread (incl. fastening nut made of PA)
 - .7 Material: PVDF
 - .8 Temperature: -40°C to +80°C
 - .9 Pressure: 0.7 to 4 bar abs.
 - .10 Measuring range: 0 to 10 m in liquids
 - .11 Block distance: 30 cm
 - .12 Protection: IP 68, submersible
 - .13 Connection cable: 15 m, Contractor to confirm length
 - .14 Resolution: +/-1 mm (ideal conditions)

- .15 Classification: Explosion hazard areas (Class1, Div1 Groups A, B,C, D), IP68
- .3 Transmitter:
 - .1 Model: Prosonic S FMU90
 - .2 Outputs: 4 to 20 mA
 - .3 Supply: 208VAC/60 Hz or 24VDC
 - .4 Setup: top hat rail design
 - .5 Temperature: 40°C to 60°C
 - .6 Classification:
 - .1 Explosion hazard areas (Class1, Div1 Groups A, B,C, D), IP68: LIT 2126, LIT 2326,
 - .2 General Purpose, IP68: LIT 4426
- .4 Accessories:
 - .1 Mounting hardware as required.
 - .2 PC configuration software for instrument setup
 - .3 Class 1 Zone 1 seals as required
- .5 Tag #: LIT 1126, LIT 3226, LIT 8126

2.6 LEVEL SWITCHES

- .1 Applicable Equipment: LSL 1126, LSH 1126, LSL 3226, LSH 3226, LSL 8126, LSH 8126,
 - .1 Liquid Type:
 - .1 Wastewater: LSH 1126, LSL 1126,
 - .2 Treated Effluent: LSH 8126, LSL 8126
 - .3 Thickened Sludge: LSL 3226, LSH 3226
 - .2 Location:
 - .1 Wetwell / Equalization Chamber: LSH 1126, LSL 1126
 - .2 Effluent Chamber: LSH 8126, LSL 8126
 - .3 TWAS Holding Tank: LSL 3226, LSH 3226
 - .3 Specified Equipment: LSL 1126, LSH 1126, LSL 3226, LSH 3226, LSL 8126, LSH 8126
 - .1 Manufacturer: Flygt or equivalent
 - .2 Model: ENM-10
 - .3 Type: Liquid level regulator
 - .4 Output: to PLC
 - .5 Accessories:
 - .1 Appropriate sized weights as required.
 - .2 Cable as required.
 - .6 Mounting: As per manufacturer's requirements.

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- .4 Tag #'s: , LSL 2126, LSH 2126, LSL 3226, LSH 3226, LSL 8126, LSH 8126

2.7 COMPACT CONDUCTIVE LEVEL SWITCH

- .1 Applicable Equipment: LSL 7326
 - .1 Liquid Type:
 - .1 Polymer: LSL 7326
 - .2 Location:
 - .1 RDT Polymer Feed System: LSL 7326
 - .3 Specified Equipment: LSL 7326
 - .1 Manufacturer: KOBOLD
 - .2 Model: NEK Compact Conductive Level Switch
 - .3 Model No.: NEK 3236
 - .4 Type: Conductive Level Switch
 - .5 Housing: Polypropylene
 - .6 Connections: 3/4" NPT
 - .7 Installation Position: Horizontal
 - .8 Electrodes: Stainless Steel
 - .9 Supply: 24 VDC
 - .10 Switch-In Delay: 0.5 sec
 - .11 Immersion Length: 36mm
 - .12 Relay: Max 1 Amp/24VDC
 - .13 Mounting: As per manufacturer's requirements
 - .4 Tag #'s: LSL 7326

2.8 CONDUCTIVITY LEVEL SWITCHES

- .1 General:
 - .1 Level switches are used for determining leaks in the WWTP. Contractor to install relays in control panel. Probe wiring to be run from location of measurement to panel.
- .2 Applicable Equipment: LS 2217, LS 3417, LS 4617
 - .1 Liquid Type:
 - .1 Water: LS 2217, LS 3417, LS 4617,
 - .2 Location:
 - .1 Headworks Room: LS 2217
 - .2 Treatment Area: LS 3417
 - .3 Pump Room: LS 4617.

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- .3 Specified Equipment: LS 3417, LS 4617
 - .1 Manufacturer: Ametek B/W Controls
 - .2 Type: Shielded Wire Suspension Electrodes
 - .3 Holder: Cord Grip
 - .4 Wetted Parts Material: Stainless Steel
 - .5 Relay Power: 120VAC
 - .6 Relay Type:
 - .1 High Level Alarm
 - .7 Relay Mounting: Standard 8 pin octal base
 - .8 Part Numbers:
 - .1 Electrodes: 6013-W6
 - .2 Wire Connectors: 6013-C-SS
 - .3 Wire: 6013-SW-[length in feet as required]
 - .4 Cord Grip Electrode Holders: 6012-CG2
 - .5 Relay: 5400-A-L1
 - .6 Relay Base: 5400-SR
 - .9 Mounting: As per manufacturer's requirements.
- .4 Specified Equipment: LS 2217
 - .1 Manufacturer: Ametek B/W Controls
 - .2 Type: Shielded Wire Suspension Electrodes
 - .3 Holder: Cord Grip
 - .4 Wetted Parts Material: Stainless Steel
 - .5 Relay Power: 120VAC
 - .6 Relay Type:
 - .1 High Level Alarm
 - .7 Relay Mounting: Standard 8 pin octal base
 - .8 Part Numbers:
 - .1 Electrodes: 6013-W6
 - .2 Wire Connectors: 6013-C-SS
 - .3 Wire: 6013-SW-[length in feet as required]
 - .4 Cord Grip Electrode Holders: 6012-CG2
 - .5 Relay: 5400-A-L1
 - .6 Relay Base: 5400-SR
 - .9 Mounting: As per manufacturer's requirements.
 - .10 **Classification: Intrinsic Safety, Explosion Proof**
- .5 Tag #'s: LS 2217, LS 3417, LS 4617

2.9 ELECTRO-PNEUMATIC POSITIONERS

- .1 General:
 - .1 Positioners shall mounted onto specified actuator. Positioner, actuator and valve shall be supplied pre-assembled. Positioner to come with mounting hardware to fit supplied valve and actuator.
- .2 Applicable Equipment: POS 4601-1, POS 4601-2

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- .3 Liquid Type:
 - .1 Bioreactor Effluent: POS 4601-1, POS 4601-2
- .4 Location:
 - .1 Membrane Treatment Area: POS 4601-1, POS 4601-2
- .5 Operating Conditions:
 - .1 Temperature: 5 to 30 C
 - .2 Air Pressure: 90 to 100 psi
- .6 Field Device Serviced:
 - .1 POS 4601-1: FCV 4601-1 – Double Acting Butterfly Valve
 - .2 POS 4601-2: FCV 4601-2 – Double Acting Butterfly Valve
- .7 Specified Equipment: POS 4601-1, POS 4601-2
 - .1 Manufacturer: ABB or equivalent.
 - .2 Model: TZID-C Compact Intelligent Positioners
 - .3 Air Supply Connections: ¼” NPT
 - .4 Output Safe Position: Fail Last
 - .5 Input:
 - .1 Analog: 4-20 mA
 - .6 Output:
 - .1 Digital: Two (2) Limit Switches (Max position & Minimum Position) with adjustable cams (ZSC 4601-x, ZSO 4601-x)
 - .2 HART Communication Protocol
 - .7 Indicator:
 - .1 LCD Display
 - .8 Electrical:
 - .1 Enclosure: NEMA 4X
 - .2 Material: Painted Aluminum
 - .3 Connections: ½” NPT
 - .4 Power: 24 VDC Loop Power
- .8 Tag #'s: POS 4601-1, POS 4601-2

2.10 GENERAL PURPOSE 2-WAY SOLENOID VALVES

- .1 Applicable Equipment: FV 1100, FV 3168, FV 9900A, FV 9900B
- .2 Liquid Type:
 - .1 Plant Service Water:, FV 1100, FV 3168,
 - .2 Compressed Air (100 psi): FV 9900A, FV 9900B
- .3 Location:
 - .1 Treatment Area: FV 3168
 - .3 Headworks: FV 9900A, FV 9900B

- .4 Operating Conditions:
 - .1 Temperature: 5 to 30 C
- .5 Size:
 - .1 12 mm: FV 9900A, FV 9900B
 - .2 25mm: FV 1100, FV 3168
- .6 Specified Valve: FV 1100, FV 3168, FV 9900A, FV 9900B
 - .1 Manufacturer: ASCO or equivalent.
 - .2 Model: 8210
 - .3 Type: Two way pilot operated solenoid globe valve
 - .1 Operation
 - .1 Normally Closed: ALL
 - .2 Normally Open: n/a
 - .4 Operating Pressure Differential: 0 to 1035 kPa (150 psi)
 - .5 Materials:
 - .1 Body: Stainless Steel
 - .2 Seals & Discs: Buna "N"
 - .3 Core Tube: 305 Stainless Steel
 - .4 Core and Plugnut: 430F Stainless Steel
 - .5 Springs: 302 Stainless Steel
 - .6 Specified Solenoid:
 - .1 Power: 120 VAC; 60 Hz
 - .2 Electrical Connection: ½" NPT
 - .3 Enclosure:
 - .1 Standard: Watertight, Types 1, 2, 3, 3S, 4, and 4X: FV 3168, FV 7280
 - .2 Explosion proof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9: FV 9900A, FV 9900B
 - .7 Approved Alternate:
 - .1 Burkert 6213 / 5282
- .7 Tag #'s: FV 1100, FV 3168, FV 9900A, FV 9900B

2.11**PILOTING SOLENOID VALVES – LOCALLY MOUNTED**

- .1 General:
 - .1 Solenoid valves are to be direct mounted on pneumatic actuator. Solenoid valves will control air flow to pneumatic actuators. Each solenoid valve shall be connected to plant compressed air system. Isolation valves shall be installed prior to each solenoid.
- .2 Applicable Equipment: SV 7360

- .3 Fluid:
 - .1 Compressed Air
- .4 Location:
 - .1 Treatment Area:
- .5 Operating Conditions:
 - .1 Temperature: 5 to 30 C
 - .2 Air Pressure: 90 to 100 psi
- .6 Valve Circuit Function:
 - .1 SV 7360: 5/2
- .7 Field Device Serviced:
 - .1 SV 7360: FV 7360 (Double Acting Pneumatic Actuated Ball Valve)
- .8 Specified Solenoid: SV 7360
 - .1 Manufacturer: ASCO
 - .2 Model: Series 8551 Direct Mount High Flow
 - .3 Solenoid Enclosure: EF (Combination Explosion proof and Water Tight Types 3, 3S, 4, 4X, 6, 6P, 7, 9)
 - .4 Convertible 3/2 – 5/2 c/w both plates
 - .5 Mounting: NAMUR (Mount directly on pneumatic actuated valve)
 - .6 Construction: Single Solenoid
 - .7 Supply Connections: 1/4" NPT
 - .8 Power: 120 VAC
 - .9 Accessories:
 - .1 Air metering devices required for controlling open and close speed
 - .2 Manual screw type over ride for open close.
- .9 Approved Alternates:
 - .1 Burkert Type 6519
- .10 Tag #'s: SV 7360

2.12 WEIGHT INDICATING TRANSMITTERS

- .1 Applicable Equipment: WIT 7132, WIT 7339, WIT 7739
 - .1 Location:
 - .1 Treatment Area: WIT 7132, WIT 7339, WIT 7739
 - .2 Specified Equipment: WIT 7132, WIT 7339, WIT 7739
 - .1 Manufacturer: Force Flow
 - .2 Capacity: 500 kg
 - .3 Spill Containment Scales: WE 7132, WE 7339, WE 7539
WE 7739

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- .1 Number of scales: Four (4)
- .2 Sump Capacity: 11 gallons
- .3 Comes with Bladder,
 - .1 Bladder Capacity: 55 gallons
 - .2 Bladder dimensions: 66" x 58"
- .4 Platform Size: For 24" diameter day tank (low profile) c/w built-in environmentally protected load cell(s): 27" x 31" x 6.5"
- .5 Material:
 - .1 Frame: 2-Part Epoxy Powder Coated Steel
 - .2 Containment Vessel: Polyethylene (LDPE)
 - .3 Roll-out Bladder: Polyethylene
- .6 Load Cells: (4) Electronic Shear Beam Strain Gauge Type with Polyethylene Protective Splash Shields
- .7 Standard Cable Length: 20 ft
- .8 Accuracy: 1/10 of 1% Full Scale
- .4 Indicator and Transmitter: WIT 7132, WIT 7339, WIT 7739
 - .1 Number of Transmitters Three (3)
 - .2 Model: Chem-Scale with SOLO G2 Indicator
 - .3 Analog Output:
 - .1 WIT 7132: Two Channel, Two (2) 4-20 mA,
 - .1 Channel 1: WE 7132
 - .2 Channel 2: Spare (for future WE 7641)
 - .2 WIT 7339: One Channel, One (1) 4-20 mA,
 - .1 Channel 1: WE 7339
 - .3 WIT 7739: Two Channel, Two (2) 4-20 mA,
 - .1 Channel 1: WE 7539
 - .2 Channel 2: WE 7539
 - .3 Output: 2 dry contact alarm relays **per channel** (low net weight, low low net weight)
 - .4 Power: 120 VAC, Single Phase, 60 Hz
 - .5 Enclosure: NEMA 4X
 - .6 Display: 2 line backlit LCD c/w turn knob for tare adjustment and level alarm values
 - .7 Indicator Functions: Net weight and gross weight
 - .8 Units: kg
 - .9 Factory Set Calibration Range: 0 to 550 kg
- .5 Accuracy: 0.1% of Full Scale
- .6 Increments: 0.1 kg
- .7 Accessories:
 - .1 PC configuration software for instrument setup
- .8 Approved Alternate(s):
 - .1 Scaletron Industries
- .2 Tag #'s: WIT 7339, WIT 7132, WIT 7739

2.13

GAS ANALYZERS AND TRANSMITTERS

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- .1 Applicable Equipment: AIT 2224/AIT 2225, AIT 4624/AIT 4625, HN/BCN 4625,HN/BCN 2225,HN
- .2 Sample & Location:
 - .1 AIT 4624/AIT 4625: Pump Room Air
 - .2 AIT 2224/AIT 2225: Headworks Room Air
- .3 Operating Conditions:
 - .1 Temperature: 1 to 35 C
- .4 Specified Equipment: AIT 2224/AIT 2225, AIT 4624/AIT 4625
 - .1 Manufacturer: Armstrong Monitoring.
 - .2 Gas Monitor
 - .1 Model: AMC-1400, Four channel Monitor with vacuum fluorescent display
 - .2 Inputs: Up to 4 x 4-20 mA
 - .3 Outputs: 4-20 mA per Channel
 - .1 AIT 2224/AIT 2225
 - .1 Channel 1: AE 2224
 - .2 Channel 2: AE 2225
 - .3 Channel 3: Spare
 - .4 Channel 4: Spare
 - .2 AIT 3424/AIT 3425
 - .1 Channel 1: AE 3424
 - .2 Channel 2: AE 3425
 - .3 Channel 3: Spare
 - .4 Channel 4: Spare
 - .3 AIT 4624/AIT 4625
 - .1 Channel 1: AE 4624
 - .2 Channel 2: AE 4625
 - .3 Channel 3: Spare
 - .4 Channel 4: Spare
 - .4 Enclosure: NEMA 4X Fiberglass Reinforced Polyester
 - .5 Supply Voltage: 110 VAC, 60 Hz
 - .6 Relay Contacts: Up to 16 SPDT 6A @ 250 VAC Res. max relays, max 4 per channel
 - .7 Dimensions: 27cm W x 35cm H x 19cm D (10.5" x 14" x 7.5")
 - .8 Operating Temperature: -20°C to 40°C (-4°F to 104°F)
 - .9 Storage Temperature: -20°C to 65°C (-40°F to 149°F)
 - .10 Monitor Warranty: Two years
 - .11 Keypad:
 - .1 Internal
 - .2 NEMA 4X External
 - .12 Alarm Thresholds: Up to 3 + Fail per Channel
 - .1 High Alarm
 - .2 High High Alarm
 - .3 Fault
 - .13 Indicators:

- .1 VFD Concentration
 - .2 LED Status per Channel
 - .14 Quantity: Two (2)
 - .15 Accessories
 - .1 External NEMA 4X Keypad - AMC-EK4
 - .2 Integral Strobe – AMC-AB110
 - .3 External NEMA 4X Sonalarm – AMC-1400-SA
 - .3 Sensors/Transmitters
 - .1 Combustible Gas: [AE 4624], [AE 2224]
 - .1 Model: AMC-360-IREP-9
 - .2 Sensor Type: Non-Dispersive Infrared (NDIR)
 - .3 Quantity: Two (2)
 - .4 CSA Certified
 - .5 Range: 0-100% LEL, Combustible Gas
 - .6 Signal Output: 4-20 mA
 - .8 Enclosure: Explosion Proof Class1, Div1 Groups BDC
 - .9 Voltage Requirement: 12-26 VDC
 - .10 Installation Wiring: Three conductor shielded cable
 - .11 Resolution: 1% of full scale
 - .12 Response Time: 90% response in less than 10 seconds
 - .13 Operating Temperature: -20°C to +50°C continuous
 - .14 Operating Humidity: 0-99% R.H. Non Condensing
 - .15 Sensor Life Expectancy: Greater than 5 yers
 - .2 Hydrogen Sulfide (H₂S): [AE 4625], [AE 2225]
 - .1 Series: AMC-282CA9
 - .2 Sensor Type: Electrochemical
 - .3 Quantity: Two (2)
 - .5 Range: 0-100 ppm, H₂S
 - .6 Signal Output: 4-20 mA
 - .8 Enclosure: As identified below
 - .9 Voltage Requirement: 12-26 VDC
 - .10 Installation Wiring: Three conductor shielded cable
 - .11 Resolution: 1% of full scale
 - .12 Response Time: 90% response in less than 10 seconds
 - .13 Operating Temperature: -40°C to +40°C continuous
 - .14 Operating Humidity: 0-99% R.H. Non Condensing
 - .5 Horn/Strobes Connected:
 - .1 Three units to be provided.
 - .1 AIT 4624/AIT 4625: HN/BCN 4625
 - .2 AIT 2224/AIT 2225: HN/BCN 2225 (Explosion Proof Version)
 - .2 Location: as shown in drawings.
 - .3 Specified Equipment:
 - .1 Manufacturer: System Sensor
 - .2 Type: Indoor 2-wire SpectrAlert Advance
 - .3 Model: P2W-P
 - .4 Standard operating temperature: 0°C to 49°C
 - .5 Strobe Flash Rate: 1 flash per second

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- .6 Electrical: 24VDC
- .7 c/w three audibility options
- .8 Mounting:
 - .1 Device to c/w Integral mounting plate.
 - .2 Wall mount as per manufacturer's requirements.

- .6 Tag #'s: AIT 2224/AIT 2225, AIT 4624/AIT 4625, HN/BCN 4625, HN/BCN 2225

2.14 VISUAL SIGNALING DEVICE (EXTERNAL DEVICE)

- .1 Applicable Equipment: BCN 4625-1, BCN 2225-1
 - .1 Equipment: Visual signaling device.
 - .2 Location
 - .1 Influent Pump Room (External Door): BCN 4425-1
 - .2 Head Works Room (External Door): BCN 2225-1
 - .3 Sludge Management Room (External Door): BCN 3425-1
 - .3 Quantity: 3
 - .4 Operation: Rotating LED Warning Light
 - .5 Electrical: 120 VAC
 - .6 Manufacturer: Federal Signal or as approved by Engineer
 - .7 Model: 225-120 R
 - .8 Colour: Red
 - .9 Rated Temperature of Operation: -50 Deg C
 - .10 Accessories: Wall Mounting Kit Federal Signal LWMB2
- .2 Tag #'s: BCN 4425-1, BCN 2225-

2.15 SMOKE DETECTOR

- .1 Applicable Equipment: SD 2214, SD 3414, SD 4614, SD 9914A, SD 9914B, SD 9914C, SD 9914D
- .2 Equipment: Smoke Detector
- .3 Location:
 - .1 Pump Room: SD 4614
 - .2 Headworks Room: SD 2214
 - .3 Treatment Area: SD 3414
 - .4 Mechanical Room: SD 9914A
 - .5 Laboratory Room: SD 9914B
 - .6 Electrical Room: SD 9914C
 - .7 Office Room: SD 9914D
- .4 Type:
 - .1 SD 2214: Weatherproof, Explosion proof
 - .2 SD 3414A: NEMA 4X

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- .3 SD 4614: NEMA 4X
- .4 SD 9914A: Commercial
- .5 SD 9914B: Commercial
- .6 SD 9914C: Commercial
- .7 SD 9914D: Commercial

- .5 Operation: Capable of detecting products of combustion, unaffected by change in temperature, humidity, and pressure.

- .6 Electrical: Unit to be 24 VDC c/w relay contacts, automatically resets when alarm condition clears

- .7 Specified Equipment:
 - .1 Manufacturer: System Sensor
 - .2 Model: 2012JA
 - .3 Temperature Range 0°C to 50°C.
 - .4 Voltage: 24 VDC
 - .6 Mounting: Ceiling Mounted

- .8 Approved alternates: Simplex, Pyrotonics, Kidde or Edwards

- .9 Tag #'s: SD 4614, SD 2214, SD 3414, SD 9914A, SD 9914B, SD 9914C, SD 9914D

2.16 HEAT DETECTORS

- .1 Applicable Equipment: TSH 2215, TSH 3415, TSH 4615, TSH 9915A, TSH 9915B, TSH 9915C, TSH 9915D,

- .2 Equipment: Heat Detector

- .3 Location:
 - .1 Pump Room: TSH 4615
 - .2 Headworks Room: TSH 2215
 - .3 Treatment Area: TSH 3415
 - .4 Mechanical Room: TSH 9915A
 - .5 Laboratory Room: TSH 9915B
 - .6 Electrical Room: TSH 9915C
 - .7 Office Room: TSH 9915D

- .4 Type:
 - .1 TSH 2214: Weatherproof, Explosion proof
 - .2 TSH 3414A: NEMA 4X
 - .3 TSH 4614: NEMA 4X
 - .4 TSH 9914A: Commercial
 - .5 TSH 9914B: Commercial
 - .6 S TSH D 9914C: Commercial
 - .7 TSH 9914D: Commercial

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- .5 Operation:
 - .1 Combination fixed temperature/rate of rise; 58 degree C fixed temperature, 8 degree C per minute rate of rise. Automatically resets when alarm condition clears.
 - .2 Fixed temperature 90 degree C fixed temperature.
- .6 Electrical: 24 VDC
- .7 Approved Products: Simplex, Pyrotonics, System Sensor or Edwards
- .8 Tag #'s: TSH 2215, TSH 3415, TSH 4615, TSH 9915A, TSH 9915B, TSH 9915C, TSH 9915D

2.17 TEMPERTAURE TRANSMITTER

- .1 Applicable Equipment: TT 2212, TT 4612, TT 3412
 - .1 General:
 - .1 Intent: Device used to detect building temperature conditions. Sensor to be mounted on PLC panel.
 - .2 Location:
 - .1 Pump Room: TT 4612
 - .2 Headworks Room: TT 2212
 - .3 Treatment Area: TT 3412
 - .3 Specified Equipment: TT 2212
 - .1 Manufacturer: Rosemount
 - .2 Model: 248HAK6U2NS:
 - .3 Temperature Range: -20 to 55°C
 - .4 Output: 4 – 20 mA
 - .5 Power: 24 VDC (loop powered)
 - .6 Certification: Intrinsic Safety, Explosion Proof
 - .7 Accessories: Provide mounting hardware as required
 - .4 Specified Equipment: TT 4612, TT 3412,
 - .1 Manufacturer: Rosemount
 - .2 Model: 248HANAU2NS:
 - .3 Temperature Range: -20 to 55°C
 - .4 Output: 4 – 20 mA
 - .5 Power: 24 VDC (loop powered)
 - .6 Certification: N/A
 - .7 Accessories: Provide mounting hardware as required.
 - .5 Tag #: TT 2212, TT 4612, TT 3412

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3. EXECUTION

3.1 INSTALLATION

- .1 The Contractor to be responsible for the correct installation and assembly of all items of equipment. Manufacturer's instructions to be carefully read and rigidly adhered to in the installation.
- .2 Any damage resulting from failure to observe the installation instruction or as a result of proceeding without sufficient knowledge of proper installations techniques will be the Contractor's responsibility.
- .3 Mounting of Instruments & Accessories
 - .1 Instruments to be installed in accordance with the drawings. Instruments shall be rigidly supported, level and plumb, and in such a manner as to provide accessibility, protection from damage, isolation from heat, shock and vibration, and freedom from interference with other equipment, piping and electrical work.
 - .2 Instruments not to be installed until heavy construction work adjacent to the instruments has been completed.
 - .3 Instruments devices including accessories to be located where they will be accessible from structural platforms, permanent ladders, or grade. Locally mounted indicating instruments to face toward, and within reading distance of a normal operating area.
 - .4 Sufficient clearance to be allowed for removal of equipment for maintenance and repair.
 - .5 Field located instruments to be mounted on building columns and walls or pipe stands and/or other means of support as required in accordance with manufacturer's instructions and the Drawings.

3.2 INSPECTION

- .1 The Contractor will include in his Bid for inspection and startup services by a qualified factory trained manufacturer's representative to inspect and certify the completed installation of the field instrument.
- .2 The Contractor will, after obtaining confirmation for the Engineer, arrange for the equipment supplier's inspection and will provide sufficient personnel and materials to assist the manufacturer in the inspection and testing of each system completely.
- .3 The Contractor will obtain from the manufacturer written certification of the complete installation and testing and will forward to the Engineer.

- .4 The Contractor will, at their own expense, repair any irregularities or discrepancies determined during the examination. Any additional trips required by the manufacturer's representative for re-testing due to faulty installation of incomplete systems shall be borne by the Contractor.

3.3 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- .1 The equipment manufacturer's technical representative shall be familiar with the equipment supplied and shall come prepared with both knowledge and equipment to perform and interpret the test, inspections and procedures recommended by the manufacturer for the starting of equipment that has not previously been run.
- .2 The equipment manufacturer's technical representative shall, immediately after completion of the inspection, convey to the Engineer in writing, confirmation of the tests and inspections carried out and the result of this examination of the work.
- .3 If the inspection reveals defects in the work, correct as soon as possible and repeat the entire inspection procedure. Repeat until the work passes the inspection.
- .4 Document the results of the inspection by the equipment manufacturer's representative.
- .5 Ensure the installation meets all manufacturer's requirements for durable and trouble-free operation.

3.4 FIELD INSPECTION

- .1 The Engineer will request that the equipment be operated to demonstrate that it will perform as specified. The Engineer will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Engineer who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Engineer of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

3.5 TRAINING

- .1 The Contractor will include in their price costs a minimum of one hour of training for the facility operating personnel for field instruments listed in this section by qualified manufacturer personnel. The training shall cover all aspects of operation, maintenance and calibration of the equipment.

3.6 TESTING, ADJUSTING AND COMMISSIONING

- .1 Testing, adjusting and commissioning of all instruments shall be in accordance with Section 01336.

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END OF SECTION

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1. GENERAL

- .1 Provide only CSA approved materials and met all applicable industry standards and codes.
- .2 Control panels shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking should be located so as to be clearly visible to qualified persons before examination, adjustment, servicing or maintenance of the equipment. All components used interior to the control panel to be "touch safe" to person or persons opening the control panel while energized.
- .3 All Control Panel Wiring to be "Touch Safe" as per IP20 Standards. This rating assures that a probe approximately the size of a finger is not able to make contact with any hazardous or energized parts.
- .4 Clearly indicate on the door of the control panel if there can be more than one voltage source.

2. PRODUCTS

2.1 CONTROL PANEL CONSTRUCTION

- .1 Provide only CSA approved materials and meet all applicable industry standards and codes.

2.2 TERMINALS

- .1 Unfused terminals to be CSA approved for 600 V, 10A, accepting #12- #18 wire. Terminals to be one of:
 - .1 Wieland WK4/U
 - .2 Weidmuller SAK4
 - .3 Phoenix Contact UT 4
- .2 Fused terminals to be CSA approved for 300 V, 10A, with blown-fuse indicator operating on 120 VAC, accepting #10 - #14 wires, and either 5x20 mm fuses or 1/4" x 1.4" fuses, or both. Terminals to be one of:
 - .1 Weidmuller ASK-1
 - .2 Wieland WK4/THSI6GL250U
 - .3 Phoenix Contact P-FU 6,3x32 LA 250 with UT 6-TG
- .3 Provide and install in control panel 10% spare terminals of each type used. Provide 10% spare fuses of each type and size loose in each control panel (Minimum 5 of each type).
- .4 Grounding terminals to be CSA approved for 300V, 15A, accepting #14 wires, grounding to the rail, colored green & yellow. Terminals to be one of:

- .1 Weidmuller SAK2.5
- .2 Wieland WK4SL
- .3 Phoenix Contact UT 4-PE
- .5 Shorting bars to be used for jumpering. Wire jumpers are not acceptable.
- .6 Terminals to be colored as shown:
 - Ground - Green & Yellow
 - 120V Line - Black
 - 120V Neutral - White
 - 24V DC - Blue, Red
- .7 All terminals to be din rail mounted.

2.3 LABELING

- .1 Each terminal to be labeled with snap on plastic tags, Wieland type 9705 , Weidmuller type FW or FS, Phoenix Contact UC-TM or, machine-printed.
- .2 All panel-mounted devices to be labelled by means of engraved lamacoid labels, white lettering on black.
- .3 Write on labels are not acceptable.

2.4 CONTROL RELAYS

- .1 Control relays to be installed in socket, with built-in LED or neon operation indicator, push-to-operate button, coil voltage as required, CSA approved.
- .2 Contacts to switch 5A 120/240V AC inductive or resistive.
- .3 Operating times to be 20 mS max for AC coil, 30 mS max for DC coil.
- .4 Life expectancy to be 100 000 operations @ 5A 120/240V AC.
- .5 Relays shall have varistor protection for AC coil, and diode protection for DC coil.
- .6 Relays to be:
 - .1 Omron MK2PIN Series
 - .2 Phoenix PR2-RSC3 Series
 - .3 Weidmuller Rider Series
- .7 Provide and install a minimum of 10% spare relays of each type used in each control panel.
- .8 Relays specified to be used as control relays only. Refer to section 16421- Motor Starters and section 16423 – Starters and Contactors for relays controlling equipment with loads greater than 5amp resistive or 2.5amp inductive.

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- .9 All relays to be labeled with type written labels. Handwritten labels are not acceptable.

2.5 TIME-DELAY RELAYS

- .1 Time-delay relays to be installed in socket, with manually-adjustable timing via knob with dial, output status light, operating voltage as required, ON-delay or OFF-delay time as indicated, CSA approved.
- .2 Contacts to switch 5A 120/240V AC inductive or resistive.
- .3 Life expectancy to be 100 000 operations @ 2A 120/240V AC.
- .4 All relays to be OMRON type H3BH, H3G, H3CA, or H3CR or approved alternative.

2.6 PILOT LIGHTS

- .1 Water and dust-proof with internal Gasket, jewelled lens, color as shown on drawings, LED bulb, voltage 120VAC.
- .2 Lights to be one of following:
 - .1 Allen-Bradley 800T
 - .2 Siemens class 52

2.7 PUSH BUTTONS

- .1 Water and dust-proof with internal Gasket, flush head, contacts rated 5A 20/240 VAC, accepting AWG 18-12 wires, removable contact blocs.
- .2 Push buttons to be one of following:
 - .1 Allen-Bradley 800T
 - .2 Siemens class 52

2.8 SELECTOR SWITCHES

- .1 Manual selector switches to be Water and dust-proof with internal Gasket, standard black lever actuator, Maintained position unless indicated, contacts rated 5A 120/240 VAC, accepting AWG 18-12 wires, removable contact blocks.
- .2 Selector switches to be one of following:
 - .1 Allen-Bradley 800T
 - .2 Siemens class 52

2.9 WIRE DUCTS

- .1 Use Panduit or equivalent plastic type.

- .2 Wiring not installed in wire ducts are to be neatly bundled and secured with wrap around spiral banding, secured with cable ties and mounting bases.

2.10 24VDC DC POWER SUPPLIES

- .1 Power supply with 24 VDC 10A output for PLC I/O to include over-voltage shutdown, 120V AC input, and CSA approval.
- .2 Output voltage to be adjustable $\pm 10\%$ via screwdriver.
- .3 Power supplies to be one of the following:
 - .1 Allen Bradley.
 - .2 Omron
 - .3 Phoenix Contact Quint Series
 - .4 Weidmuller

2.11 UNINTERRUPTIBLE POWER SUPPLIES

- .1 General Features: 6000VA rack mount version.
 - .1 UPS to be of the "dual online conversion" type, with 120V AC input and 120V AC sine-wave output, light to indicate output active, light to indicate whether unit is operating from battery or 120VAC input, and output switch.
 - .2 UPS to be CSA approved.
 - .3 UPS units to come complete with **external** battery fail and low external contact relay card module. Contacts are to be 5A 120/240V AC inductive or resistive.
 - .4 UPS to be Eaton 9PX6KP2 or approved equivalent 6000VA + 6000VA PowerPass Distribution Module.
 - .5 Provide and install manufacturer recommend breaker in local electrical panel.
 - .6 UPS to include PowerPass distribution module (PPDM) option

2.12 NETWORK RACK

- .1 General Features: 42U Network Rack.
 - .1 Network rack to be 600W x 1991H x 1070D.
 - .2 Includes baying hardware, key(s), keyed alike doors and side panels, leveling feet, mounting hardware, pre-installed casters, and side panels.
 - .3 Quick release doors.
 - .4 Color: Black
 - .5 Maximum mounting depth: 915
 - .6 IP20
 - .7 Front door and vertical panels to be minimum 16 gauge
 - .8 Rear door, roof, and side panels to be minimum 18 gauge
 - .9 Accessories: SKU# AR7701 bolt down kit.

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10. Network rack to be Schneider APC NetShelter SX series 42U enclosure AR3100 or approved equivalent.

END OF SECTION

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1. GENERAL

- .1 Should any equipment or software indicated below be no longer available it is the Contractors responsibility to provide equal or better equipment or Software. The Contractor is to confirm with Owners Representative for any part number alterations and order equipment **AFTER** signed reviewed shop drawings have been issued.

2. PRODUCTS

2.1 NETWORKING EQUIPMENT

- .1 Ubiquiti Wireless Access Point with PoE (Model # AniFi AC Pro).
 - .1 Location
 - .1 Laboratory – Quantity 1
 - .2 Pump Room – Quantity 1
 - .3 Treatment Room - Quantity 1
 - .2 Provide and install 120VAC powered Inline POE adapter between internet switch and Wireless Access Point.

2.3 ETHERNET DATA SWITCHES

- .1 Location
 - .1 Waste Water Treatment Plant – Network Rack – Controls Switch Head – Quantity 1
 - .2 Waste Water Treatment Plant – Network Rack – Controls Switch Tail – Quantity 1
 - .3 Waste Water Treatment Plant – Network Rack – Internet Switch – Quantity 1
- .2 24 + 2G Port Standard Ethernet Switch
 - .1 Manufacturer: NTron
 - .2 Model: 7026TX
 - .3 Ports: 24-RJ45 at 10/100BaseTX, 2 10/100/1000BaseSFP
 - .4 Redundant Input Voltage: 85-264 VAC
 - .5 Flow Control: half-duplex/full duplex
 - .6 Status Indication: Power Connection/Activity
 - .7 Storage Temperature: -40°C - 85°C
 - .8 Operating Temperature: -40°C - 80°C
 - .9 Rating: IP 30
 - .10 Mounting: Rackmount
 - .11 Protocols:
 - .1 EtherNet I/P
 - .2 Modbus/TCP
 - .12 Accessories
 - .1 SFP Transceiver – Quantity 2
 - .1 Gigabit Copper
 - .2 RJ-45 Style Connector

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3. EXECUTION

3.1 INSTALLATION

- .1 Contractor is responsible for installation, wiring, testing, and assisting the Owner representative in commissioning of all PLC equipment, PLC communication equipment, PC equipment and Operator interfaces.
- .2 The Contractor shall supply and deliver to the Owner's Representative any of the computer, PLC and networking products identified herein for the purpose of programming and configuration. The Owner's Representative will advise the contractor when and which items will be required on a later date. The Contractor will pay all costs associated with handling, extended warranties, etc.
- .3 Contractor shall supply all required cabling to connect hardware above.

3.2 PROGRAMMING

- .1 See Section 00800 - Supplementary Conditions.

3.3 WARRANTY

- .1 Manufacture warranty will commence from date of installation, or delivery to Owner's representative, whichever comes first, for any item listed herein.
- .2 The Contractor is expected to honor manufacture warranty periods for any expired warranty periods not achieving the above criteria.
- .3 The Owner reserves the right to withhold any amount of payment up to a maximum of \$15,000 until the Contractor provides satisfactory proof of warranty for items in this section.

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 This section of the specifications refers to the piping, fittings, valves and all piping specialties and supporting devices to be installed under this contract. Also included are the equipment, valve and commodity identification legends for all piping systems to be installed.
- .2 Control valves and other in-line equipment, such as flow meters, pumps, flow control valves, flow switches, pressure switches, solenoid valves, pressure gauges, etc., supplied under Divisions 11 and 13, are to be installed under this Section.

1.2 RELATED SECTIONS

- .1 Section 01300 - Submittals
- .2 Section 01790 - Operation and Maintenance Manuals
- .3 Section 13311 - Instrumentation – Wiring
- .4 Section 13312 - Instrumentation – Field Instruments
- .5 Section 15015 - Mechanical General Requirements
- .6 Section 15020 - Detailed Piping Specifications
- .7 Section 15110 - Valves
- .8 Section 15190 – Hydrostatic and Pressure Testing

1.3 REFERENCE STANDARDS

- .1 Conform to the following reference standards:
 - .1 ANSI A13.1, Scheme for the Identification of Piping Systems
 - .2 ANSI B1.20.1, Pipe Threads, General Purpose
 - .3 ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
 - .4 ANSI B16.3, Malleable Iron threaded Fittings Class 150 and 300
 - .5 ANSI B16.5 Steel Pipe Flanges and Flanged Fittings
 - .6 ANSI B16.9, Factory-Made Wrought Steel Butt Welding Fittings
 - .7 ANSI B16.11, Forged Steel Fittings, Socket Welding and Threaded
 - .8 ANSI B16.12, Cast Iron Threaded Drainage Fittings
 - .9 ANSI B16.15, Pipe Flanges and Flanged Fittings, Classes 150 and 300
 - .10 ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
 - .11 ANSI B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - .12 ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes
 - .13 ASME B31.1, Power Piping
 - .14 ASME B31.3, Process Piping
 - .15 ASME B31.9, Building Services Piping

- .16 ANSI B32, Solder Metal
- .17 ANSI B36.10M, Welded and Seamless Wrought Steel Pipe
- .18 ANSI B36.19M, Stainless Steel Pipe
- .19 ASME Section IX, Boiler and Pressure Vessel Code; Welding and Brazing Requirements
- .20 ASTM A47, Malleable Iron Castings
- .21 ASTM A53, Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless
- .22 ASTM A74, Cast Iron Soil Pipe and Fittings
- .23 ASTM A105/A105M, Forgings, Carbon Steel, for Piping Components
- .24 ASTM A106, Seamless Carbon Steel Pipe for High Temperature Service
- .25 ASTM A126, Grey-Iron Castings for Valves, Flanges, and Pipe Fittings
- .26 ASTM A135, Electric-Resistance-Welded Steel Pipe
- .27 ASTM A139, Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over)
- .28 ASTM A167, Stainless Steel and Heat-Resisting Chromium- Nickel Steel Plate
- .29 ASTM A181/181M, Forgings, Carbon Steel, for General Purpose Piping
- .30 ASTM A182/182M, Forged or Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
- .31 ASTM A193/193M, Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
- .32 ASTM A194/194M, Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
- .33 ASTM A197, Cupola Malleable Iron
- .34 ASTM A234/A234M, Pipe Fittings of Wrought Carbon Steel and Alloy steel for Moderate and Elevated Temperatures
- .35 ASTM A240, Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels
- .36 ASTM A269, Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- .37 ASTM A276, Stainless and Heat-Resisting Steel Bars and Shapes
- .38 ASTM A307, Carbon steel Bolts and Studs, 60,000 psi Tensile Strength
- .39 ASTM A312/312M, Seamless and Welded Austenitic Stainless Steel Pipe
- .40 ASTM A320/320M, Alloy Steel Bolting Materials for Low-Temperature Service
- .41 ASTM A403/A403M, Wrought Austenitic Stainless Steel Piping Fittings
- .42 ASTM A409/A409M, Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
- .43 ASTM A480/A480M, General Requirements for Flat-Rolled Stainless for Heat-Resisting Steel Plate, Sheet and Strip
- .44 ASTM A536, Ductile Iron Castings
- .45 ASTM A563, Carbon and Alloy Steel Nuts
- .46 ASTM A570/A570M, Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
- .47 ASTM A774/A774M, As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
- .48 ASTM A778, Welded, Unannealed Austenitic Stainless Steel Tubular Products
- .49 ASTM B88, Seamless Copper Water Tube
- .50 ASTM C76, Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- .51 ASTM C564, Rubber Gaskets for Cast Iron Soil Pipe and Fittings
- .52 ASTM D638, Test Method for Tensile Properties of Plastics

- .53 ASTM D792, Test Method for Specific Gravity and Density of Plastics by Displacement
- .54 ASTM D1248, Polyethylene Plastics Moulding and Extrusion Materials
- .55 ASTM D1457, PTFE Moulding and Extrusion Materials
- .56 ASTM D1784, Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
- .57 ASTM D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- .58 ASTM D2241, Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
- .59 ASTM D2466, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- .60 ASTM D2467, Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- .61 ASTM D2513, Thermoplastic Gas Pressure Pipe, Tubing and Fittings
- .62 ASTM D2564, Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- .63 ASTM D2665, Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
- .64 ASTM D2996, Filament-Wound Reinforced Thermosetting Resin Pipe
- .65 ASTM D3212, Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals
- .66 ASTM D3261, Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings
- .67 ASTM D4101, Polypropylene Plastic Injection and Extrusion Materials
- .68 ASTM D4174, Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems
- .69 ASTM F441, Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
- .70 ASTM F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
- .71 AWWA C105, Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
- .72 AWWA C110, Ductile-Iron and Grey-Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
- .73 AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Grey-Iron Pipe and Fittings
- .74 AWWA C115, Flanged Ductile-Iron and Grey-Iron Pipe with Threaded Flanges
- .75 AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Moulds or Sand-Lined Moulds, for Water and Other Liquids
- .76 AWWA C200, Steel Water Pipe, 6 Inches and Larger
- .77 AWWA C203, Coal Tar Protective Coatings and Linings for Steel Water Pipelines – Enamel and Tape – Hot Applied
- .78 AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 Inches through 144 Inches
- .79 AWWA C206, Field Welding of Steel Water Pipe
- .80 AWWA C207, Steel Pipe Flanges for Waterworks Services – Sizes 4 Inch Through 144 Inch
- .81 AWWA C208, Dimensions for Fabricated Steel Water Pipe Fittings
- .82 AWWA C209, Cold-Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
- .83 AWWA C210, Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe

- .84 AWWA C214, Tape Coating Systems for the Exterior of Steel Water Pipelines
- .85 AWWA C301, Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids
- .86 AWWA C303, Reinforced Concrete Pressure Pipe – Steel Cylinder Type, Pretensioned, for Water and Other Liquids
- .87 AWWA C600, Installation of Ductile-Iron Water Mains and their Appurtenances
- .88 AWWA C606, Grooved and Shouldered Joints
- .89 AWWA C651, Disinfecting Water Mains
- .90 AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
- .91 AWWA M11; Steel Pipe – A Guide for Design and Installation
- .92 CGA, Canadian Gas Association Standards
- .93 CAN/CGA B105 – Installation Code for Digester Gas Systems
- .94 CISPI 301, Specification Data for Hubless Cast Iron Sanitary System with No-Hub Pipe and Fittings
- .95 CPC, Canadian Plumbing Code
- .96 CSA B52, Mechanical Refrigeration Code
- .97 CSA B64 Series CSA Standards on Vacuum Breakers and Backflow
- .98 CAN3-B70, Cast Iron Soil Pipe, Fittings, and Means of Joining
- .99 CSA B137.3, Rigid PVC Pipe for Pressure Applications
- .100 CSA B139, Installation Code for Oil Burning Equipment
- .101 CSA B140.0 General Requirements for Oil Burning Equipment
- .102 CSA B158.1 Cast Brass Solder Joint Drainage, Waste and Vent Fittings
- .103 CAN3-B181.2 PVC Drain, Waste and Vent Pipe and Pipe Fittings
- .104 CSA CAN3-Z299.3, Quality Verification Program Requirements
- .105 CSA Z662 Oil and Gas Pipeline Systems
- .106 CSA B242 Groove and Shoulder Type Mechanical Pipe Couplings
- .107 EJMA STDS, Standards of Expansion Joint Manufacturers' Association, Edition No. 6
- .108 Fluid Sealing Association Technical Handbook, Rubber Expansion Joint Division
- .109 FEDSPEC, L-C530B(1), Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
- .110 MIL-H-13528B, Hydrochloric Acid, Inhibited, Rust Removing
- .111 MIL-S-8660C, Silicone Compound
- .112 MIL-STD-810C, Environmental Test Methods
- .113 MSS SP25, Standard Marking System for Valves, Fittings, Flanges and Unions
- .114 MSS SP43, Wrought Stainless Steel Butt Welding Fittings
- .115 SAE J1227, Assessing Cleanliness of Hydraulic Fluid Power Components and Systems
- .116 SSPC-P3, Canadian Government Standards Board
- .117 SSPC-SP6, Canadian Government Standards Board
- .118 SSPC-SP10, Canadian Government Standards Board
- .119 Plumbing and Drainage Regulations of Province of Saskatchewan
- .120 Gas Protection Regulations of the Province of Saskatchewan
- .121 Pressure Vessel Act of the Province of Saskatchewan
- .122 The American Society of Mechanical Engineers. (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, Part I – Power Boilers
 - .2 ASME Boiler and Pressure Vessel Code, Part IV – Heating Boilers
 - .3 ASME Boiler and Pressure Vessel Code, Part VIII – Pressure Vessels

- .4 ASME Boiler and Pressure Vessel Code, Part IX – Welding and Brazing Qualifications
- .123 The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
- .124 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
- .125 Department of Environment of the Province of Saskatchewan
- .126 Air-Conditioning and Refrigeration Institute (ARI)
- .127 National Fire Protection Association (NFPA)
- .128 Air Movement and Control Association (AMCA)
- .129 Canadian Gas Association
 - .1 CAN/CGA B149.1 Natural Gas Installation Code
 - .2 CAN/CGA-B149.2 Propane Installation Code
- .130 National Building Code
- .131 National Sanitation Foundation (NSF)
- .132 American Petroleum Institute (API)
- .133 CSA B214-07 Installation code for hydronic heating systems

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data.
- .2 Shop drawings and product data to include the following:
 - .1 Performance curves, which include differential head, efficiency, water NPSHR, and brake horsepower (where applicable).
 - .2 Outline and arrangement drawings.
 - .3 Cross-section drawings.
 - .4 Materials of construction.

1.5 UNIFORMITY OF EQUIPMENT

- .1 All valves, gauges and other equipment to be supplied by one manufacturer throughout to the extent practical. Variations will be permitted only where the major supplier cannot supply a particular piece of equipment as specified.

1.6 DRAWINGS AND DESIGN

- .1 The drawings are intended to show the major details of the mechanical work but it is the Contractor's responsibility to examine the electrical, mechanical, structural and architectural drawings before beginning the work and report to the Owner's Representative any discrepancies or interferences which may occur.

1.7 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790 - Operation and Maintenance Manuals.
- .2 Include the reviewed tag lists.

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1.8 PIPE MATERIALS – GENERAL

- .1 All pipe materials to be new, free from defects and conforming to applicable reference standards.
- .2 All materials, linings and coatings in contact with water to be NSF approved for potable water.
- .3 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.

1.9 PIPE SIZES

- .1 Where the pipe size is not specified, provide pipe with the sizes required by the Plumbing Code. Small piping not described by the Plumbing Code or otherwise specified herein shall be 12 mm nominal diameter.

1.10 JOINTS – GENERAL

- .1 Connect piping using joints not readily disassembled only where shown and where not otherwise specified. Provide joints which maybe disassembled at the minimum, within 1.0 metre of any connection to equipment, on both sides of structural penetrations, within 0.6 metres of all threaded end valves, and at the spacing specified in the detailed piping specification sheets.
- .2 For carbon steel piping less than 75 mm in diameter, butt-weld or use threaded couplings. Use unions where disassembly is required.
- .3 For steel piping equal to or greater than 75 mm in diameter, where not specified or shown otherwise, butt-weld according to ASME Boiler and Pressure Vessel Code or furnish slip-on flanges, conforming to ANSI B16.5, Class 150. Unless indicated otherwise on the drawings or detail specifications, where disassembly is required, use flanges.
- .4 For stainless steel tubing use stainless steel compression fittings.
- .5 For schedule rated stainless steel pipe smaller than 75 mm in diameter, socket-weld pipe. Where disassembly is required, use threaded unions.
- .6 For thin wall or schedule rated stainless steel pipe equal to or greater than 75 mm in diameter, butt-weld pipe unless otherwise shown or specified.
- .7 For copper or brass piping, use soldered couplings. Where disassembly is required, use compression unions.
- .8 For ductile iron piping, where not shown or otherwise specified, and for other piping where specified or shown, use grooved joints in accordance with AWWA C606.
- .9 Where not shown or otherwise specified, use solvent weld joints for PVC and FRP piping. Provide flanges or unions where disassembly is required.

1.11 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

2. PRODUCTS

2.1 PIPE, FITTINGS AND VALVES

- .1 All, fittings and standard valves to be in accordance with the line code sheet accompanying this section. All piping materials to be in accordance with the line code sheet accompanying section 15020.

2.2 FLANGES

- .1 Unless otherwise noted, make flanges on steel pipe Class 150, conforming to ANSI B16.5. Companion flanges for connection to cast iron or ductile iron equipment flanges shall be refaced to be flush with the companion flange.
- .2 Make flanges on stainless steel piping stainless steel slip-on, rolled-angle Van-Stone type, with a stainless steel back-up ring drilled to ANSI B 16.1, Class 125. Make the angle ring thickness equal or greater than the pipe or fitting to which it is welded. For digester gas services, make the flanges Lap-joint type with galvanized steel Lap-joint flange and in accordance with CGA B105. For instrument air services, make the flanges Lap-joint type with a stainless steel Lap-joint flange.
- .3 Provide Class 125 flanges on cast or ductile pipe, conforming to ANSI B 16. 1.
- .4 General requirements for flanges are as follows:
 - .1 Compatible flanges for mating to equipment or valves.
 - .2 Provide flat-faced flanges on each side of butterfly valves.
 - .3 For steel piping, provide weld neck flanges on both sides of wafer or lug body valves.
- .5 Do not use slip-on flanges that are attached to a pipe by means of set screws and gaskets.

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2.3 LINK SEALS

- .1 Seal pipes passing through concrete walls as indicated on drawings, in a watertight manner, with link type expanding rubber seals as manufactured by the Thunderline Corporation.
- .2 Link seals shall have EPDM seal element, composite pressure plates, and steel bolts with zinc chromate treatment.
- .3 Size to suit cored hole or sleeved hole as required.
- .4 Support pipe on either side of seal so that seal is not load bearing.

2.4 DIELECTRIC COUPLINGS

- .1 Wherever pipes of dissimilar metals are joined use dielectric couplings.
- .2 Use insulating unions for pipe sizes 50 mm and smaller and insulating flanges for pipe sizes larger than 50 mm.

2.5 UNIONS

- .1 Provide unions at all locations for all pipe materials so that the Operator can easily perform required maintenance of all equipment.

2.6 SOLDERED COUPLINGS

- .1 Soldered couplings for copper pipe conform to ANSI B16.26. Solder to be lead free conforming to ASTM B32 and the Plumbing Code.

2.7 THREADED COUPLINGS

- .1 Make screwed joints using American Standard threads to ANSI B1.20.1 .
- .2 Use paste as thread lubricant for threaded joints, Loctite or approved equal.
- .3 Conform to ASTM A182 or ASTM A276, Class 150, for threaded connections to stainless steel pipe, threadolets to be shop welded to the pipe at the locations specified.
- .4 Provide threaded-end to flanged-end adaptors where required to connect to flanges.

2.8 COMPRESSION COUPLINGS

- .1 Furnish compression couplings for stainless steel tubing of the same material as the pipe, capable of withstanding the maximum pressure to which the pipe is subjected.
- .2 Furnish compression couplings for copper and brass tubing of copper, suitable for the maximum pressure of the pipe, conforming to ANSI B16.26.

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2.9 GROOVED JOINT COUPLINGS

- .1 Fabricate grooved joint couplings of ductile iron to ASTM A536, and in accordance with AWWA C606. Provide cut or rolled grooves in pipe and fittings in accordance with AWWA C606. Rolled grooves and roll-groove type joints are not acceptable.
- .2 Steel Pipe: Use flexible style couplings for all buried service pipe, all pipe greater than 300 mm in diameter, for pipe less than 300 mm in diameter in rack mounted piping assemblies, and for grooved joints adjacent to pump or blower suction and discharge where grooved joints are used for noise and vibration control. Use rigid style couplings in all other applications.
- .3 Where grooved joint piping systems connect to equipment or to flanged valves, meters, or other sensing devices; use grooved joint flanges or flange adapters. Acceptable products are: Tyler Groove to Flange Fittings or Victaulic Flange adapters. Where the Contractor chooses to use grooved joint flanges rather than the indicated adapters, piping modifications required to suit this change are the responsibility of the Contractor. Make full allowance for piping disassembly and access to the face of equipment.
- .4 All couplings to be internally and externally epoxy coated.

2.10 FLEXIBLE COUPLINGS

- .1 Flexible Couplings for non-buried to be Brico D-0-L
 - .1 Stainless steel construction with stainless steel bolts, nuts and washers.
 - .2 Gaskets: fabricated of material suitable to the service conditions.

2.11 FITTINGS

- .1 For steel pipelines 75 mm in diameter or greater, fittings to conform to ANSI B16.9, ANSI B16.11 or ANSI B16.5. Provide fittings with a wall thickness equal to or greater than the pipe. In steel pipelines less than 75 mm in diameter provide threaded malleable iron fittings, conforming to ANSI B16.3.
- .2 Provide long radius steel grooved-joint fittings conforming to ANSI B16.9 in steel grooved-joint pipeline systems. Grooved joint adapters may be welded to fitting ends; dimension and cut or roll the groove of the adapter in accordance with the coupling manufacturer's recommendations; materials and inside diameter to be the same as the pipe; grind the interior weld smooth and meet the lining manufacturer's recommendations.
- .3 For steel grooved-joint pipe of diameters of 150 mm and less, the Contractor may provide ductile iron grooved-joint fittings which have an outside diameter equal to the steel pipe diameter. Provide ductile iron to ASTM A536, dimensioned to 1.5 diameter radius bends, and cut grooving dimensions to AWWA C606 EPS dimensions. The lining and coating of the ductile iron fittings must equal the lining and coating of the steel pipeline system.
- .4 Standard radius elbows to dimensions of ANSI B16.5 may be provided on clean water grooved-joint piping systems only.

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- .5 Provide butt welding fittings in stainless steel pipelines less than 75 mm of the same class as the pipe, conforming to ASTM A403 and ANSI B16.11. Provide socket welding fittings in stainless steel pipelines less than 75 mm to Cl. 3000, same material as the pipe, and ANSI B16.1 1. Fabricate fittings in stainless steel pipelines equal to or greater than 75 mm in diameter using similar materials and classes as the pipe and conform to ASTM A774.
- .6 Provide fittings in flanged ductile iron pipelines that conform to ANSI B16.1 and in grooved end or mechanical joint ductile iron pipelines to AWWA C110.
- .7 Provide ductile iron fittings in PVC pipelines that conform to AWWA C110 or provide PVC to CSA B137.3, of the same material and class as the pipe.
- .8 Provide fittings in FRP pipelines of the same material and class as the pipe.
- .9 Provide copper fittings in copper pipelines conforming to ANSI B16.26.
- .10 Provide eccentric reducers in horizontal lines with the flat side on top, unless shown otherwise.
- .11 Provide concentric reducers in vertical lines unless indicated otherwise.
- .12 Provide long radius elbows unless otherwise shown. Provide smooth flow carbon or stainless steel elbows 350 mm and less, to ANSI B16.9. Provide mitred elbows greater than 350 mm, to AWWA C208 unless otherwise shown or specified. Use 3-piece construction unless otherwise shown or specified.
- .13 Provide fittings in concrete cylinder pipe fabricated from metal plate, cement lined and coated, and in accordance with AWWA C301. Dimensions to AWWA C208.

2.12 GASKETS

- .1 For flat faced flanges, use full-face gaskets. For raised-face flanges, use ring type gaskets. Conform to ASTM B16.21.
- .2 Use gasket materials for flanged connections suitable for the temperature, pressure, and corrosivity of the fluid conveyed in the pipeline. Refer to detailed pipe specifications for recommended gasket material. Material designations used in the detailed pipe specification sheets are as follows:
 - .1 EPDM: ethylene-propylene-diene-terpolymer 70 durometer.
 - .2 Bl. Neoprene: neoprene (black) 70 durometer.
 - .3 Nitrile: nitrile (Buna N).
 - .4 SBR: Styrene-butadiene (red).
 - .5 Natural rubber: natural rubber.
 - .6 Compressed synthetic fibres (Kevlar): ASTM F104 (F7712400), and neoprene binder: 1.7 MPa (ASTM F152), 0.2 mL/h Leakage Fuel A (ASTM F37).
 - .7 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400) and SBR binder: 1.7 MPa (ASTM F1 52), 0.1 mL/h Leakage Fuel A (ASTM F37).
 - .8 Gylon - Type 1: Garlock Style 3500, 1.35 MPa (ASTM F152), 0.22 mL/h Leakage Fuel A (ASTM F37).

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- .9 Gylon-Type2: Garlock Style 3510, 1.35 MPa (ASTM F152), 0.04 mL/h Leakage Fuel A (ASTM F37).
- .10 CPE - Chlorinated Polyethylene.
- .3 Unless otherwise specified, minimum Gasket Material Thickness for full face gaskets:
 - .1 75 to 250 mm pipe diameter; 1.6 mm thick.
 - .2 Greater than 250 mm pipe diameter; 3.2 mm. thick.
- .4 Unless otherwise specified, minimum gasket material thickness for raised face ring gaskets:
 - .1 75 to 100 mm pipe diameter; 1.6 mm thick.
 - .2 Greater than 100 mm. pipe diameter; 3.2 mm thick.
- .5 Grooved joint gasket materials to be as recommended by the manufacturer for the service conditions indicated. Unless otherwise specified, provide flush seal type gaskets for all grooved joint systems. Acceptable products: Gustin-Bacon RigiGrip, Victaulic Flush-Seal.

2.13 BOLTS AND NUTS

- .1 Provide hex head bolts and nuts. Threads to be ANSI B1.1, standard coarse thread series.
- .2 For general interior service, use bolts and nuts conforming to ASTM A307, Grade A; nuts conforming to ASTM A563, Gr.A.
- .3 For exposed (exterior), submerged, buried, installed below the main floor slab and concrete encased service, provide stainless steel bolts, nuts and washers; bolts conforming to ASTM A193, Gr.B8, C1.1; nuts conforming to ASTM A194, Gr.8.
- .4 Provide hot dip galvanized bolts, nuts and washers for use with hot dip galvanized Van Stone flange back-up rings and Lap-joint flange back-up rings.
- .5 Provide hex nuts equal to or less than 25 mm. Greater than 25 mm, provide heavy hex.

2.14 ANCHOR BOLTS

- .1 Provide hot dip galvanized, L – type anchor bolts, nuts and washers for use with concrete support blocks.
- .2 Use bolts and nuts conforming to ASTM A307, Grade A; nuts conforming to ASTM A563, Grade A.
- .3 Refer to the standard drawings at the end of this section.

2.15 EPOXY COATING (INTERIOR/EXTERIOR PIPING & VALVE SURFACES)

- .1 General
 - .1 All coatings in contact with potable water shall be to AWWA C210, ANSI/NSF 60/61 suitable for use in potable water applications.
 - .2 All coatings shall be factory applied by the fitting, piping or valve manufacturer or by a specialized coating firm approved by the Owner's Representative.

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- .3 Coat all non-galvanized/non-stainless steel surfaces in contact with water.
- .2 Coating Materials and Applications
 - .1 Coating Material: The coating material shall be a two component, epoxy liquid coating suitable for use in potable water applications.
 - .2 Application: The coating shall be cold applied and holiday free in accordance with the coating manufacturer's specifications.
- .3 Surface Preparations
 - .1 All surfaces shall be blast cleaned to SSPC-SP5 prior to and within 4 hours of coating. Newly cast objects need not to be sandblasted if not contaminated with soil, oil, grease etc. and if coating takes place within 4 hours after casting.
- .4 Field Applied Coatings
 - .1 Apply to damaged areas of shop coated surfaces and at field welds.
 - .2 Clean and prepare surfaces in accordance with the manufacturers recommendations.
 - .3 Repair coating with an epoxy compatible with the factory-applied epoxy and finish in accordance with the coating manufacturers specifications.
- .5 Inspection
 - .1 The coating shall be pinhole free.
 - .2 The Owner reserves the right to obtain independent coating testing.
 - .3 The cost of independent coating testing shall be born by the Owner unless the inspection was requested by the Contractor.
 - .4 If the independent test shows that the coating is unacceptable, the Contractor shall bear the full cost of all testing and reapplication to the satisfaction of the Owner.
- .6 Color Schedule
 - .1 All piping, valves, and equipment shall be color coded and the finish colors shall be as shown on the color schedule in Section 9907 or as directed by the Engineer.
- .7 Acceptable product:
 - .1 Devoe BAR-RUST 233H (NSF approved) Multi-Purpose Epoxy Coating, DFT 12 - 16 mils
 - .2 Or approved alternate

2.16 FIELD APPLIED COATING AND WRAPPING

- .1 Buried steel piping shall have an external protective wrapping to protect against corrosion. The wrapping shall consist of a primer followed by a polyken tape covering and then a polyethylene rock shield. The system of primer and tape shall conform to AWWA C209.
- .2 The tape shall be a polyken tape with butyl rubber backing.
- .3 Primer shall have a base of rubber and synthetic resins, compatible with tape, and suitable for hand application.

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- .4 The rock shield shall be black polyethylene, 40-mil thickness, supplied in rolls 1050-mm wide, Renfrew 350-40 or as approved.
- .5 Buried steel flanges shall have an external protective wrapping to protect against corrosion. The wrapping shall consist of a primer followed by a Denso tape covering.

2.17 GALVANIZING

- .1 Where piping is to be galvanized, hot dip zinc coat to CSA G164 with a minimum coating of 550 g/m².

2.18 RPVC CONDUIT

- .1 Tubing shall be installed in RPVC conduit where indicated on Contract Drawings.
- .2 Tubing of 10 mm diameter and smaller is to be installed in 25 mm diameter RPVC conduit complete with long radius elbows.
- .3 Tubing of 12 mm diameter to be installed in 50 mm diameter RPVC conduit complete with long radius elbows.

2.19 TRACER WIRE

- .1 Buried non-metallic piping shall be installed with insulated tracer wire.
- .2 Insulated tracer wire; 2.0mm (14 gauge) shall be placed above the pipeline and directly over the centre of the pipeline. The Contractor must ensure that the tracer wire is not cut, scraped, or nicked during installation. Termination points shall be installed on Pipeline Warning Sign Posts at approximately 2 km spacing.
- .3 The Contractor shall test and the Engineer shall check the tracer wire. It shall be the Contractor's responsibility to locate and repair any malfunctions discovered by either the Contractor or the Engineer.

2.20 PIPE HANGERS AND SUPPORTS

- .1 General:
 - .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 1983 and MSS-SP58-1983.
 - .2 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
 - .3 Dielectrically isolate all piping from dissimilar metal supports.
- .2 Upper Attachments:
 - .1 Concrete:
 - .1 Inserts for cast-in-place concrete: galvanized steel wedge to MSS-SP58-1983, type 18. ULC listed for pipe 20 mm size through 200 mm.
 - .1 Acceptable product: Anvil Fig. 281; Myatt.

- .2 Carbon steel plate with clevis, for surface mount - malleable iron socket, expansion case and bolt. Minimum two expansion cases and bolts for each hanger.
 - .1 Acceptable product: Anvil - Fig. 49, Socket Fig. 290, Expansion Case Fig. 117; Myatt.
- .2 Steel Beam (bottom flange):
 - .1 Cold piping 50 mm size or smaller: malleable iron C clamp to MSS-SP58-198 type 19, ULC listed.
 - .1 Acceptable product: Anvil Fig. 61; Myatt.
 - .2 Cold piping 65 mm size and larger and all hot piping: malleable iron beam clamp to MSS-SP58-1983 type 28 or 29, ULC listed.
 - .1 Acceptable product: Anvil Fig. 229; Myatt.
- .3 Steel Beam (top):
 - .1 Cold piping 50 mm size or smaller: malleable iron "top of beam" clamp to MSS-SP58-1983 type 19, ULC listed.
 - .1 Acceptable product: Anvil Fig. 61; Myatt.
 - .2 Cold piping 65 mm size and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP58-1983 type 25, ULC listed.
 - .1 Acceptable product: Anvil Fig. 227; Myatt.
- .4 Steel Joist:
 - .1 Cold piping 50 mm size and smaller: steel washer plate with double locking nuts.
 - .1 Acceptable product: Anvil Fig. 60; Myatt.
 - .2 Cold piping 65 mm size and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.
 - .1 Acceptable product: Anvil - washer plate Fig. 60, clevis Fig. 66, socket Fig. 290, Myatt.
- .5 Steel Channel or Angle (bottom):
 - .1 Cold piping 50 mm size and smaller: malleable iron C clamp to MSS-Sp58-1983 type 23, ULC listed.
 - .1 Acceptable product: Anvil Fig. 86; Myatt.
 - .2 Cold piping 65 mm size and larger and all hot piping: universal channel clamp, ULC listed.
 - .1 Acceptable product: Anvil 226; Myatt.
- .6 Steel Channel or Angle (top):
 - .1 Cold piping 50 mm size or smaller: malleable iron "top of beam" C clamp to MSS-SP58-1983 type 19 ULC listed.
 - .1 Acceptable product: Anvil Fig. 61; Myatt.

- .2 Cold piping 65 mm size and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP58-1983 type 25, ULC listed.
 - .1 Acceptable product: Anvil Fig. 227; Myatt.
- .3 Middle Attachment (rod):
 - .1 Carbon steel threaded rod, electro-galvanized for finish.
 - .1 Acceptable product: Anvil Fig. 146; Myatt.
- .4 Pipe Attachment:
 - .1 Cold piping, steel or cast iron: hot piping, steel with less than 25 mm horizontal movement: hot piping, steel with more than 300 mm middle attachment rod length: adjustable clevis to MSS-SP58-1983 type 1, ULC listed.
 - .1 Acceptable product: Anvil Fig. 260; Myatt.
 - .2 Cold piping, hot copper with less than 25 mm horizontal movement; hot copper with more than 300 mm middle attachment rod length: adjustable clevis to MSS-SP58-1983 type 1, copper plated.
 - .1 Acceptable product: Anvil Fig. CT-65; Myatt.
 - .3 Suspended hot piping, steel and copper with horizontal movement in excess of 25 mm; hot steel with middle attachment rod 300 mm or less: pipe roller to MSS-1983 type 43.
 - .1 Acceptable product: Anvil Fig. 181; Myatt.
 - .4 Bottom supported hot piping, steel or copper: pipe roller stand to MSS-SP58-1983 type 45.
 - .1 Acceptable product: Anvil Fig. 271; Myatt.
- .7 Riser Clamps:
 - .1 Steel or cast iron pipe: galvanized carbon steel to MSS-SP58-1983 type 42, ULC listed.
 - .1 Acceptable product: Anvil Fig. 261; Myatt.
 - .2 Copper pipe: carbon steel copper finished to MSS-SP58-1983 type 42.
 - .1 Acceptable product: Anvil Fig. CT-121; Myatt.
- .8 Strut Mounted (galvanized carbon steel):
 - .1 Copper piping: cushion clamp c/w thermoplastic rubber.
 - .1 Acceptable product: Anvil PS1400; Hydra-Zorb.
- .9 Saddles and Shields:
 - .1 Cold piping 30 mm and larger: protection shield with high density insulation under shield with interrupted vapour barrier.
 - .1 Acceptable product: Anvil Fig. 167; Myatt.
 - .2 Hot piping 30 mm size and larger: protective saddle with insulation under saddle.
 - .1 Acceptable product: Anvil Fig. 160 to 166; Myatt.

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2.21 DUCT HANGERS AND SUPPORTS

- .1 Hangers: Galvanized steel band iron or rolled angle and 10 mm rods.
- .2 Wall Supports: Galvanized steel band iron or fabricated angle bracket.
- .3 Vertical Support at Floor: Rolled angle.

2.22 RACK AND TRAPEZE SUPPORTS

- .1 Provide steel trapeze and pipe rack components having a minimum thickness of 2.7 mm (12 gauge) with a maximum deflection of 1/240 of the span unless otherwise noted.
- .2 Provide trapeze pipe support cross members and general fittings as required.
- .3 Approved Supplier:
 - .1 Unistrut or approved equal

2.23 FINISHES ON HANGER RODS, HANGERS AND SUPPORTS

- .1 All steel hanger rods, hangers and supports shall be galvanized or factory primed with alkyl red oxide primer to CAN/CGSB-1.40-M89.

2.24 INSTRUMENT AIR CONNECTIONS

- .1 Provide instrument air connections to each instrument with a run of 6 mm nylon tubing from the nearest instrument air header to within close proximity of each device requiring instrument air.
- .2 Terminate each tubing run with a 12 mm ball valve (stainless steel) within 1500 mm horizontal distance of the device and 1,500 mm off the floor. Group multiple valves neatly together with a common orientation.
- .3 Provide a vertical riser connection at the header to avoid condensate entrainment. From the top of the riser, slope the tubing generally down to the device.

2.25 QUICK DISCONNECTS

- .1 Provide quick disconnects which are not disconnectable under pressure. Unless otherwise shown or specified, provide products listed below.
- .2 For air service, acceptable products are:
 - .1 Dixon Air King
 - .2 Tomco, 12 mm diameter. Tomco, THK.
- .3 For water service, sizes as shown. Acceptable products are:
 - .1 For 25 mm or less diameter hose, two lug, malleable iron, female NPT: Dixon Air King.

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- .2 For 38 mm and 50 mm diameter hose, two four lug, malleable iron, female NPT: New Line Dixon Air King.
- .3 For 75 and 100 mm diameter or greater; quick-acting, dual clip: Rite-pro, Dixon.

2.26 FLUSHING CONNECTIONS

- .1 Provide flushing connections on all piping for the conveyance of sludge, scum, grit or other liquid containing solids greater than 0.5 percent. Locate flushing connections adjacent to all isolation valves, on dead end branches, at tees and 90 degree elbows, and at intermediate locations which limit the distance between flushing connections to less than 30 metres. Show flushing connections on piping submittals.
- .2 Allow for 5 – 12.5 mm sample ports tapped into 150 to 300 mm pipes. Engineer will provide location during commissioning.

2.27 PURGE CONNECTIONS

- .1 Provide purge connections on all gas lines. Locate adjacent to both sides of all isolation valves and spectacle flanges, and at any other locations shown in the drawings. Purge points shall be a minimum of 20 mm NPS pipe, fitted with a shut off valve which shall be capped.

2.28 MECHANICAL BRANCH CONNECTIONS

- .1 Provide mechanical branch connections as required for flushing connections and pipe tappings. Provide branch connection recommended by the manufacturer for the service and pipe installed. Acceptable products are:
 - .1 Gruvlock Clamp T
 - .2 Ford Service Saddles (F/FS)
 - .3 Victaulic Mechanical T

2.29 DRAIN VALVES

- .1 Locate at all low points and section isolating valves unless otherwise specified.
- .2 Minimum 20 mm size unless otherwise specified: straight pattern bronze with hose end male thread and complete with cap and chain.

2.30 ELECTRICAL MOTORS

- .1 Supply mechanical equipment complete with electrical motors.
- .2 Provide motors to CEMA and CSA standards for hard, continuous service, designed to limit temperature rise to 40°C for open housing and 50°C for drip proof housing, and operate at 1200 or 1800 r/min unless otherwise specified.
- .3 Motors shall have ball or roller type bearings.
- .4 Provide grease lubrication fittings on motors with frame sizes 254T and larger.

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- .5 Refer to electrical specification for voltage, phase and cycle.

2.31 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 7.5 kW: standard adjustable pitch sheaves, having +/- 10% range. Use mid-position of range for specified r/min.
- .4 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .5 Motor slide rail adjustment plates to allow for centre line adjustment.

2.32 GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm sheet metal tops and bottoms.
 - .3 38 mm diameter holes on both shaft centers for insertion of tachometer.
 - .4 removable for servicing.
 - .5 Install guards to allow movement of motors for adjusting belt tension.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .5 Unprotected inlets and outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

2.33 SPARE PARTS AND SPECIAL TOOLS

- .1 To section 01795 – Spare Parts as follows.
 - .1 One set of belts for each piece of machinery.
 - .2 One filter cartridge or set of filter media for each filter or filter bank in addition to the final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by the equipment manufacturer.

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2.34 ACCESS DOORS

- .1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting, and servicing.
- .2 Flush mounted 600 mm x 600 mm for body entry and maximum size possible to 300 mm x 300 mm for hand entry unless otherwise noted. Doors to open 180 degrees, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
 - .1 Special areas such as tiles or marble surfaces: use stainless steel with brushed satin or polished finish as directed by consultant.
 - .2 remaining areas: use prime coated steel.
- .4 Installation:
 - .1 Locate such that all concealed items are accessible.
 - .2 Locate such that hand or body entry is achieved.
 - .3 Installation is specified in applicable sections.

2.35 FLASHING

- .1 Steel Flashing: 0.55 mm galvanized steel.
- .2 Lead Flashing: sheet lead, as follows:
 - .1 For Waterproofing: 25 kg/m².
 - .2 For Soundproofing: 5 kg/m².
 - .3 Lead Sheet Size:
 - .1 Roof Plumbing Vents: as required to provide base flashing overlap to ARCA detail.
 - .2 Floor Drains: minimum 920 x 920 mm and as specified.
 - .3 Other Locations: as specified.
- .3 Safes: 25 kg/m² sheet lead or 200 micrometre neoprene.
- .4 Caps: Steel, 0.70 mm thickness minimum, 1.6 mm thickness at fire resistance structures.

2.36 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.

2.37 TEMPORARY OR TRIAL USAGE

- .1 Temporary or trial usage by the engineer of mechanical equipment supplied under contract shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.

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- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

3. EXECUTION

3.1 EXAMINATION

- .1 Examine areas where work is to be performed for:
 - .1 Anything that affects execution and quality of work.
 - .2 Piping clearances.

3.2 VALVES AND EQUIPMENT IDENTIFICATION

- .1 Tagging:
 - .1 See Section 1.11.
- .2 The drawings designate the size and line service specification of all pipe, fittings, valves and equipment to be supplied by the Contractor in the following manner.
- .3 Valve Identification Symbols
 - .1 Valve Identity Symbols

<u>Symbol</u>	<u>Valve Type</u>
ARV	Air Release Valve
BAV	Ball Valve
BBV	Block and Bleed Valve
BPV	Back Pressure Valve
BUV	Butterfly Valve
BV	Block Valve
CAV	Combination Air Vacuum
CHV	Check Valve
DCVA	Double Check Valve Assembly
FCV	Flow Control Valve
GAV	Gate Valve
GLV	Globe Valve
NEV	Needle Valve
PRV	Pressure Reducing Valve
PSV	Pressure Sustaining, Pressure Relief Valve
SV	Solenoid Valve

- .2 Valve Marking
Each valve to bear the manufacturer's name or trademark and reference symbol to indicate the service conditions for which the manufacturer guarantees the valve. The marking to be in accordance with MSS-SP-25.

.3 Manual Valve Actuators

.1 Actuators for valves to be as follows:

Type of Valve	Size	Valve Actuator
Gate Valve	250 mm & smaller	Handwheels
Globe Valve	250 mm & smaller	Handwheels
Butterfly Valves	100 mm & smaller	Lever operated
	150 mm & larger	Gear operated
Ball Valves	100 mm & smaller	Lever operated
Plug Valves	100 mm & smaller	Lever operated
	150 mm & larger	Gear Operated

.4 Valve operators to turn in a counter-clockwise direction to open unless otherwise indicated on the drawings.

.4 Equipment Identification

.1 Processes

<u>Symbol</u>	<u>Equipment</u>
AC	Air Compressor
B	Blower
EXP	Expansion Joint
FI	Flow Indicator
M	Mixer
PI	Pressure Indicator
P	Pump
SK	Skimmer
STR	Strainer
TK	Tank

.2 Plumbing

<u>Symbol</u>	<u>Equipment</u>
CO	Cleanout
DWH	Domestic Water Heater
ED	Equipment Drain
FD	Floor Drain
FFD	Funnel Floor Drain
FSL	Flow Switch
HB	Hose Bibb
HD	Hub Drain
NFHB	No Freeze Hose Bib
PTK	Pressure Tank
PS	Pressure Switch
RD	Roof Drain

.3 Heating, Ventilation, and Air Conditioning

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<u>Symbol</u>	<u>Equipment</u>
B	Boiler
BDD	Back Draft Damper
CC	Cooling Coil
CF	Ceiling Fan
CU	Condensing Unit
DM	Damper
EF	Exhaust Fan
ET	Expansion Tank
FC	Fan Coil Unit
FF	Force Flow Unit
GC	Glycol Fill Tank
L	Louvre
P	Pump
SF	Supply Fan
T	Thermostat
UH	Unit Heater

3.3 PIPING INSTALLATION

- .1 General:
 - .1 Conform to requirements of ANSI B31 code for pressure piping.
 - .2 Install straight, parallel and close to walls and ceilings, with specified pitch. Use standard fittings for direction changes.
 - .3 Install groups of piping parallel to each other, spaced to permit application of insulation (when required), identification, and service access, on hangers.
 - .4 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
 - .5 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.
 - .6 Install flanged or welded nozzles, branch connections, welding outlets, adapters and taps, true and faced at right angles to the axis of the pipe. Do not extend connection inside of pipe.
 - .7 Make pipe ends round and true, suitable for weld connection.
 - .8 Prepare pipe ends in accordance with ANSI B16.25 for butt welding.
 - .9 All welded stainless steel to be pickled and passivated as per ASTM A380 after welding.
 - .10 Copper pipe and tubing to be free from surface damage. Replace damaged pipe or tubing.
 - .11 Ream ends of pipe and tubes before being made up.
 - .12 Lay metal tubing so that it is not in contact with dissimilar metal and will not be kinked or collapsed.
 - .13 Use non-corrosive lubricant or Teflon tape applied to male thread only.
 - .14 Groove pipe ends, cut square, seating surface clean and free from indent and score marks.
 - .15 Install dielectric fittings wherever piping of dissimilar metals are joined.
 - .16 Install flanges or unions to permit removal of equipment and valves without disturbing piping systems, as required by piping standard.

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- .17 Clean ends of pipes or tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.
- .18 Support piping during construction to prevent abnormal stresses on the pipe works.
- .19 Install pipe supports as required.
- .20 Install pipe hangers as required.

- .2 Flanges Bolting to Valves:
 - .1 Do not weld adjacent flanges when any valve is in place.
 - .2 Remove valve prior to welding.
 - .3 Clean gasket surfaces, flange faces and butt welding connections.
 - .4 Protect connecting surfaces.

- .3 Bolted Connections:
 - .1 Clean pipe ends and gaskets.
 - .2 Lubricate gaskets with soapy water and bolts with thread lubricant.
 - .3 Tighten bolts progressively by crossover method and not in rotation around the joint.
 - .4 Tighten bolts to the torque recommended by the manufacturer.
 - .5 Use properly sized wrenches for bolt tightening to prevent rounding of nut and bolt heads.

- .4 Threaded Connections:
 - .1 Clean pipe ends and threads.
 - .2 Use appropriate pipe dope for potable use when threading pipe.

3.4 WELDING SPECIFICATIONS

- .1 Welders Qualifications:
 - .1 All welders shall have qualified under ASME B31.3-2018 Standard and have a Saskatchewan F3/F4 Pressure Welding Certificate. Welders shall be qualified by a local approved testing agency.

- .2 Welding Procedures:
 - .1 Submit details of the procedures for Owner's Representative's review.
 - .2 All welding shall be carried out in accordance with ASME BPVC, Section IX, and ASME B31.1, B31.3, and B31.9 for Pressure Piping.
 - .3 The Contractor shall use adequate weather shields to protect the welding operation from rain, snow and wind. The Owner's Representative has the right to stop all welding if in his opinion adverse weather conditions will affect the quality of the weld.
 - .4 Where more than one pass is required, each pass, except the first and the final one, shall be peened to relieve shrinkage stresses. All dirt, slag and flux shall be removed before the succeeding bead is applied.

- .3 Standard of Acceptability:
 - .1 The Engineer shall have the right to inspect all welds by visual, radiological or other non-destructive test method. Inspection may be made during welding or after the weld has been completed. Under visual examination welds shall be free of cracks, inadequate penetration, unrepaired burn-through and other defects, and

shall present a neat workmanlike appearance. Radiological examination may be used at the discretion of the Owner's Representative to determine the penetration, slag inclusion, cracks and other defects. The Owner's Representative shall be the sole judge as to the acceptability of each weld.

- .2 If a dispute results as to the acceptability of a weld, a specimen may be taken of the weld at the location determined by the Owner's Representative and subjected to tests in accordance with ASME B31.3-2018 Standards. An acceptable weld shall be per CSA Z662.
- .3 If the specimen test shows that the weld is unacceptable as outlined above, the Contractor shall bear the full cost of all testing and repairing the pipe where the specimen is removed to the satisfaction of the Owner's Representative. The Owner's Representative shall have the right to reject any weld if in his opinion the weld defects are detrimental to the strength of the weld.
- .4 The cost of all radiological inspection shall be born by the Owner unless the inspection was requested by the Contractor.

.4 Leakage Testing

- .1 Leakage testing on completed butt joints shall normally be made by testing the line hydrostatically to the pressure rating of the pipe.

.5 Repair of Defective Welds

- .1 Minor defects in welds may be removed by grinding out the defective portion. Replacement welds in joints may be checked by repeating the original test.
- .2 Major defects and all cracks shall be cut out mechanically and the joint re-welded.
- .3 All cost for repairing defective welds, including radiographic inspection of the corrected work, shall be borne by the Contractor.

3.5 VALVE INSTALLATION

.1 Storage of Valves:

- .1 Store valves in cool and clean location, away from moving vehicles or other objects.
- .2 Prevent dirt and debris entering the valve internals.
- .3 Protect the valve seats against painting.
- .4 Store valves with their handwheels, operator shafts and operators in an upright position.

.2 Handling Valves

- .1 Do not place chains, cables and ropes through valve ports or attached to operators or handwheels.
- .2 Use sling either around valve body or with bolts or rods through the flange holes.

.3 Installation of Valves:

- .1 Installation of valves to be by competent personnel and in strict accordance with manufacturer's instructions.
- .2 Inspect pipe and remove all foreign debris or objects that may prevent closing of valve prior to the installation of any valves.
- .3 Install butterfly valves with their operating shafts in the horizontal position unless otherwise directed by the Owner's Representative.

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- .4 Flanges or fittings adjacent to butterfly valves shall not be welded with the valve in place.

3.6 INSERTS

- .1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- .2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.
- .3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
- .4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.7 PIPE HANGERS AND SUPPORTS

- .1 Hanger Spacing

Spacing and middle attachment rod diameter as specified in paragraphs below or as table below, whichever is more stringent.

- .1 Plumbing piping: most stringent requirements of the Plumbing Code for the Province of Saskatchewan or authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas piping: up to 15 mm size - every 1.8 m.
- .4 Copper piping: up to 15 mm size - every 1.5 m.
- .5 PVC piping: To manufacturer's recommendation for the maximum temperature of the service and to prevent any visible deflection or movement.
- .6 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .7 Within 300 mm of each horizontal elbow.
- .8 Table:

Maximum Pipe Size(mm)	Rod Diameter (mm)	Maximum Spacing Steel (m)	Maximum Spacing Copper (m)
To 30	10	2.1	1.8
40	10	2.7	2.4
50	10	3.0	2.7
65	10	3.6	3.0
75	10	3.6	3.0
100	16	4.2	3.6
150	22	5.1	
200	22	5.7	
250	22	6.6	
300	22	6.9	

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- .2 Hanger Installation:
 - .1 Offset Hanger so that rod is vertical in operating position.
 - .2 Adjust hangers to equalize load.

3.8 EQUIPMENT BASES AND SUPPORTS

- .1 Provide for major equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.
- .2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- .3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.9 LOW VELOCITY DUCT HANGERS AND SUPPORTS

- .1 Hanger Minimum Sizes:
 - .1 Up to 750 mm wide: 25 x 1.6 mm at 3 m spacing.
 - .2 790 to 1200 mm wide: 40 x 1.6 mm at 3 m spacing.
 - .3 Over 1200 mm wide: 40 x 1.6 mm at 2.4 m spacing.
- .2 Horizontal Duct on Wall Supports Minimum Sizes:
 - .1 Up to 450 mm wide: 40 x 1.6 mm or 25 x 25 x 3 mm at 2.4 m spacing.
 - .2 480 x 1000 mm wide: 40 x 40 x 3 mm at 1.2 m spacing.
- .3 Vertical Duct on Wall Supports Minimum Sizes at 3.65 m spacing:
 - .1 Up to 610 mm wide: 40 x 1.6 mm.
 - .2 640 to 900 mm wide: 25 x 25 x 3 mm.
 - .3 Over 1520 mm wide: 50 x 3 mm.
 - .4 940 to 1200 mm wide: 30 x 30 x 3 mm.
- .4 Vertical Duct Floor Supports Minimum Sizes, riveted or screwed to ducts:
 - .1 Up to 1520 mm wide: 40 x 40 x 3 mm.
 - .2 Over 1520 mm wide: 50 x 3 mm.

3.10 FLASHING

- .1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.
- .2 Flash vent and soil pipes projecting 75 mm minimum above roof membrane with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides. For pipes through outside walls turn flange back into wall and caulk.
- .3 Flash floor drains over finished areas with lead minimum 250 mm clear on sides. Fasten flashing to drain clamp device.
- .4 Provide curbs for mechanical roof installations, minimum 200 mm high.

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- .5 Attach counterflashings to mechanical equipment and lap base flashings on roof curbs.
- .6 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Use storm collars above all roof jacks.
- .7 Screw vertical flange section of roof jacks to face of curb.
- .8 Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to manufacturer's data for sound control.

3.11 PROTECTION OF OPENINGS

- .1 Protect equipment and system openings from dirt, dust and other foreign materials.
- .2 Thoroughly clean piping, ducts and equipment of dirt, cuttings, and other foreign substances prior to being put into operation.

3.12 EQUIPMENT PIPING CONNECTIONS

- .1 Where equipment connections are a different size from the piping serving it all associated isolating valves and fittings to be the larger pipe size unless specifically indicated otherwise on the drawings. This rule to also apply in the case of control valves.

3.13 SLEEVES

- .1 Provide individual metal sleeves for all pipes, tubes or ducts penetrating all walls and floor slabs. Grout tightly in place for full depth of wall or slab.
- .2 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
- .3 Standard sleeves to be 22 Ga. galvanized sheet steel with lock seam joints.
- .4 Use cast iron or steel pipe sleeve with annular fin continuously welded at midpoint:
 - .1 Through foundation walls.
 - .2 Where sleeve extends above finished floor.
- .5 Sizes:
 - .1 Refer to mechanical drawings for details.
 - .2 Provide 6 mm clearance all around, between sleeves and pipe or between sleeve and insulation.
- .6 Terminate sleeves flush with surface of concrete and masonry and above floors.
- .7 For pipes passing through roofs, use cast iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction; caulk between sleeve recess and pipe; fasten roof flashing to clamp device; make water-tight, durable joint.

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- .8 Voids Around Pipes:
 - .1 Where sleeves pass through walls or floors, caulk space between sleeve and insulation or between sleeve and pipe with dry oakum. Seal space at each end of sleeve with waterproof, fire retardant, non-hardening mastic.
 - .2 Ensure no contact between copper tube or pipe and ferrous sleeve.
 - .3 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint.
- .9 Where pipes and ducts pass through walls and floors having a fire separation rating, pack the space with approved caulking material and seal in accordance with CGSB19-GP-9.

3.14 ESCUTCHEONS AND PLATES

- .1 Install on pipes passing through finished walls, floors, and ceilings.
- .2 Use chrome or nickel plated brass, solid type with set screws for ceiling or wall mount.
- .3 Inside diameter to fit around finished pipe. Outside diameter to cover opening or sleeve.
- .4 Where sleeve extends above finished floor, escutcheons or plates to clear sleeve extension.
- .5 Secure to pipe or finished surface but not to insulation.

3.15 CUTTING AND PATCHING

- .1 Minimize cutting and patching required. Set sleeves and mark openings in concrete forms and masonry structure prior to the placement of concrete or masonry.

END SECTION

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1. GENERAL

1.1 INTENT

- .1 This section contains detailed piping specifications.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Contractor to provide detailed piping spool sheets before fabrication of piping. Spool sheets to include the following:
- .1 Outline and arrangement drawings
 - .2 Dimensional data
 - .3 Piping material
 - .4 List of fittings

1.3 PIPING IDENTIFICATION

- .1 The drawings designate the size and line service specification of pipe to be supplied by the Contractor in the following manner.

- .1 Line Identification is placed on each line in the following manner:

	PW	-	150	-	A1	-	D
Commodity	_____		_____		_____		_____
Line Size	_____		_____		_____		_____
Piping Line Code	_____		_____		_____		_____
Special Treatment	_____		_____		_____		_____

e.g. potable water, 150 mm line size, standard weight steel, internal epoxy coated

- .2 Legends and tables identifying the commodity, line code and special treatment symbols are included in this section of the specifications.

- .1 Commodity Symbols for Line Identification:

AA	Aqua Ammonia
ACI	Acid (pH Adjustment)
ACS	Powdered Activated Carbon Solution
AD	Air Distribution
AS	Air Supply
AL	Alum
ALS	Alum Solution
ALG	Algaecide Solution

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AMG	Ammonia Gas
AMS	Ammonia Solution
BWS	Backwash Supply
CA	Citric Acid
CAS	Citric Acid Solution
CDG	Carbon Dioxide Gas
CDS	Carbon Dioxide Solution
CIPS	Clean in Place Supply
CIPR	Clean in Place Return
CIPD	Clean in Place Drain
CLG	Chlorine Gas
CLS	Chlorine Solution
CO	Coagulant
COS	Coagulant Solution
CS	Caustic Soda
DCW	Domestic Cold Water
DHW	Domestic Hot Water
DHWR	Domestic Hot Water Recirculation
DE	DAF Effluent
DW	DAF Waste
DL	Diesel Fuel
DR	Drain
EW	Effluent Water
FL	Fluoride
FTW	Filter to Waste
FW	Filtered Water
G(H)	Natural Gas (High Pressure)
G(L)	Natural Gas (Low Pressure)
GLS	Glycol Supply
GLR	Glycol Return
HWS	Hot Water Supply
HWR	Hot Water Return
IA	Instrument Air
OF	Overflow
PLY	Polyelectrolyte (Liquid)
PLYS	Polyelectrolyte Solution
PO	Polymer
POS	Polymer Solution
PPS	Potassium Permanganate Solution
PSW	Plant Service Water
PW	Potable Water
RAS	Return Activated Sludge
RF	Refrigerant
RJW	Reject Water
RW	Raw Water
S	Sanitary Waste
SAM	Sample Line
SAS	Soda Ash Solution

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SB	Sodium Bisulphate
SEN	Sensing Line
SH	Sodium Hypochlorite
SLG	Sludge
SPSW	Softened Plant Service Water
SU	Supernatant
SV	Sanitary Vent
TEW	Tempered Effluent Waste
VE	Vent
WAS	Waste Activated Sludge
WT	Weeping Tile
XR	Excess Recirculation

.3 Line Codes:

The following is a description of the general line code classifications.

Line Code	Flange Rating	Schedule/ Thickness	Basic Material	Special Notes	Maximum Design Pressure
A1	ANSI 150	-	Carbon Steel	Standard Weight	Varies
A2	ANSI 150	-	Carbon Steel	Extra Strong	Varies
A3	ANSI 300	-	Carbon Steel	Extra Strong	Varies
B1	ANSI 150	Sch 80	PVC	-	Varies
B2	ANSI 150	Sch 40	PVC	-	Varies
B3	ANSI 150	SDR 18	PVC	-	1620 kPa
B4	ANSI 150	SDR 21	PVC	-	1380 kPa
B5	ANSI 150	SDR 26	PVC	-	1100 kPa
B6	ANSI 150	SDR 28	PVC	-	-
B7	ANSI 150	SDR 32.5	PVC	-	860 kPa
B8	ANSI 150	SDR 35	PVC	-	-
B9	ANSI 150	SDR 41	PVC	-	690 kPa
B10	ANSI 150	SDR 51	PVC	-	550 kPa
B11	ANSI 150	C900 & C 905	PVC	-	1050 kPa
B12	-	SCH 80	PVC (Well Riser Pipe)	Certa-Lock	-
C1	-	Type K	Copper	-	-
C2	-	Type L	Copper	-	-
C3	-	Type M	Copper	-	-
D1	ANSI 150	SCH 10S	Stainless Steel 304L	-	Varies
D2	ANSI 150	SCH 10S	Stainless Steel 316L	-	Varies
D3	ANSI 150	-	Stainless Steel 304L	Standard Weight	Varies
D4	ANSI 150	-	Stainless Steel 316L	Standard Weight	Varies
D5	ANSI 300	SCH 40S	Stainless Steel 304L	-	Varies
D6	ANSI 300	SCH 40S	Stainless Steel 316L	-	Varies
D7	ANSI 300	SCH 80S	Stainless Steel 316L	-	Varies
D8	ANSI 300	SCH 80S	Stainless Steel 316L	-	Varies
E1	-	-	PVC-DWV	-	Plumbing Code
E2	-	-	ABS-DWV	-	Plumbing Code
F1	-	-	Big "O" Drain	c/w filter sock	-

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G1	ANSI 150	-	Ductile Iron	-	-
G2	ANSI 150	-	Cast Iron	-	-
H1	-	DR 9	HDPE, C906	-	1380 kPa
H2	-	DR 11	HDPE, C906	-	1100 kPa
H3	-	DR 13.5	HDPE, C906	-	900 kPa
H4	-	DR 15.5	HDPE, C906	-	760 kPa
H5	-	DR 17	HDPE, C906	-	690 kPa
H6	-	DR 32	HDPE, C906	-	315 kPa
H7	-	DR 11	PE2406, Yellow	-	522 kPa
H11	-	-	PEX A, Water Service	-	690 kPa
J1	-	-	Asbestos Cement Pipe	-	-
J2	-	Class V	Reinforced Concrete Pipe	-	-
K1	-	-	PE OD Tubing	-	-
K2	-	-	PE ID Tubing	-	-
K3	-	-	LLDPE OD Tubing	-	-
K4	-	-	PP OD Tubing	-	-

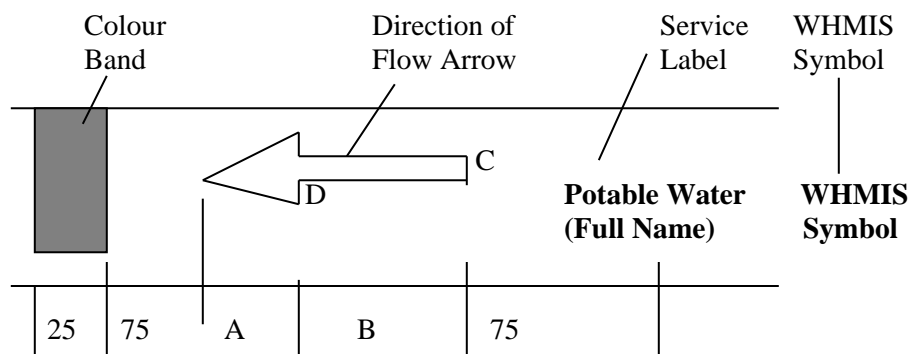
.4 Special Treatment Code:

Symbol Description

- (A) Cement mortar lining
- (B) Internal hot applied coal tar lining
- (C) External hot applied coal tar lining
- (D) Internal epoxy coated
- (E) External epoxy coated
- (F) External yellow jacketed
- (G) External double wrap polyken tape
- (H) Externally insulated
- (J) External shop prime
- (K) Densyl mastic wrap - buried flanges, couplers, and valves
- (L) Galvanized
- (M) Rock shield
- (N) Frost shield
- (P) Installed in RPVC conduit
- (R) Tracer wire installed above pipe

.5 Pipe Identification Symbols:

- .1 The marking of the piping is to correspond to the following sketch:



- .2 Sizing Requirements - The sizing and spacing of the various components in relation to the outside diameter of the pipe on which they are to be painted is to be as follows:

OUTSIDE DIA OF PIPE
(OVER INSULATION)

	A	B	C	D
12min - 25 mm	12mm	50mm	6mm	3mm
32 mm - 50 mm	25mm	75mm	2mm	6mm
64 mm. and up	38mm	87mm.	25 mm	12mm

.3 Application

- .1 All pipeline identification symbols are to be adhesive labels.
- .2 Surface of pipe or insulation, on which symbols are to be applied, must be clean and dry.

.4 Symbol Colours

- .1 Colour **Band - width of colour band is to be 25 mm** on all diameters of pipe. Colour is to correspond to Section 09907 - Painting of Process Pipe and Equipment.
- .2 Direction of Flow Arrow - arrow is to indicate direction of flow of media in pipe. If direction is either way, a double headed arrow is to be used as shown in "Sizing Requirements". Colour arrow is to be black when pipe is a light colour. Colour of arrow is to be white when pipe is a dark colour.
- .3 Service Label – Labels are to designate what is in pipe.

- .5 Location of Symbols- No hard and fast rules for the location of piping identification symbols are laid down, however some general requirements and guidelines are noted below.

- .6 The purpose is to present the information to the maintenance person at the point in the building where it is likely to be needed.
- .7 The maintenance person must not have to climb around objects, over pipes, etc., to read a pipe symbol. They shall be presented in such a manner that they are clearly visible when standing in a normal manner in the room or space. If the normal access to a space is above the pipes, then they should be identified on their tops so that they can be seen when looking down. The line of sight of the maintenance person shall always be kept in mind.
- .8 Places for pipe identification are as follows:
 - .1 On lateral runs where they leave risers at various floor levels.
 - .2 On risers in pipe spaces near locations where entry to personnel is provided.
 - .3 Near valves or branches where a number of pipes are racked together on a pipe rack.
 - .4 Near pipe connection points to major pieces of equipment. Keep symbols far enough away so they would not get damaged by maintenance activity around equipment.
 - .5 Near major shut-off valves at entry point of utility to building.
 - .6 Near pipe exit point from building.
- .9 Long runs of pipe in building shall be identified approximately every 15 m (50').
- .10 A pipe passing through a wall should be identified on both sides of wall.
- .11 Before undertaking the work, the Contractor is to complete a sample for viewing by the Consultant and Owner in order to obtain approval to proceed. The stencils prepared and the proposed paint are to be checked at that time by these parties.

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SERVICE: Refer to Contract Drawings		LINE CODE: A1
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	650 mm to 900 mm	Steel, ASTM A139 Grade B, or AWWA C200.91 seamless or welded, 9.5 mm wall.
	600 mm or smaller	Steel, ASTM A53 Grade B, seamless or welded, standard wall (STD).
Fittings	75 mm to 900 mm	Steel, ASTM A234 Grade WPB, butt weld, standard wall (STD).
	65 mm or smaller	Steel, ASTM A197 Class 300, malleable iron, screwed.
NOTE: Elbows to be long radius unless otherwise specified.		
Flanges	650 mm to 900 mm	Steel, AWWA C207 Class D, slip-on, flat faced with serrated finish.
	75 mm to 600 mm	Standard is steel to ANSI 16.5 Class 150, or AWWA C207 Class D, slip-on or weld-neck, raised face. Orifice Flanges to be Class 300 Carbon Steel to ASTM A105, slip-on, raised face. Flanges mated to equipment with cast iron flat faced flanges or rubber seated butterfly valves to be flat faced. Flanges for use on grooved pipe to be Victaulic Style 741.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class E flange.		
Bolts	All sizes	ASTM A193 Grade B7 hex head. To be plated for corrosion resistance.
Nuts	All sizes	ASTM A194 Grade 2H, hex head semi-finished. To be plated for corrosion resistance.
Submerged Bolts & Nuts	All sizes	Stainless Steel 316L.
Flange Gaskets	40 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.

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SERVICE: Refer to Contract Drawings		LINE CODE: A1
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Flange Gaskets (cont'd)	300 mm to 450 mm	Red Rubber, ring type for RF flanges, full face for FF flange, 3 mm thick.
	500 mm & larger	Red Rubber, ring type for RF flanges, full face for FF flange, 6 mm thick.
	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 300, malleable iron, ground joint, bronze to iron seat.
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts). .1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated. .2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring.
Victaulic Gasket	All Sizes	Ductile Iron Pipe: Grade "M" Halogenated Butyl or Grade "S" Nitrile seal ring to AWWA Standards.
	50 mm to 300 mm	Steel Pipe: Grade "E" EPDM suitable up to 110 deg C or Grade "EHP" EPDM suitable up to 121 deg C or Grade "T" Nitrile.

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SERVICE: Refer to Contract Drawings		LINE CODE: A1
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Victaulic Gasket (con't)	350 mm to 600 mm	Steel Pipe: Grade "E" EPDM FlushSeal gasket suitable up to 110 deg C or "T" Nitrile FlushSeal gasket.
Thread Compound	As required	Teflon tape CAN/ULC-S642.
Gate Valves	75 mm to 450 mm	Class 125, OS&Y, rising stem, FF flange, IBBM, Crane No. 465 ½; Red-White/Toyo No. 421A. Class 250, OS&Y, rising stem, FF flange, IBBM, Crane 7½E; Kitz 300CLS (Class 300).
	65 mm & smaller	Class 300 WOG, Bronze, rising stem, wedge disk, Crane No. 431; Red-White/Toyo No. 298.
	75 mm to 200 mm	Class 125, OS&Y, rising stem, FF flange, IBBM, Crane No. 251; Red-White/Toyo No. 400A. Class 250, OS&Y, rising stem, FF flange, IBBM, Crane No. 21E; Kitz 300 SCO (Class 300).
Globe Valves	65 mm & smaller	Class 300 WOG, Bronze, rising stem, screwed, Crane No. 7; Red-White/Toyo No. 221.
	75 mm to 750 mm	See Section 15015: Mechanical General Requirements
	50 mm & smaller	Class 200, Y pattern swing check bronze, screwed, Crane No. 36; Red-White/Toyo No. 360.
Check Valves	50 mm to 75 mm	Resilient or rubber seated, wafer lug style, bronze disk, with lever operator. Dezurik, Bray, Dresser, Mueller, American Darling, Watts.
	75 mm to 1050 mm	See Section 15015: Mechanical General Requirements
Butterfly Valves	75 mm to 350 mm	Class 150, full bore, cast steel body, TFE seat and seal, SS ball and stem, RF flange, W-K-M Dynaseal 310; Kitz No. 150SCTA.
	65 & smaller	Class 1000, cast steel body, TFE seat and seal, SS ball and stem, screwed, W-K-M Dyanseal 310; M.A.S. No. CSSDR-1 unless otherwise noted
Ball Valves		

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SERVICE: Refer to Contract Drawings		LINE CODE: A1
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Ball Valves (con't)	25 mm	Kitz Class 600, Fig. AKUTKM 316, screwed.
Plug Valves	75 mm to 600 mm	Class 150, semi-steel body, resilient plug, Buna-N seal, nickel seat, FF flange. Dezurik Fig. 118F-6-RS17; Homestead Ballcentric 1532-EWG.
	65 mm & smaller	Class 300 WOG, bronze body, resilient plug, Buna filled, TFE U-ring seal, screwed. Dezurik Fig. 1205-1-RS16; Homestead Ballcentric Fig. 6112.
Strainers	65 mm & larger	Iron body, Y pattern, flanged, 20 mesh model screen, Crane No. 989 ½; Red-White/Toyo No. 381A, SS screen unless otherwise noted.
<p>NOTE:</p> <p>.1 If class 125 iron body, bronze mounted, FF flanged gate valve is used the design pressure to be limited to 1035 kPa for valves 400 mm size and larger, and 1380 kPa for gate valves 300 mm and smaller.</p> <p>.2 If Class 125 iron body, bronze mounted, FF flanged globe valve is used the design pressure to be limited to 1380 kPa.</p>		

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SERVICE: Refer to Contract Drawings		LINE CODE: A2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	900 mm or smaller	Steel, ASTM A53 Grade B, seamless or welded, extra strong (XS).
Fittings	75 mm to 900 mm	Steel, ASTM A234 Grade WPB, butt weld, extra strong (XS).
	65 mm or smaller	Steel, ASTM A197 Class 300, malleable iron, screwed.
<p><u>NOTE:</u> Elbows to be long radius unless otherwise specified.</p>		
Flanges	650 mm to 900 mm	Steel, AWWA C207 Class D, slip-on, flat faced with serrated finish.
	75 mm to 600 mm	<p>Standard is steel to ANSI 16.5 Class 150, or AWWA C207 Class D, slip-on or weld-neck, raised face.</p> <p>Orifice Flanges to be Class 300 Carbon Steel to ASTM A105, slip-on, raised face.</p> <p>Flanges mated to equipment with cast iron flat faced flanges or rubber seated butterfly valves to be flat faced.</p> <p>Flanges for use on grooved pipe to be Victaulic Style 741.</p>
<p><u>NOTE:</u> Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class E flange.</p>		

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SERVICE: Refer to Contract Drawings		LINE CODE: A2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	ASTM A193 Grade B7 hex head. To be plated for corrosion resistance.
Nuts	All sizes	ASTM A194 Grade 2H, hex head semi-finished. To be plated for corrosion resistance.
Submerged Bolts & Nuts	All sizes	Stainless Steel 316L.
Flange Gaskets	40 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges, full face for FF flange, 3 mm thick.
	500 mm & larger	Red Rubber, ring type for RF flanges, full face for FF flange, 6 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings.
		Bolt sleeves to be spirally wound mylar materials.
		Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers.
		Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 300, malleable iron, ground joint, bronze to iron seat.
Pipe Couplings	65 mm & smaller	Use unions.

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SERVICE: Refer to Contract Drawings		LINE CODE: A2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings (cont'd)	75 mm & larger	The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts). .1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated. .2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring.
Victaulic Gasket	All Sizes 50 mm to 300 mm 350 mm to 600 mm	Ductile Iron Pipe: Grade "M" Halogenated Butyl or Grade "S" Nitrile seal ring to AWWA Standards. Steel Pipe: Grade "E" EPDM suitable up to 110 deg C or Grade "EHP" EPDM suitable up to 121 deg C or Grade "T" Nitrile. Steel Pipe: Grade "E" EPDM FlushSeal gasket suitable up to 110 deg C or "T" Nitrile FlushSeal gasket.
Thread Compound	As required	Teflon tape CAN/ULC-S642.
Gate Valves	75 mm to 450 mm	Class 125, OS&Y, rising stem, FF flange, IBBM, Crane No. 465 ½; Red-White/Toyo No. 421A. Class 250, OS&Y, rising stem, FF flange, IBBM, Crane 7½E; Kitz 300CLS (Class 300).
	65 mm & smaller	Class 300 WOG, Bronze, rising stem, wedge disk, Crane No. 431; Red-White/Toyo No. 298.
Globe Valves	75 mm to 200 mm	Class 125, OS&Y, rising stem, FF flange, IBBM, Crane No. 251; Red-White/Toyo No. 400A. Class 250, OS&Y, rising stem, FF flange, IBBM, Crane No. 21E; Kitz 300 SCO (Class 300).
	65 mm & smaller	Class 300 WOG, Bronze, rising stem, screwed, Crane No. 7; Red-White/Toyo No. 221.

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SERVICE: Refer to Contract Drawings		LINE CODE: A2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Check Valves	75 mm to 750 mm	See Section 15015: Mechanical General Requirements
	50 mm & smaller	Class 200, Y pattern swing check bronze, screwed, Crane No. 36; Red-White/Toyo No. 360.
Butterfly Valves	50 mm to 75 mm	Resilient or rubber seated, wafer lug style, bronze disk, with lever operator. Dezurik, Bray, Dresser, Mueller, American Darling, Watts.
Butterfly Valves	75 mm to 1050 mm	See Section 15015: Mechanical General Requirements
Ball Valves	75 mm to 350 mm	Class 150, full bore, cast steel body, TFE seat and seal, SS ball and stem, RF flange, W-K-M Dynaseal 310; Kitz No. 150SCTA.
Ball Valves	65 & smaller	Class 1000, cast steel body, TFE seat and seal, SS ball and stem, screwed, W-K-M Dyanseal 310; M.A.S. No. CSSDR-1 unless otherwise noted
	25 mm	Kitz Class 600, Fig. AKUTKM 316, screwed.
Plug Valves	75 mm to 600 mm	Class 150, semi-steel body, resilient plug, Buna-N seal, nickel seat, FF flange. Dezurik Fig. 118F-6-RS17; Homestead Ballcentric 1532-EWG.
	65 mm & smaller	Class 300 WOG, bronze body, resilient plug, Buna filled, TFE U-ring seal, screwed. Dezurik Fig. 1205-1-RS16; Homestead Ballcentric Fig. 6112.
Strainers	65 mm & larger	Iron body, Y pattern, flanged, 20 mesh model screen, Crane No. 989 ½; Red-White/Toyo No. 381A, SS screen unless otherwise noted.

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SERVICE: Refer to Contract Drawings		LINE CODE: A2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Strainers	50 mm & smaller	Iron body, Y pattern, screwed, 20 mesh model screen, Crane No. 988 ½; Red-White/Toyo No. 380, SS screen, c/w BAV on Drain.
<p><u>NOTE:</u> .1 If class 125 iron body, bronze mounted, FF flanged gate valve is used the design pressure to be limited to 1035 kPa for valves 400 mm size and larger, and 1380 kPa for gate valves 300 mm and smaller.</p> <p>.2 If Class 125 iron body, bronze mounted, FF flanged globe valve is used the design pressure to be limited to 1380 kPa.</p>		

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SERVICE: Refer to Contract Drawings		LINE CODE: A3
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	900 mm or smaller	Steel, ASTM A53 Grade B, seamless or welded, extra strong (XS).
	650 mm to 900 mm	Steel, ASTM A234 Grade WPB, butt weld, extra strong (XS).
	75 mm to 600 mm	Steel, ASTM A234 Grade WPB, butt weld extra strong (XS).
Fittings	65 mm or smaller	Steel, ASTM A197 Class 300, malleable iron, screwed.
<p><u>NOTE:</u> Elbows to be long radius unless otherwise specified.</p>		
Flanges	650 mm to 900 mm	Steel, AWWA C207 Class D, slip-on, flat faced with serrated finish.
	75 mm to 600 mm	Standard is steel to ANSI 16.5 Class 300, or AWWA C207 Class D, slip-on or weld-neck, raised face.
		Orifice Flanges to be Class 300 Carbon Steel to ASTM A105, slip-on, raised face.
		Flanges mated to equipment with cast iron flat faced flanges or rubber seated butterfly valves to be flat faced.
		Flanges for use on grooved pipe to be Victaulic Style 741.
<p><u>NOTE:</u> Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class E flange.</p>		

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SERVICE: Refer to Contract Drawings		LINE CODE: A3
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	ASTM A193 Grade B7 hex head. To be plated for corrosion resistance.
Nuts	All sizes	ASTM A194 Grade 2H, hex head semi-finished. To be plated for corrosion resistance.
Submerged Bolts & Nuts	All sizes	Stainless Steel 316L.
Flange Gaskets	40 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges, full face for FF flange, 3 mm thick.
	500 mm & larger	Red Rubber, ring type for RF flanges, full face for FF flange, 6 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings.
		Bolt sleeves to be spirally wound mylar materials.
		Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers.
		Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 300, malleable iron, ground joint, bronze to iron seat.
Pipe Couplings	65 mm & smaller	Use unions.

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SERVICE: Refer to Contract Drawings		LINE CODE: A3
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings (cont'd)	75 mm & larger	The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts).
Victaulic Gasket	All Sizes	Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. 2065 kPa maximum working pressure
	50 mm to 300 mm	Ductile Iron Pipe: Grade "M" Halogenated Butyl or Grade "S" Nitrile seal ring to AWWA Standards.
	350 mm to 600 mm	Steel Pipe: Grade "E" EPDM suitable up to 110 deg C or Grade "EHP" EPDM suitable up to 121 deg C or Grade "T" Nitrile.
Thread Compound	As required	Steel Pipe: Grade "E" EPDM FlushSeal gasket suitable up to 110 deg C or "T" Nitrile FlushSeal gasket.
Gate Valves	75 mm to 450 mm	Teflon tape CAN/ULC-S642.
		Class 125, OS&Y, rising stem, FF flange, IBBM, Crane No. 465 ½; Red-White/Toyo No. 421A.
Globe Valves	65 mm & smaller	Class 250, OS&Y, rising stem, FF flange, IBBM, Crane 7½E; Kitz 300CLS (Class 300).
	75 mm to 200 mm	Class 300 WOG, Bronze, rising stem, wedge disk, Crane No. 431; Red-White/Toyo No. 298.
	65 mm & smaller	Class 125, OS&Y, rising stem, FF flange, IBBM, Crane No. 251; Red-White/Toyo No. 400A.
		Class 250, OS&Y, rising stem, FF flange, IBBM, Crane No. 21E; Kitz 300 SCO (Class 300).
		Class 300 WOG, Bronze, rising stem, screwed, Crane No. 7; Red-White/Toyo No. 221.

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SERVICE: Refer to Contract Drawings		LINE CODE: A3
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Check Valves	75 mm to 750 mm	See Section 15015: Mechanical General Requirements
	50 mm & smaller	Class 200, Y pattern swing check bronze, screwed, Crane No. 36; Red-White/Toyo No. 360.
Butterfly Valves	50 mm to 75 mm	Resilient or rubber seated, wafer lug style, bronze disk, with lever operator. Dezurik, Bray, Dresser, Mueller, American Darling, Watts.
Butterfly Valves	75 mm to 1050 mm	See Section 15015: Mechanical General Requirements
Ball Valves	75 mm to 350 mm	Class 150, full bore, cast steel body, TFE seat and seal, SS ball and stem, RF flange, W-K-M Dynaseal 310; Kitz No. 150SCTA.
Ball Valves	65 & smaller	Class 1000, cast steel body, TFE seat and seal, SS ball and stem, screwed, W-K-M Dyanseal 310; M.A.S. No. CSSDR-1 unless otherwise noted
	25 mm	Kitz Class 600, Fig. AKUTKM 316, screwed.
Plug Valves	75 mm to 600 mm	Class 150, semi-steel body, resilient plug, Buna-N seal, nickel seat, FF flange. Dezurik Fig. 118F-6-RS17; Homestead Ballcentric 1532-EWG.
	65 mm & smaller	Class 300 WOG, bronze body, resilient plug, Buna filled, TFE U-ring seal, screwed. Dezurik Fig. 1205-1-RS16; Homestead Ballcentric Fig. 6112.
Strainers	65 mm & larger	Iron body, Y pattern, flanged, 20 mesh model screen, Crane No. 989 ½; Red-White/Toyo No. 381A, SS screen unless otherwise noted.

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SERVICE: Refer to Contract Drawings		LINE CODE: A3
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Strainers	50 mm & smaller	Iron body, Y pattern, screwed, 20 mesh model screen, Crane No. 988 ½; Red-White/Toyo No. 380, SS screen, c/w BAV on Drain.
<p><u>NOTE:</u> .1 If class 125 iron body, bronze mounted, FF flanged gate valve is used the design pressure to be limited to 1035 kPa for valves 400 mm size and larger, and 1380 kPa for gate valves 300 mm and smaller.</p> <p>.2 If Class 125 iron body, bronze mounted, FF flanged globe valve is used the design pressure to be limited to 1380 kPa.</p>		

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SERVICE: Refer to Contract Drawings		LINE CODE: B1
PRIMARY FLANGE RATING: CLASS 150		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	300 mm & smaller	PVC, rigid, to ASTM D 1785 and CSA B137.3, or NSF14. Sch. 80.
Fittings	300 mm & smaller	PVC, socket weld, to ASTM D 2467. Sch. 80.
Flanges	All sizes	Class 150, PVC socket weld.
Bolts (dry)	All sizes	To ASTM A193 Grade B7. To be plated for corrosion resistance.
Nuts (dry)	All sizes	Semi-finished, hex head, to ASTM A194 Grade 2H. To be plated for corrosion resistance.
Ball Valves	All sizes	PVC body and ball TFE seat, socket ends, true-union safe-block design, PTFE seats, viton O-ring seals, Chemline or as approved.
Check Valves	50 mm & larger	See Section 15015: Mechanical General Requirements
Check Valves for chemical feed lines	38 mm & smaller	True Union Ball or Swing Check, Chemline or as approved
Butterfly Valves	75 mm to 1050 mm	See Section 15015: Mechanical General Requirements
Air Release Valves	12 mm to 50 mm	See Section 15015: Mechanical General Requirements
Needle valves	All sizes	316 Stainless steel, Century valves or approved equal
Unions	75 mm & larger	Use flanges
	65 mm & smaller	Use Class 150 PVC
Strainers	50 mm & smaller	Iron body, Y pattern, screwed, 20 mesh model screen, Crane No. 988 1/2; Red-White/Toyo No. 380, SS screen, c/w BAV on Drain.

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SERVICE: Refer to Contract Drawings		LINE CODE: B1
PRIMARY FLANGE RATING: CLASS 150		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller 75 mm & larger	Use unions. The coupling type to be as shown on the drawings and to suit outside diameter of pipe .1 Victaulic Style 77 standard weight. .2 Use Victaulic adapters, length to suit pipe diameter.
Victaulic Gasket	All Sizes	Grade "M" seal ring to AWWA Standards.
Diaphragm Valves	40 mm & smaller	Class 150 PVC Type 1, Grade 1, Body with Neoprene or teflon diaphragm, true union, screwed, socket, Chemline, ITT Grinnel, Chemtrol.
Diaphragm Valves	50 mm to 150 mm	Class 150 PVC Type 1, Grade 1 with neoprene or teflon diaphragm, flanged, Chemline, ITT Grinnel, Chemtrol.

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SERVICE: Refer to Contract Drawings		LINE CODE: B2
PRIMARY FLANGE RATING: CLASS 150		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	300 mm & smaller	PVC, rigid, to ASTM D 1785 and CSA B137.3, or NSF14. Sch. 40.
Fittings	300 mm & smaller	PVC, socket weld, to ASTM D 2467. Sch. 80.
Flanges	All sizes	Class 150, PVC socket weld.
Bolts (dry)	All sizes	To ASTM A193 Grade B7. To be plated for corrosion resistance.
Nuts (dry)	All sizes	Semi-finished, hex head, to ASTM A194 Grade 2H. To be plated for corrosion resistance.
Ball Valves	All sizes	PVC body and ball TFE seat, socket ends, true-union safe-block design, PTFE seats, viton O-ring seals, Chemline or as approved.
Check Valves	50 mm & larger	See Section 15015: Mechanical General Requirements
Check Valves for chemical feed lines	38 mm & smaller	True Union Ball or Swing Check, Chemline or as approved
Butterfly Valves	75 mm to 1050 mm	See Section 15015: Mechanical General Requirements
Air Release Valves	12 mm to 50 mm	See Section 15015: Mechanical General Requirements
Needle valves	All sizes	316 Stainless steel, Century valves or approved equal
Unions	75 mm & larger	Use flanges
	65 mm & smaller	Use Class 150 PVC
Strainers	50 mm & smaller	Iron body, Y pattern, screwed, 20 mesh model screen, Crane No. 988 1/2; Red-White/Toyo No. 380, SS screen, c/w BAV on Drain.

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SERVICE: Refer to Contract Drawings		LINE CODE: B2
PRIMARY FLANGE RATING: CLASS 150		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller 75 mm & larger	Use unions. The coupling type to be as shown on the drawings and to suit outside diameter of pipe .1 Victaulic Style 77 standard weight. .2 Use Victaulic adapters, length to suit pipe diameter.
Victaulic Gasket	All Sizes	Grade "M" seal ring to AWWA Standards.
Diaphragm Valves	40 mm & smaller	Class 150 PVC Type 1, Grade 1, Body with Neoprene or teflon diaphragm, true union, screwed, socket, Chemline, ITT Grinnel, Chemtrol.
Diaphragm Valves	50 mm to 150 mm	Class 150 PVC Type 1, Grade 1 with neoprene or teflon diaphragm, flanged, Chemline, ITT Grinnel, Chemtrol.

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SERVICE: Refer to Contract Drawings		LINE CODE: C1
PRIMARY FLANGE RATING:		DESIGN PRESSURE: 2800 kPa
TEMPERATURE (MAX): 100°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Copper, Type K, to ASTM B88.
Fittings	50 mm & smaller	Wrought copper or cast brass to ASTM B75.
Joints	All sizes	For hard drawn – solder, ASTM B32, 95-5 wire solder, Gr. 95 TA. (Solder and flux to be less than 0.2% lead). For soft drawn – use flare or compression type couplings.
Gate Valves	50 mm & smaller	Class 200 WOG, bronze body, non-rising stem, solder joint, Crane Fig. 1701; Red-White/Toyo Fig. 281A; Jenkins Fig. 993AJ; Kitz No. 41.
Ball Valves	50 mm & smaller	Bronze 2-piece body, chrome-plated brass ball, PTFE seats, solder joint, 4100 kPa CWP, handle operator, Crane 9300 series.
Globe Valves	50 mm & smaller	Class 200 WOG, bronze body, non-rising stem, replaceable composition disc to 95°C, solder joint, Crane Fig. 1310; Red-White/Toyo Fig 221 (requires adaptors); Jenkins Fig. 106BPJ; Kitz No. 10.
Strainer	50 mm & smaller	Class 150, bronze body, screwed ends, 80 mesh stainless steel screen, Hayward Y-strainer model 80 or as approved.

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SERVICE: Refer to Contract Drawings		LINE CODE: C2
PRIMARY FLANGE RATING:		DESIGN PRESSURE:
TEMPERATURE (MAX): 100°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	100 mm & smaller	Copper, Type L, to ASTM B88.
Fittings	100 mm & smaller	Wrought copper or cast brass to ASTM B75.
Joints	All sizes	For hard drawn – solder, ASTM B32, 95-5 wire solder, Gr. 95 TA. (Solder and flux to be less than 0.2% lead). For soft drawn – use flare or compression type couplings.
Gate Valves	100 mm & smaller	Class 200 WOG, bronze body, non-rising stem, solder joint, Crane Fig. 1701; Red-White/Toyo Fig. 281A; Jenkins Fig. 993AJ; Kitz No. 41.
Ball Valves	100 mm & smaller	Bronze 2-piece body, chrome-plated brass ball, PTFE seats, solder joint, 4100 kPa CWP, handle operator, Crane 9300 series.
Globe Valves	100 mm & smaller	Class 200 WOG, bronze body, non-rising stem, replaceable composition disc to 95°C, solder joint, Crane Fig. 1310; Red-White/Toyo Fig 221 (requires adaptors); Jenkins Fig. 106BPJ; Kitz No. 10.
Strainer	100 mm & smaller	Class 150, bronze body, screwed ends, 80 mesh stainless steel screen, Hayward Y-strainer model 80 or as approved.

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SERVICE: Refer to Contract Drawings		LINE CODE: D1
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 304L, seamless or straight seam welded, annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A778 Type 304L, seamless or straight seam welded, Schedule 10S, annealed, pickled and passivated per ASTM A380
Fittings	50 mm & smaller	Stainless Steel, ASTM A403 Type 304L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L
	65 mm & larger	Stainless Steel, ASTM A774 Type 304L, welded, Schedule 10S
NOTE: 1. All structural penetrations shall consist of a type 304 stainless steel Schedule 10S thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 304L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774/A774M, Type 304L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 304L, Class 150, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D1
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 304L.
Nuts	All sizes	Stainless Steel 304L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 304L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 150, stainless steel Type 304L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D1
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: D2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 316L, seamless or straight seam welded, annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A778 Type 316L, seamless or straight seam welded, Schedule 10S, annealed, pickled and passivated per ASTM A380
Fittings	50 mm & smaller	Stainless Steel, ASTM A403 Type 316L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L
	65 mm & larger	Stainless Steel, ASTM A774 Type 316L, welded, Schedule 10S
NOTE: 1. All structural penetrations shall consist of a type 316L stainless steel Schedule 10S thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 316L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774 Type 316L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 316L, Class 150, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 316L.
Nuts	All sizes	Stainless Steel 316L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 316L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 150, stainless steel Type 316L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D2
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: D3
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 304L, seamless or straight seam welded, standard weight (STD), annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A778 Type 304L, seamless or straight seam welded, standard weight (STD), annealed, pickled and passivated per ASTM A380
Fittings	50 mm & smaller	Stainless Steel, ASTM A403 Type 304L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L, standard weight (STD)
	65 mm & larger	Stainless Steel, ASTM A774 Type 304L, welded, standard weight (STD)
NOTE: 1. All structural penetrations shall consist of a type 304 stainless steel Schedule 40 thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 304L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774 Type 304L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 304L, Class 150, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D3
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 304L.
Nuts	All sizes	Stainless Steel 304L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 304L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 150, stainless steel Type 304L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D3
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 304 bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: D4
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 316L, seamless or straight seam welded, standard weight (STD), annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A778 Type 316L, seamless or straight seam welded, standard weight (STD), annealed, pickled and passivated per ASTM A380
Fittings	50 mm & smaller	Stainless Steel, ASTM A403 Type 316L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L, standard weight (STD)
	65 mm & larger	Stainless Steel, ASTM A774 Type 316L, welded, standard weight (STD)
NOTE: 1. All structural penetrations shall consist of a type 316L stainless steel Schedule 10S thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 316L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774 Type 316L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 316L, Class 150, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D4
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 316L.
Nuts	All sizes	Stainless Steel 316L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 316L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 150, stainless steel Type 316L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D4
PRIMARY FLANGE RATING: CLASS 150 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: D5
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°c		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 304L, seamless or straight seam welded, Schedule 40S, annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A778 Type 304L, seamless or straight seam welded, Schedule 40S, annealed, pickled and passivated per ASTM A380
Fittings	50 mm & smaller	Stainless Steel, ASTM A403 Type 304L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L, Schedule 40S
	65 mm & larger	Stainless Steel, ASTM A774 Type 304L, welded, Schedule 40S
NOTE: 1. All structural penetrations shall consist of a type 304 stainless steel Schedule 40 thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 304L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774 Type 304L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 304L, Class 300, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D5
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 304L.
Nuts	All sizes	Stainless Steel 304L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 304L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 300, stainless steel Type 304L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D5
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 304 bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: D6
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 316L, seamless or straight seam welded, Schedule 40S, annealed, pickled and passivated per ASTM A380
	65 mm & larger	
Fittings	50 mm & smaller	Stainless Steel, ASTM A778 Type 316L, seamless or straight seam welded, Schedule 40S, annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A403 Type 316L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L, Schedule 40S
		Stainless Steel, ASTM A774 Type 316L, welded, Schedule 40S
NOTE: 1. All structural penetrations shall consist of a type 316L stainless steel Schedule 10S thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 316L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774 Type 316L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 316L, Class 300, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D6
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 316L.
Nuts	All sizes	Stainless Steel 316L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 316L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 300, stainless steel Type 316L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D6
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: D7
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 304L, seamless or straight seam welded, Schedule 80S, annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A778 Type 304L, seamless or straight seam welded, Schedule 80S, annealed, pickled and passivated per ASTM A380
Fittings	50 mm & smaller	Stainless Steel, ASTM A403 Type 304L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L, Schedule 80S
	65 mm & larger	Stainless Steel, ASTM A774 Type 304L, welded, Schedule 80S
NOTE: 1. All structural penetrations shall consist of a type 304 stainless steel Schedule 40 thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 304L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774 Type 304L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 304L, Class 300, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D7
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 304L.
Nuts	All sizes	Stainless Steel 304L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 304L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 300, stainless steel Type 304L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D7
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 304 bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: D8
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	50 mm & smaller	Stainless Steel, ASTM A312/A312M Type 316L, seamless or straight seam welded, Schedule 80S, annealed, pickled and passivated per ASTM A380
	65 mm & larger	Stainless Steel, ASTM A778 Type 316L, seamless or straight seam welded, Schedule 80S, annealed, pickled and passivated per ASTM A380
Fittings	50 mm & smaller	Stainless Steel, ASTM A403 Type 316L, Threaded, forged, 1,000 CWP, ASTM A182/A182M, Grade F316L, Schedule 80S
	65 mm & larger	Stainless Steel, ASTM A774 Type 316L, welded, Schedule 80S
NOTE: 1. All structural penetrations shall consist of a type 316L stainless steel Schedule 10S thimble 2. Elbows to be long radius unless otherwise specified.		
Angle Collars	100 mm & smaller	Stainless Steel, ASTM A403 Type 316L, slip-on or butt weld
	150 mm & larger	Stainless Steel, ASTM A774 Type 316L, slip-on or butt weld
Van Stone Flanges, Rolled Angle, FF or RF	All Sizes	Stainless steel Type 316L, Class 300, ASTM A182 / ASME SA-182
Flange Adapters	50 mm to 300 mm 50 mm to 150 mm	Flanges for use on grooved pipe to be Victaulic Style 741 Style 441 stainless steel flange adapter.
NOTE: Flanges attached to fittings to be weld neck type equal in material, dimensions and rating to the Class D flange.		

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SERVICE: Refer to Contract Drawings		LINE CODE: D8
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.9		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Bolts	All sizes	Stainless Steel 316L.
Nuts	All sizes	Stainless Steel 316L.
Submerged Bolts & Nuts	All sizes	Stainless Steel 316L.
Flange Gaskets	75 mm to 250 mm	Red Rubber, ring type for RF flanges, full face for FF flanges, 2 mm thick.
	300 mm to 450 mm	Red Rubber, ring type for RF flanges, full face for FF flange, 3 mm thick.
Cathodically isolating flange kit	All sizes	Gaskets to be type "E", full faced, G-10 or G-11, 3 mm thick, epoxy glass, c/w homogeneous (jointless) nitrile O-rings. Bolt sleeves to be spirally wound mylar materials. Double washers to be G-10 or G-11 epoxy glass backed up with zinc plated steel washers. Pikotek "PGE" WS; PSI, Gasket Seal.
Unions	75 mm & larger	Use Flanges.
	65 mm & smaller	Class 300, stainless steel Type 316L, Teflon O-Ring

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SERVICE: Refer to Contract Drawings		LINE CODE: D8
PRIMARY FLANGE RATING: CLASS 300 ANSI B16.5		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE: 1.3 mm
ITEM	SIZES	GENERAL DESCRIPTION
Pipe Couplings	65 mm & smaller	Use unions.
	75 mm & larger	<p>The coupling type c/w harness (to AWWA M11) to be as shown on the drawings and to suit outside diameter of pipe (for submerged or buried service use Stainless Steel 316L bolts & nuts).</p> <p>.1 Flexible couplings to be Dresser Style 38, Robar. Couplings to be epoxy coated.</p> <p>.2 Victaulic Style 77 standard weight; Victaulic Style 44 w/ Type "D" Vic-ring. For submerged or buried service coupling to be Stainless Steel Victaulic Style 77S.</p> <p>.3 Use Victaulic adapters, length to suit pipe diameter.</p>
Victaulic Gasket	All Sizes	Grade "E" EPDM suitable up to 230 deg F or Grade "T" Nitrle.
Thread Compound	As required	Teflon tape.
Plug Valves	All Sizes	Cast iron body and cover, ASTM A126 Class B; Cast iron plug, ASTM A126 Class B, c/w resilient facing, ASTM D2000-BG. Val-Matic or Dezurik.
Ball Valves	50 mm to 32 mm	Crane model 9502.

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SERVICE: Refer to Contract Drawings		LINE CODE: E1
PRIMARY FLANGE RATING: CSA B181.2		DESIGN PRESSURE: Plumbing Code
TEMPERATURE (MAX): 60°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	40 mm to 200 mm	PVC – DWV to CSA B181.2
Fittings	40 mm to 200 mm	PVC – DWV, Type 1, socket ends.
Joints	All sizes	Solvent cement to conform to CSA B181.2

SERVICE: DR, SW, SV		LINE CODE: E2
PRIMARY FLANGE RATING: CSA B181.2		DESIGN PRESSURE: Plumbing Code
TEMPERATURE (MAX): 60°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Pipe	40 mm to 200 mm	PVC – DWV to CSA B181.2
Fittings	40 mm to 200 mm	PVC – DWV, Type 1, socket ends.
Joints	All sizes	Solvent cement to conform to CSA B181.2

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SERVICE: Refer to Contract Drawings		LINE CODE: K1
PRIMARY FLANGE RATING:		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Tubing	6 mm – 25 mm	Polyethylene (PE) OD Tubing. Contractor to field confirm all tubing lengths and suitability for service.
Fittings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Couplings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Adapters	6 mm – 25 mm	Quick-disconnect (push to connect) to NPT threaded adapters with acetal bodies, nitrile, O-rings, acetal collets. NSF approved.
Ball Valves	12 mm – 25 mm	Chemline Type 21 true union ball valves with end connections suitable for connecting to tubing.
Back Pressure Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.
Pressure Relief Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.

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SERVICE: Refer to Contract Drawings		LINE CODE: K2
PRIMARY FLANGE RATING:		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Tubing	6 mm – 25 mm	Polyethylene (PE) ID Tubing. Contractor to field confirm all tubing lengths and suitability for service.
Fittings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Couplings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Adapters	6 mm – 25 mm	Quick-disconnect (push to connect) to NPT threaded adapters with acetal bodies, nitrile, O-rings, acetal collets. NSF approved.
Ball Valves	12 mm – 25 mm	Chemline Type 21 true union ball valves with end connections suitable for connecting to tubing.
Back Pressure Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.
Pressure Relief Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.

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SERVICE: Refer to Contract Drawings		LINE CODE: K3
PRIMARY FLANGE RATING:		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Tubing	6 mm – 25 mm	Linear Low Density Polyethylene (LLPE) OD Tubing. Contractor to field confirm all tubing lengths and suitability for service. Rated for 150 psi (minimum). Temperature range -40 to +40 degrees Celsius.
Fittings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Couplings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Adapters	6 mm – 25 mm	Quick-disconnect (push to connect) to NPT threaded adapters with acetal bodies, nitrile, O-rings, acetal collets. NSF approved.
Ball Valves	12 mm – 25 mm	Chemline Type 21 true union ball valves with end connections suitable for connecting to tubing.
Back Pressure Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.
Pressure Relief Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.

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SERVICE: Refer to Contract Drawings		LINE CODE: K4
PRIMARY FLANGE RATING:		DESIGN PRESSURE:
TEMPERATURE (MAX): 40°C		CORROSION ALLOWANCE:
ITEM	SIZES	GENERAL DESCRIPTION
Tubing	6 mm – 25 mm	Polypropylene (PP) OD Tubing. Contractor to field confirm all tubing lengths and suitability for service. Rated for 150 psi (minimum). Temperature range -40 to +40 degrees Celsius.
Fittings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Couplings	6 mm – 25 mm	Quick-disconnect (push to connect) fittings with acetal bodies, nitrile, O-rings, acetal collets. Rated for 150 psi (minimum)
Adapters	6 mm – 25 mm	Quick-disconnect (push to connect) to NPT threaded adapters with acetal bodies, nitrile, O-rings, acetal collets. NSF approved.
Ball Valves	12 mm – 25 mm	Chemline Type 21 true union ball valves with end connections suitable for connecting to tubing.
Back Pressure Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.
Pressure Relief Valves	12 mm – 25 mm	Chemline SB10/11 series with end connections suitable for connecting to tubing.

END OF SECTION

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1. GENERAL

1.1 RELATED REQUIREMENTS

- .1 Spare Parts and Maintenance Materials: Division 1.

2. PRODUCTS

2.1 SPARE PARTS AND MAINTENANCE MATERIALS SCHEDULE

Item	Quantity
Chemical Treatment Supplies:	
Bypass Filter - string wound filter media for hydronic systems:	Thirty (30) for each size per system
Chemical Treatment for Hydronic System	Amount equal to 50% of initial fill charge for each system.
Pump Seals:	One (1) for each pump type and size
Air Filters:	
Air System (Furnace / Makeup Air Handling Unit) - Complete Replacement Set of Air Filters	Four (4) for each system
Blower Intake Filter Box – Replacement Filters	Thirty (30) 635 x 356 x 50 mm pleated filters
Lubricating oil for:	
Air Cooled Condensing Units:	Amount equal to 100% of initial charge for each system.
Belt Driven Equipment:	
Belts:	Two sets of belts for each drive type and size.

2.2 EQUIPMENT AND TOOLS

- .1 Unless specified otherwise, provide one of each of the following equipment and tools to facilitate proper operation and maintenance of mechanical equipment and systems:
- .1 Keys for non-freeze hose bibbs. Provide one key for each hose bibb.
 - .2 Five keys for air vents and drain cocks.
 - .3 Gas cock wrenches. Provide one wrench for each gas cock.
 - .4 One key/screwdriver for security grille access.
 - .5 One thermostat adjustment kit.

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.6 One of each type of thermometer and pressure gauge for use with Pete's Plugs.

3. EXECUTION

3.1 DELIVERY

.1 Deliver spare parts and maintenance materials to project site or other location designated by Owner.

END OF SECTION

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1. GENERAL

1.1 REFERENCE DOCUMENTS

- .1 Pipe supports shall meet the requirements of ANSI/ASME B31.1-1995, Power piping.
- .2 Duct hangers shall follow the recommendations of the SMACNA Duct Manuals.

1.2 GENERAL REQUIREMENTS

- .1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.
- .2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.
- .3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.
- .4 Fasten hangers and supports to building steel or inserts in concrete construction.
- .5 Provide and set sleeves required for equipment, including openings required for placing equipment.
- .6 Dielectrically isolate dissimilar metals.
- .7 Pipe, duct and conduit supports are not all necessarily shown on the Contract Drawings. The Contractor is responsible to ensure sufficient supports are supplied, fabricated, and installed to properly secure all pipe, fittings, and equipment to satisfy manufacturer's recommendations.

1.3 APPROVALS

- .1 Obtain approval from the Engineer prior to drilling for inserts and supports for piping systems.
- .2 Obtain approval from the Engineer prior to using percussion type fastenings.
- .3 Use of perforated band iron, wire or chain as hangers is not permitted.

2. PRODUCTS

2.1 INSERTS

- .1 Inserts shall be galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

- .2 Size inserts to suit threaded hanger rods.

2.2 PIPE HANGERS AND SUPPORTS

- .1 Hangers: Pipe sizes 15 mm to 40 mm: Adjustable wrought steel ring.
- .2 Hangers: Pipe sizes 50 mm to 100 mm and Cold Pipe Sizes 150 mm Over: Adjustable wrought steel clevis.
- .3 Hangers: Sanitary and Heating Systems: Corrosive areas and below grade to be 304 stainless steel rod with stainless support ring.
- .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.
- .5 Wall Support: Pipe Sizes to 80 mm: Cast iron hook.
- .6 Wall Support: Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm and over.
- .7 Vertical Support: Steel riser clamp.
- .8 Floor Support: Pipe Sizes to 100 mm and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.
- .9 Floor Support: Hot Pipe Sizes 150 mm and over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.
- .10 Design hangers so they cannot become disengaged by movements of supported pipe.
- .11 Provide copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping.
- .12 Insulate all piping from dissimilar metal supports.

2.3 HANGER RODS

- .1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.
- .2 Where exposed to corrosive environments threaded rods are to be 304 stainless steel.

2.4 DUCT HANGERS AND SUPPORTS

- .1 Hangers: Galvanized steel band iron or rolled angle and 10 mm rods.
- .2 Wall Supports: Galvanized steel band iron or fabricated angle bracket.
- .3 Vertical Support at Floor: Rolled angle, suitably protected from corrosion.

2.5 FLASHING

- .1 Steel Flashing: 0.55 mm galvanized steel.
- .2 Lead Flashing: sheet lead, as follows:
 - .1 For Waterproofing: 25 kg/m².
 - .2 For Soundproofing: 5 kg/m².
 - .3 Lead Sheet Size:
 - .1 Roof Plumbing Vents: as required to provide base flashing overlap to ARCA detail.
 - .2 Floor Drains: minimum 920 x 920 mm and as specified.
 - .3 Other Locations: as specified.
- .3 Safes: 25 kg/m² sheet lead or 200 micrometre neoprene.
- .4 Caps: Steel, 0.70 mm thickness minimum, 1.6 mm thickness at fire resistance structures.

2.6 SLEEVES

- .1 Pipes through Floors: Form with 1.2 mm galvanized steel.
- .2 Pipes through Beams, Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with steel pipe or 1.2 mm thickness galvanized steel.
- .3 Round Ducts: Form sleeves with galvanized steel.
- .4 Rectangular Ducts: Form sleeves with galvanized steel or wood.
- .5 Size large enough to allow for expansion with continuous insulation.

2.7 FINISHES ON HANGER RODS, HANGERS AND SUPPORTS

- .1 All steel hanger rods, hangers and supports shall be galvanized or factory primed with alkyd red oxide primer to CAN/CGSB-1.40-M89.

3. EXECUTION**3.1 INSERTS**

- .1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

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- .2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.
- .3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
- .4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.2 PIPE HANGERS AND SUPPORTS

- .1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size	Distance Between Supports	Hanger Rod Diameter
15 mm	1.8 m	10 mm
20 mm to 40 mm	1.8 m	10 mm
50 mm & 65 mm	3 m	10 mm
80 mm & 100 mm	3.6 m	16 mm
150 mm to 300 mm	4.3 m	22 mm
350 mm to 450 mm	6.1 m	25 mm

- .2 Install hangers to provide minimum 12 mm clear space between finished covering and adjacent work.
- .3 Place a hanger within 300 mm of each horizontal elbow.
- .4 Use hangers which are vertically adjustable 40 mm minimum after piping is erected.
- .5 Support horizontal soil pipe near each hub with 1.5 m maximum spacing between hangers.
- .6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Where practical, support riser piping independently of connected horizontal piping.

3.3 LOW VELOCITY DUCT HANGERS AND SUPPORTS

- .1 Hanger Minimum Sizes:
 - .1 Up to 750 mm wide: 25 x 1.6 mm at 3 m spacing.
 - .2 790 to 1200 mm wide: 40 x 1.6 mm at 3 m spacing.

- .2 Horizontal Duct on Wall Supports Minimum Sizes:
 - .1 Up to 450 mm wide: 40 x 1.6 mm or 25 x 25 x 3 mm at 2.4 m spacing.
 - .2 480 x 1000 mm wide: 40 x 40 x 3 mm at 1.2 m spacing.
- .3 Vertical Duct on Wall Supports Minimum Sizes at 3.65 m spacing:
 - .1 Up to 610 mm wide: 40 x 1.6 mm.
 - .2 640 to 900 mm wide: 25 x 25 x 3 mm.
 - .3 940 to 1200 mm wide: 30 x 30 x 3 mm.
- .4 Vertical Duct Floor Supports Minimum Sizes, riveted or screwed to ducts:
 - .1 Up to 1520 mm wide: 40 x 40 x 3 mm.

3.4 EQUIPMENT BASES AND SUPPORTS

- .1 Provide for major equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.
- .2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- .3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.5 FLASHING

- .1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.
- .2 Flash vent and soil pipes projecting 75 mm minimum above roof membrane with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides. For pipes through outside walls turn flange back into wall and caulk.
- .3 Flash floor drains over finished areas with lead minimum 250 mm clear on sides. Fasten flashing to drain clamp device.
- .4 Provide curbs for mechanical roof installations, minimum 200 mm high.
- .5 Attach counterflashings to mechanical equipment and lap base flashings on roof curbs.

- .6 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Use storm collars above all roof jacks.
- .7 Screw vertical flange section of roof jacks to face of curb.
- .8 Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to manufacturer's data for sound control.

3.6 SLEEVES

- .1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
- .2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.
- .3 Where piping or ductwork passes through floor, ceiling or wall, close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.
- .4 Install chrome plated escutcheons where piping passes through finished surfaces.

END OF SECTION

1. GENERAL

1.1 REFERENCE STANDARD

- .1 Provide and install mechanical equipment so that Average Noise Criteria Curves, as outlined in ASHRAE Guide, are not exceeded.

1.2 SUBMITTALS

- .1 Provide vibration isolation shop drawings showing isolator locations, load on each isolator, inertia slab dimensions.

1.3 GENERAL REQUIREMENTS

- .1 Supply vibration isolation equipment and materials by one supplier. Consider side loading of equipment and inertia bases when calculating maximum loads on isolators.
- .2 Ensure equipment is sufficiently rigid for isolator point loading.

1.4 INSPECTION

- .1 Provide inspection services by vibration isolation equipment and materials manufacturer's representative for final installation and provide written report that installation is in accordance with specifications and manufacturer's recommendations.

2. PRODUCTS

2.1 INERTIA BASES

- .1 Type A: Integral structural steel fan and motor base with motor slide rails.
- .2 Type B: Slung structural steel base with gusseted brackets.
- .3 Type C: Reinforced 20 MPa concrete base with full depth perimeter structural channel frame, with gusseted brackets and anchor bolts.
- .4 Type D: Reinforced 20 MPa concrete base with chamfered edges without channel frame.

2.2 VIBRATION ISOLATORS

- .1 Type 1: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
- .2 Type 2: Open spring mount with iso-stiff springs (horizontal stiffness equal to vertical stiffness).
- .3 Type 3: Open spring mount with iso-stiff springs, heavy mounting frame and limit stop.
- .4 Type 4: Closed spring mount with iso-stiff springs and limit stop.

- .5 Type 5: Closed spring hanger with acoustic washer.
- .6 Type 6: Closed spring hanger with 25 mm thick acoustic isolator.
- .7 Type 7: Elastomer mount with threaded insert and hold down holes.
- .8 Type 8: Neoprene jacketed pre-compressed moulded fiberglass.
- .9 Type 9: Rubber waffle pads, 30 durometer, minimum 12 mm thick, maximum loading 280 kPa. Use neoprene in oily locations or outdoors.
- .10 Type 10: Rubber-steel-rubber pads, 12 mm thick rubber waffle pads bonded to 6 mm thick steel plate.
- .11 Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.
- .12 Colour code spring mounts, springs selected to operate at no greater than 2/3 solid deflection and have 6 mm ribbed neoprene pads.

3. EXECUTION

3.1 APPLICATION

- .1 Provide vibration isolators for mechanical motor driven equipment throughout, unless specifically noted otherwise.

3.2 INSTALLATION

- .1 Set steel bases for 15 mm clearance between housekeeping pad and base. Set concrete inertia bases for 50 mm clearance. Adjust equipment level.
- .2 Provide spring isolators on piping connected to isolated equipment as follows: up to 100 mm diameter, first 3 points of support; 125 mm to 200 mm diameter, first 4 points of support; 250 mm diameter and over, first 6 points of support. Static deflection of first point shall be twice deflection of isolated equipment.

3.3 PERFORMANCE

- .1 Install inertia bases of type and thickness, and isolators of type and static deflection.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Site painting of mechanical work: Division 9

2. PRODUCTS

2.1 TAGS, LABELS AND BANDING

- .1 Laminated Plastic Nameplate: self-adhesive composite laminated plastic nameplates with one smooth white surface and core of black plastic. Designed to leave black lettering on a white background when engraved.
 - .1 Mechanical Equipment: engraved lettering 20 mm high.
 - .2 Panels and Panel Mounted Equipment: engraved lettering 20 mm high.
 - .3 Equipment Cabinet front mounted switches and displays: engraved lettering 8 mm high.
- .2 Colour Banding Tape: adhesive backed plastic tape, integrally coloured.
- .3 Identification Labels: adhesive backed plasticized labels, yellow colour, with:
 - .1 Legends consisting of black lettering, minimum 50 mm high.
 - .2 Black direction of flow arrows.
- .4 Stencils: 50 mm high black lettering and flow arrows.

3. EXECUTION

3.1 LABELS

- .1 Use identification labels or stencils to apply legends and direction of flow arrows, as detailed in APWSS Colour Coding Requirements, and as follows:
 - .1 Apply to full colour coded mechanical piping and to mechanical ductwork in sufficient numbers of locations to provide easy identification.
 - .2 Apply to intermittent colour coded mechanical piping wherever colour coding bands occur.
- .2 Adhere labels with sufficient coat of contact cement to ensure permanent adhesion. Seal with two coats of clear lacquer.
- .3 Identify major mechanical equipment with laminated plastic nameplates.
- .4 Identify electric starting switches, electric disconnects and remote push buttons with laminated plastic nameplates.

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3.2 TAGS

- .1 Tag all valves in mechanical rooms, and all circuit balancing and isolating valves external to mechanical room except valves at terminal heating and cooling equipment.
- .2 Identify and tag air terminal boxes and radiator valves with numbers.
- .3 Identify and tag thermostats relating to terminal boxes and valve numbers.
- .4 Identify and tag temperature sensors or intelligent thermostats by mnemonic and related terminal box and valve numbers.

3.3 LOCATION IDENTIFICATION

- .1 Provide equipment, valve and damper location tacks or adhesive disks in T-bar type ceilings, colour coded as follows:
 - .1 Yellow - HVAC Equipment
 - .2 Red - Fire Dampers/Smoke Dampers
 - .3 Green - Plumbing Valves
 - .4 Blue - Heating/Cooling Valves.
- .2 Locate tacks or disks in corner of T-bar panel closest to equipment.

3.4 DIRECTORIES

- .1 Install valve tag directory on wall in mechanical room.

END OF SECTION

1. GENERAL

1.1 RELATED REQUIREMENTS

- .1 Mechanical General Requirements: Section 15010.

1.2 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1 for requirements pertaining to product options and substitutions.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Comply with requirements of Section 15010.
- .2 Submit an insulation schedule, including the following information for each application:
- .1 Material
 - .2 "k" value
 - .3 Thickness
 - .4 Density
 - .5 Finish
 - .6 Jacket
- .3 Submit product data and test reports when requested to substantiate that insulation and recovery assemblies meet flame/smoke development ratings and performance requirements for the assembly and thickness used.

1.4 DEFINITIONS

- .1 For the purposes of this section, the following definitions apply:
- .1 Concealed: ductwork and equipment in shafts, furring, suspended ceilings and attics.
 - .2 Exposed: ductwork and equipment in mechanical rooms or otherwise not "concealed".
 - .3 "k" Value: thermal conductivity of insulating material per unit of thickness (W/m.°C).

1.5 FLAME/SMOKE DEVELOPMENT RATINGS

- .1 Duct insulation, recovery materials, vapour barrier facings, tapes and adhesives shall have maximum flame spread ratings less than or equal to 25 and maximum smoke developed less than or equal to 50, when tested in accordance with CAN/ULC S102-1988, NFPA 255-1996 or ASTM E84-96a.
- .2 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTM C411-82.

2. PRODUCTS

2.1 HOT DUCT INSULATION

.1 Hot Duct Insulation - Round and Oval:

- .1 Material: formaldehyde-free, flexible glass fiber blanket insulation and aluminum foil reinforced with fiber glass scrim to CAN/CGSB-51-GP-11M.
- .2 "k" Value: maximum 0.038 W/m.°C at 24°C mean temperature.
- .3 Service Temperature: 20°C to 65°C.
- .4 Specified material:
 - .1 Manufacturer: John Manville/ Microlite XG Formaldehyde Free Fiber Glass Duct Wrap Insulation

.2 Hot Duct Insulation - Rectangular

- .1 Material: formaldehyde-free, flexible glass fiber blanket insulation and aluminum foil reinforced with fiber glass scrim to CAN/CGSB-51-GP-11M.
- .2 "k" Value: maximum 0.035 W/m.°C at 24°C mean temperature.
- .3 Service Temperature: 20°C to 65°C.
- .4 Specified material:
 - .1 Manufacturer: John Manville/ Microlite XG Formaldehyde Free Fiber Glass Duct Wrap Insulation

2.2 COLD DUCT INSULATION

.1 Cold Duct Insulation - Round and Oval:

- .1 Material: formaldehyde-free, flexible glass fiber blanket insulation and aluminum foil reinforced with fiber glass scrim to CAN/CGSB-51-GP-11M.
- .2 "k" Value: maximum 0.038 W/m.°C at 24°C mean temperature.
- .3 Service Temperature: -40°C to 65°C.
- .4 Specified material:
 - .1 Manufacturer: John Manville/ Microlite XG Formaldehyde Free Fiber Glass Duct Wrap Insulation

.2 Cold Duct Insulation - Round (Exposed to Outdoors):

- .1 Material: formaldehyde-free, flexible glass fiber blanket insulation and aluminum foil reinforced with fiber glass scrim to CAN/CGSB-51-GP-11M.
- .2 "k" Value: maximum 0.038 W/m.°C at 24°C mean temperature
- .3 Service Temperature: -40°C to 65°C.
- .4 Specified material:
 - .1 Manufacturer: John Manville/ Microlite XG Formaldehyde Free Fiber Glass Duct Wrap Insulation

.3 Cold Duct Insulation - Rectangular:

- .1 Material: formaldehyde-free, flexible glass fiber blanket insulation and aluminum foil reinforced with fiber glass scrim to CAN/CGSB-51-GP-11M.

- .2 "k" Value: maximum 0.038 W/m.°C at 24°C mean temperature.
- .3 Service Temperature: 20°C to 65°C.
- .4 Specified material:
 - .1 Manufacturer: John Manville/ Microlite XG Formaldehyde Free Fiber Glass Duct Wrap Insulation

2.3 ACOUSTIC DUCTWORK INSULATION

- .1 Material: flexible duct liner insulation made from strong, glass fibers bonded with a thermosetting resin.
- .2 Acoustic Properties: minimum NRC or 0.75 for 25 mm thickness.
- .3 "k" Value: maximum 0.035 W/m°C at 24°C mean temperature.
- .4 Service Temperature: -40°C to 65°C.
- .5 Surface Finish: air stream side coated to prevent fibre erosion. Surface roughness not exceeding 0.58 mm.
- .6 Specified material:
 - .1 Manufacturer: John Manville/ Linacoustic RC Fiber Glass Duct Liner with Reinforced Coating System.

2.4 ACCESSORIES

- .1 FSK Tape: vapour barrier tape consisting of laminated aluminum foil, glass fiber scrim and paper, with pressure sensitive self adhesive.
- .2 ASJ Tape: vapour resistant tape consisting of all service jacket material with pressure sensitive self adhesive.
- .3 Contact Adhesive: quick setting, adhesive to adhere flexible or rigid mineral fibre insulation to ducts.
- .4 Lap Seal Adhesive: quick setting adhesive for joints and lap sealing of vapour barriers.
- .5 Pins: welding pins 4 mm diameter shaft with 35 mm diameter head for installation through the insulation. Length to suit thickness of insulation with 32 mm square nylon retaining clips.
- .6 Finishing Cement: to CAN/CGSB-51.12-95, Type 1 - mineral fibre hydraulic setting thermal insulating and finishing cement for use up to 650°C.

2.5 RECOVERY MATERIALS

- .1 Aluminum Jacket reinforced with fiber glass scrim laminated to UL rated kraft, secured with mechanical fastener.
- .2 Canvas finish to match existing finishes.

3. EXECUTION

3.1 INSTALLATION, GENERAL

- .1 Dimensions shown are clear inside free area measurement regardless of insulation placement. Fabricate ducts accordingly.
- .2 Apply insulation after required duct system tests have been completed and inspected by the Owner.
- .3 Ensure duct surfaces are clean and dry before installing insulation.
- .4 Install insulation over entire surface of duct, for full length of duct run including portions of duct passing penetrations through walls and floors.
- .5 Install insulation in a manner to insure hangers and standing duct seams do not penetrate insulation.
- .6 Locate finished seams in least visible location.
- .7 Insulate and clad exterior ductwork as cold duct and 50mm of insulation. Where ducts are insulated with acoustic insulation, the exterior insulation can be reduced to maintain a total 50mm insulation R-value.
- .8 Install insulation at ambient temperatures within acceptable ratings for tapes, sealants and adhesives.

3.2 COLD DUCT INSULATION APPLICATION

- .1 Adhere mineral fibre insulation to round and oval ductwork with adhesive applied in 150 mm wide strips on 400 mm centres. Band on outside until mastic sets then remove bands.
- .2 Butt mineral fibre insulation and seal joints with lap seal adhesive; cover joint with FSK tape.
- .3 Secure rigid insulation on rectangular ducts with 50% area coverage of adhesive and impale on pins located 400 mm on centre and secure in place with the retaining clips.
- .4 Butt rigid insulation on rectangular ducts and seal joints with lap seal adhesive; cover joints with 100 mm strips of open mesh cloth imbedded between two coats of lap seal adhesive.

3.3 ACOUSTIC DUCT INSULATION APPLICATION

- .1 Line ducts with flexible or rigid acoustic insulation. Line plenums with rigid acoustical insulation. Adhere insulation to duct with 100% coverage of contact adhesive and pins located 400 mm OC each way. Secure in place with retaining clips. Remove excess length of pins and cover with brush coat of lap seal adhesive.
- .2 Bevel corners at joints and butt together. Brush coat all cut edges with lap seal adhesive. Install acoustic gauze over all cut corners and joints and brush coat with lap seal adhesive.

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- .3 Where duct velocities exceed 20 m/s, cover insulation with 0.8 mm perforated galvanized steel with 24% free area.

3.4 EXPOSED DUCTS

- .1 Finish ducts exposed to outdoors with aluminum jacket. Caulk all joints on jacket for weathertight finish.
- .2 Interior ducts exposed in mechanical spaces to be finished with canvas to match existing. Painted with any required identification.

3.5 INSULATION TYPE AND THICKNESS SCHEDULE

Service Type	Insulation Type	Insulation Thickness (mm)
Exhaust and relief ducts within 3 m of exterior openings	Hot duct	25
Relief ducts and plenums	Hot duct	25
Supply ducts and plenums	Hot duct	25
Outside air	Cold duct	50
Mixing plenums	Cold duct	50
Supply air plenums	Cold duct	25
Medium pressure supply ducts	Cold duct	25
Low pressure supply ducts	Cold duct	25
Supply and return ducts exposed to outdoors	Cold duct	50
Ventilation equipment	Cold duct	50

END OF SECTION

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1. GENERAL

1.1 RELATED REQUIREMENTS

- .1 Mechanical General Requirements: Section 15015

1.2 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1 for requirements pertaining to product options and substitutions.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Comply with requirements of Section 15015.
- .2 Submit an insulation schedule, for each application include the following information:
 - .1 Materials
 - .2 "k" value
 - .3 Thickness
 - .4 Density
 - .5 Finish
 - .6 Jacketing
- .3 Submit product data and test reports when requested to substantiate that insulation and recovery assemblies meet flame/smoke development ratings and performance requirements for the assembly and thickness used.

1.4 DEFINITIONS

- .1 For the purposes of this Section, the following definitions apply:
 - .1 Concealed: piping systems and equipment in trenches, shafts, furring, and suspended ceilings.
 - .2 Exposed: piping systems and equipment in mechanical rooms or otherwise not "concealed".
 - .3 "k" Value: thermal conductivity of insulating material per unit of thickness (W/m.°C).

1.5 FLAME/SMOKE DEVELOPMENT RATINGS

- .1 Pipe insulations, recovery materials, tapes, vapour barrier facings and adhesives shall have maximum flame spread rating of 25 and maximum smoke developed rating of 100 except in plenum spaces and air handling systems where maximum smoke development rating shall be 50, when tested in accordance with CAN/ULC-S102-1988, NFPA 255-1996, or ASTM E84-96a.
- .2 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTM C441-82.

2. PRODUCTS

2.1 HOT PIPE INSULATION

- .1 Hot Pipe Insulation - Mineral Fibre:
 - .1 Material: Hi-Lo Temp Formaldehyde Free fiber glass insulation to CAN/CGSB-51.9-92.
 - .2 "k" Value: maximum 0.035 W/m.°C at 24°C mean temperature.
 - .3 Service Temperature: up to 150°C.
 - .4 Jacket:
 - .1 Indoor Piping: PVC jacket thickness of 0.5 mm
 - .2 Outdoor Piping: Aluminum jacket thickness of 0.5 mm
 - .3 Blower Piping: Aluminum jacket thickness of 0.5 mm
 - .5 Specified material:
 - .1 Manufacturer: Johns Manville / Zeston 2000 PVC insulated fitting covers and jacketing.

2.2 COLD PIPE & DUCT INSULATION

- .1 Cold Pipe Insulation: Mineral Fibre:
 - .1 Material: Hi-Lo Temp Formaldehyde Free fiber glass insulation to CAN/CGSB-51.9-92.
 - .2 "k" Value: maximum 0.035 W/m.°C at 24°C mean temperature.
 - .3 Service Temperature: -14°C to 100°C.
 - .4 Jacket:
 - .1 Indoor Piping: PVC jacket thickness of 0.5 mm.
 - .2 Outdoor Piping: Aluminum jacket thickness of 0.5 mm
 - .5 Specified material:
 - .1 Manufacturer: Johns Manville / Zeston 2000 PVC insulated fitting covers and jacketing.

2.3 ENGINE EXHAUST INSULATION

- .1 Not Applicable

2.4 ACCESSORIES

- .1 For mineral fibre insulation materials:
 - .1 ASJ Tape: vapour resistant tape consisting of all service jacket material with pressure sensitive self adhesive.
 - .2 Adhesive: quick setting adhesive for joints and lap sealing.
- .2 Finishing Cement: to CAN/CGSB-51.12-95 Type 1 - mineral fibre hydraulic setting thermal insulating and finishing cement for use up to 650°C.

- .3 Equipment Insulation: For all valves and fittings provide flexible removable insulation jackets.

2.5 RECOVERY MATERIALS

- .1 Aluminum: to 0.5 mm thick with longitudinal slip joints and 50 mm end laps, 0.4 mm thick die shaped fitting covers with factory attached protective liner on interior surface.
- .2 PVC: to CAN/CGSB-51.53-95, 0.38 mm thick for interior use, off-white in colour with one-piece premoulded fitting covers.

3. EXECUTION

3.1 INSTALLATION, GENERAL

- .1 Apply insulation after required piping system tests have been completed and inspected by the Owner's Representative.
- .2 Ensure piping surface is clean and dry before insulating.
- .3 Locate cover seams in least visible locations.
- .4 Stagger butt joints where multi-layered insulation is used.
- .5 On vertical piping with diameters 25 mm and larger, use insulation supports welded or bolted to pipe directly above lowest pipe fitting. Repeat supports on 4.5 m centers and at each valve and flange.
- .6 Tightly fit insulation sections to pipe to make smooth and even surfaces. Cut insulation for proper fit where weld beads protrude. Bevel away from studs and nuts to allow their removal without damage to insulation. Trim closely and neatly around extending parts of pipe saddles, supports, hangers, clamp guides and seal with insulating/finishing cement.

3.2 HOT PIPE INSULATION APPLICATION

- .1 Apply mineral fibre insulation when pipe surface temperatures are 50°C to 60°C.
- .2 Apply mineral fibre insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings. Seal butt joints with 100 mm wide ASJ tape.
- .3 Terminate mineral fibre insulation at each end of unions and flanges. Trowel finishing cement into bevel.
- .4 Cover fittings and valves with equivalent thickness of finishing cement. Apply finishing cement over exposed fittings and valves before applying canvas recovering.

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- .5 Cut mineral fibre insulation layers straight on 10 m centers with 25 mm gap to allow for expansion between terminations. Pack void tightly with insulation and protect joints with aluminum sleeves.
- .6 Recover exposed mineral fibre insulated piping with PVC.
- .7 Recover mineral fibre insulated piping exposed to outdoors with aluminum.
- .8 Do not insulate the following piping system components:
 - .1 Hot water heating piping in radiation cabinets.
 - .2 Unions, flanges, strainers, expansion joints, flexible piping connectors
 - .3 Condensate trap assemblies and drip legs.
 - .4 Chrome plated or stainless steel piping.
 - .5 Valve bonnets on domestic water systems.

3.3 COLD PIPE & DUCT INSULATION APPLICATION

- .1 Insulate 2 m portion of plumbing vents measured from roof outlet back. Do not insulate remaining vent piping.
- .2 Insulate storm sewer piping throughout. Insulate final 2 m portion from outlet drain back with 25 mm insulation.
- .3 Apply mineral fibre insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings. Apply adhesive to ends of butt joints and seal joint seams with 100 mm wide strips of joint tape.
- .4 Insulate complete system including valves, unions, flanges, strainers. Cover fittings and valves with equivalent thickness of finishing cement. Cover finishing cement with open mesh glass cloth and adhesive. Seal lap joints with 100% coverage of joint tape and seal the assembly with adhesive.
- .5 Recover mineral fibre insulated piping with PVC jacket.
- .6 Recover mineral fibre insulated piping exposed to outdoors with aluminum.

3.4 COLD EQUIPMENT INSULATION APPLICATION

- .1 Tightly butt edges and stagger joints. Seal joints with 100 mm wide FSK tape.
- .2 Cover insulation with 25 mm galvanized hexagonal mesh and 12 mm coat of finishing cement. Finish with a final 12 mm coat of finishing cement and recover with canvas.

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3.5 INSULATION TYPE AND THICKNESS SCHEDULE

Service Type and Nominal Pipe Diameter (mm)	Insulation Type	Insulation Thickness (mm)
Heating piping		
50 and smaller	Hot pipe	25
65 and larger	Hot pipe	40
Equipment	Hot Equipment	25
Blower piping (aluminum recovery to be used)		
50 and smaller	Hot/cold pipe	25
65 and larger	Hot/cold pipe	40
Equipment	Hot Equipment	25
Domestic Hot Water and recirculation		
50 and smaller	Hot pipe	25
65 and larger	Hot pipe	40
Domestic cold water		
40 and smaller	Cold pipe	12
50 and larger	Cold pipe	25
Plumbing vents		
All sizes	Cold pipe	25
Hot water storage tanks	Hot equipment	50
Condenser water piping indoors		
25 and smaller	Cold pipe	25

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 This section of the specifications refers to the supply, installation and testing of manually operated channel slide gates used for isolation, throttling, relief, regulating, including those requiring electric, hydraulic, or pneumatic actuation. Contractor to refer to Contract Drawings.

1.2 RELATED SECTIONS

- .1 Section 01340 - Shop Drawings, Product Data and Samples
- .2 Section 01790 - Operation and Maintenance Data and Manuals
- .3 Section 13311 - Instrumentation - Wiring
- .4 Section 13312 - Field Instruments
- .5 Section 15015 - Mechanical General Requirements
- .6 Section 15020 - Detailed Piping Specifications

1.3 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1 for requirements pertaining to product options and substitutions.

1.4 GATE SIZES

- .1 Gate sizes are specified in preferred metric sizes.

1.5 SOURCE OF SUPPLY

- .1 Gates of same type shall be by a single manufacturer.

1.6 DEFINITIONS

- .1 Valve Identification
 - .1 Process piping valves are identified on the drawings by valve symbols. Refer to the Contract Drawings for lists of valve symbols and labels.
- .2 Actuators
 - .1 Supply valves with standard operators as detailed herein, unless otherwise noted in the Contract Documents.

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1.7 SUBMITTALS

- .1 Technical data, specifications, dimensional drawings, and installation, operation and maintenance drawings for each type of valve, indicating valve number, materials of construction, dimensions, head loss characteristics through the valve, operating torque and valve end configuration.

1.8 SHOP DRAWINGS

- .1 Comply with requirements of Section 15015.
- .2 Submit equipment schedule before ordering.
- .3 Submit shop drawings in accordance with Section 01330 - Submittals.
- .4 Include a complete list of all tag identifications.

1.9 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790 - Operation and Maintenance Data.
- .2 Include the reviewed tag lists

1.10 IDENTIFICATION

- .1 Indicators shall bear the following information permanently marked on body:
 - .1 Manufacturer's name or trademark.
 - .2 Flow direction.
 - .3 Serial number

1.11 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick, plastic Romark "Ultra Suede", 8mm high alphanumeric characters, Helvetica font (01040 cutter), reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

1.12 MATERIALS

- .1 All materials to be new, free from defects and conforming to applicable reference standards.
- .2 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.

2. PRODUCTS

2.1 GENERAL

- .1 The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.
- .2 Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of water control gates.
- .3 Equipment Description
 - .1 All instruments are given a description "Tag #". The Tag # refers to the description relative to the P & I drawings and mechanical drawings for reference.

2.2 DRAWINGS

- .1 Process and Instrumentation Drawings and Mechanical Drawings indicate location of valves and intent of operation.
- .2 Detailed process drawings, HVAC drawings, process standard drawings, HVAC standard drawings, yard piping drawings and service piping schematics indicate the valves on the process schematics plus other valves required for isolation.

2.3 PERFORMANCE

- .1 Slide gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.05 USgpm per foot (0.60 l/min per meter) of seal periphery under the design seating head and unseating head.
- .2 The slide gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).
- .3 The gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

2.4 FRAME

- .1 The gate frame shall be constructed of structural members or formed plate. Material shall be Type 304 SS in accordance with ASTM A-240. The guide slot shall be of UHMWPE (ultra high molecular weight polyethylene). The frame configuration shall be of the flush-bottom type.

2.5 SLIDE

- .1 The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under design head.

2.6 GUIDES AND SEALS

- .1 Guides shall be made of UHMWPE and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.
- .2 Side seals shall be made of UHMWPE of the self-adjusting type. A compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.
- .3 Seals shall maintain the specified leakage rate in both seating and unseating conditions. The bottom seal shall be made of resilient neoprene set into the bottom member of the frame and shall form a flush bottom.

2.7 STEM AND COUPLINGS

- .1 The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lb (178 N) effort on the crank or handwheel.
- .2 The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.
- .3 For stems in more than one piece and with a diameter of 1 ¾ inches (45 mm) and larger, the different sections shall be joined together by solid bronze couplings. Stem with a diameter smaller than 1 ¾ (45 mm) shall be pinned to an extension tube.
- .4 The couplings shall be grooved and keyed and shall be of greater strength than the stem.
- .5 Gates having width equal or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

2.8 STEM GUIDES

- .1 Stem guides shall be fabricated from type 304L (or 316L) stainless steel. The guide shall be equipped with a UHMWPE bushing. Guides shall be adjustable and spaced in accordance with the manufacturer's recommendation. The L/r ration shall not be greater than 200.

2.9 STEM COVER

- .1 Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

2.10 LIFTING MECHANISM

- .1 Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.
- .2 All bearings and gears shall be enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.
- .3 Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178 N) on the crank or handwheel and shall be able to withstand, without damage an effort of 80 lbs (356 N).
- .4 The crank shall be removable and fitted with a corrosion resistant rotating handle. The maximum crank radius shall be 15 inches (381 mm) and the maximum handwheel diameter shall be 24 inches (610 mm).

2.11 YOKE

- .1 Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

2.12 SPARE PARTS

- .1 Provide spare parts in accordance with Division 1.
- .2 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five years.

2.13 SLIDE GATES

- .1 Applicable Equipment: WG 3001-1, WG 3001-2, WG 3002-1, WG 3002.2, , FT 3001-1, FT 3001-2, FT 3002-1, FT 3002-2
 - .1 Liquid Type:
 - .1 Screened Wastewater: WG 3001-1, WG 3001-2, WG 3002-1, WG 3002-2 , , FT 3001-1, FT 3001-2, FT 3002-1, FT 3002-2
 - .2 Location:
 - .1 Aerobic Tanks: WG 3001-1, WG 3001-2, WG 3002-1, WG 3002.2
 - .2 Treatment Room: FT 3002-1, FT 3002-2
 - .3 Exterior: FT 3002-1, FT 3002-2
 - .3 Gate Size (**Contractor to refer to contract drawings**):
 - .1 450 W x 550 H mm: WG 3001-1, WG 3001-2, WG 3002-1, WG 3002.2
 - .4 Weir Gates: WG 3001-1, WG 3001-2, WG 3002-1, WG 3002.2, FT 3001-1, FT 3001-2, FT 3002-1, FT 3002-2 (**Contractor to refer to contract drawings**):
 - .1 Supplier: H. Fontaine Ltd.

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- .2 Model: Series 404, Self-contained frame
 - .1 Concrete Wall Mounted with pedestal-mounted gearbox and crank operator
 - .3 Fluid Temperature: 2 to 25 °C
 - .4 Frame, yoke, stem guides, slide, stem extension: Stainless steel ASTM A-240 type 316L
 - .5 Guides, side seals, stem guide liner: Ultra high molecular weight polyethylene (UHMWPE) ASTM D-4020
 - .6 Compression cord: Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
 - .7 Bottom seal: Neoprene ASTM D2000 Grade 2 BC-510
 - .8 Threaded stem: Stainless steel ASTM A-276 type 316
 - .9 Fasteners: ASTM F593 and F594 GR2
 - .10 Pedestal, handwheel and crank: Tenzaloy aluminum
 - .1 WG 3001-1: FT 3001-1
 - .2 WG 3001-2: FT 3001-2
 - .3 WG 3002-1: FT 3002-1
 - .4 WG 3002-2: FT 3002-2
 - .11 Gasket (between frame and wall): EPDM ASTM 1056
 - .12 Stem cover: Polycarbonate ASTM D-3935
 - .13 Lift nut, couplings: Manganese bronze ASTM B584 UNS-C86500
 - .14 Accessories:
 - .1 Operator Shaft 316 SS
- .2 Tag #: WG 3001-1, WG 3001-2, WG 3002-1, WG 3002-2, FT 3001-1, FT 3001-2, FT 3002-1, FT 3002-2

3. EXECUTION

3.1 SHIPMENT, PROTECTION AND STORAGE

- .1 Deliver valves to site using loading methods which do not damage casings or coatings.
- .2 Clearly tag valves, stating size, type, coatings and mating parts.
- .3 Store on site until ready for incorporation in the work using methods recommended by manufacturer to prevent damage, undue stresses, or weathering.

3.2 INSTALLATION

- .1 Install all equipment in strict accordance with manufacturer's and supplier's instructions.
- .2 Any damage resulting from either failure to observe the installation instructions or as a result of proceeding with the work without complete knowledge of how it is to be done will be the Contractor's responsibility.
- .3 Make equipment installation and connections by skilled tradesmen to the best standard.
- .4 Carry out work to produce a neat, accurate, secure, functional installation.

- .5 Repair at own expense, any damage done to the installation of materials while carrying out the work.
- .6 Install supports and bases in advance of equipment installation in accordance with manufacturer's instructions.
- .7 Generally pipe supports and hangers are not shown unless for indication purposes only.

3.3 VALVE EXTENSIONS

- .1 Install valve extensions where necessary to provide clearance from installation.

3.4 EQUIPMENT TESTING PROCEDURE

- .1 Submit a thorough description of the procedures to be employed in testing this equipment. The procedure will be reviewed by the Engineer for suitability and should be submitted 3 weeks prior to any testing.

3.5 FIELD TESTING

- .1 When equipment installation has been completed to the standards indicated by these specifications, arrange for the Engineer to review installation and operation.

3.6 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- .1 The equipment manufacturer's technical representative shall be familiar with the equipment supplied and shall come prepared with both knowledge and equipment to perform and interpret the test, inspections and procedures recommended by the manufacturer for the starting of equipment that has not previously been run.
- .2 The equipment manufacturer's technical representative shall, immediately after completion of the inspection, convey to the Engineer in writing, confirmation of the tests and inspections carried out and the result of this examination of the work.
- .3 If the inspection reveals defects in the work, correct as soon as possible and repeat the entire inspection procedure. Repeat until the work passes the inspection.
- .4 Document the results of the inspection by the equipment manufacturer's representative.
- .5 Ensure the installation meets all manufacturer's requirements for durable and trouble-free operation.

3.7 FIELD INSPECTION

- .1 The Engineer will request that the equipment be operated to demonstrate that it will perform as specified. The Engineer will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Engineer who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Engineer of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 This section of the specifications refers to the supply, installation and testing of manually operated valves used for isolation, throttling, relief, regulating, and for specialty valves including those requiring electric, hydraulic, or pneumatic actuation.

1.2 RELATED SECTIONS

- .1 Section 01340 - Shop Drawings, Product Data and Samples
- .2 Section 01790 - Operation and Maintenance Data and Manuals
- .3 Section 13311 - Instrumentation - Wiring
- .4 Section 13312 - Field Instruments
- .5 Section 15015 - Mechanical General Requirements
- .6 Section 15020 - Detailed Piping Specifications

1.3 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1 for requirements pertaining to product options and substitutions.

1.4 VALVE SIZES

- .1 Valves sizes are specified in preferred metric sizes.

1.5 SOURCE OF SUPPLY

- .1 Valves of same type shall be by a single manufacturer.

1.6 DEFINITIONS

- .1 Valve Identification
 - .1 Process piping valves are identified on the drawings by valve symbols. Refer to the Contract Drawings for lists of valve symbols and labels.
- .2 Actuators
 - .1 Supply valves with standard operators as detailed herein, unless otherwise noted in the Contract Documents.

1.7 SUBMITTALS

- .1 Technical data, specifications, dimensional drawings, and installation, operation and maintenance drawings for each type of valve, indicating valve number, materials of construction, dimensions, head loss characteristics through the valve, operating torque and valve end configuration.

1.8 SHOP DRAWINGS

- .1 Comply with requirements of Section 15015.
- .2 Submit equipment schedule before ordering.
- .3 Submit shop drawings in accordance with Section 01330 - Submittals.
- .4 Include a complete list of all tag identifications.

1.9 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790 - Operation and Maintenance Data.
- .2 Include the reviewed tag lists

1.10 IDENTIFICATION

- .1 Indicators shall bear the following information permanently marked on body:
 - .1 Manufacturer's name or trademark.
 - .2 Pressure rating.
 - .3 Flow direction.
 - .4 Serial number

1.11 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick, plastic Romark "Ultra Suede", 8mm high alphanumeric characters, Helvetica font (01040 cutter), reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

1.12 MATERIALS

- .1 All materials to be new, free from defects and conforming to applicable reference standards.
- .2 All materials, linings and coatings in contact with water to be NSF approved for potable water.
- .3 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.
- .4 Provide Canadian Registry Number (CRN) designated by the Province of Saskatchewan for each valve type.

2. PRODUCTS

2.1 GENERAL

- .1 Unless otherwise indicated, valves shall be the same size as the pipe run in which they are to be installed.
- .2 Equipment Description
 - .1 All instruments are given a description "Tag #". The Tag # refers to the description relative to the P & I drawings and mechanical drawings for reference.

2.2 DRAWINGS

- .1 Process and Instrumentation Drawings and Mechanical Drawings indicate location of valves and intent of operation.
- .2 Detailed process drawings, HVAC drawings, process standard drawings, HVAC standard drawings, yard piping drawings and service piping schematics indicate the valves on the process schematics plus other valves required for isolation.

2.3 VALVE ENDS

- .1 In pipe runs less than 50 mm diameter provide valves with female threaded ends, unless indicated otherwise. Threads to conform to ANSI B1.20.1.
- .2 Valves in pipe runs equal to or greater than 50 mm diameter to be flanged unless indicated otherwise.
- .3 For cast iron body valves, drill flanges to Class 125 pattern conforming to ANSI B16.1. For steel body valves, flanges to be Class 150 pattern or Class 300 pattern conforming to ANSI B16.5 or as noted.
- .4 Do not use grooved joint valve ends.
- .5 Use flanged joints for buried and exterior valves. Flanges to be compatible with pipe and jointing technique used.

- .6 Use flanged joints for buried butterfly valves.
- .7 Lug style wafer body valves shall have tapped holes, suitable for the bolt spacing of the pipe flanges placed on either side.
- .8 Wafer body valves shall have positioning holes, suitable for the bolt spacing of the pipe flanges placed on either side.
- .9 End flanges for gate valves to be integral with the gate valve body and be faced and drilled in accordance with ANSI B16.1, Class 125 flanges.

2.4 VALVE STEM EXTENSIONS

- .1 Provide valve stem extensions where additional clearance is required or of where valve operation without the extension is difficult and in manholes.
- .2 Where angle valve stem extensions are employed, they shall be angle geared. Universal joint types are not permitted.

2.5 SPARE PARTS

- .1 Provide spare parts in accordance with Division 1.
- .2 Provide a list of all spare parts which would be expected to be required under normal conditions for a period of five years.

2.6 RESILIENT SEATED BUTTERFLY VALVES

- .1 Applicable Equipment: BUV 5101A, BUV 5101B, BUV 5103, BUV 7980, BUV 6001, BUV 6310-1, BUV 6310-2,
 - .1 Liquid Type:
 - .1 Plant Service Water: BUV 7980,
 - .2 Effluent: BUV 5101A, BUV 5101B, BUV 5103
 - .3 Air: BUV 6001, BUV 6310-1, BUV 6310-2
 - .2 Valve Type:
 - .1 Wafer: BUV 6310-1, BUV 6310-2, BUV 5101A, BUV 5101B, BUV 5103, BUV 7980, BUV 6001
 - .2 Lugged: N/A
 - .3 Full Flange: N/A
 - .3 Location:
 - .1 Pump Room: BUV 5101A, BUV 5101B, BUV 5103, BUV 7980,
 - .2 Treatment Area: BUV 6001, BUV 6310-1, BUV 6310-2
 - .4 Valve Size:
 - .1 50 mm: BUV 7980
 - .2 75 mm: BUV 6001, BUV 6310-1, BUV 6310-2
 - .2 100 mm: BUV 5101A, BUV 5101B, BUV 5103

- .5 Specified Valves: BUW 5101A, BUW 5101B, BUW 5103, BUW 6001, , BUW 6310-1, BUW 6310-2, BUW 7980
 - .1 Supplier: Bray or approved alternate
 - .2 Model: Resilient Seated Butterfly Valve
 - .3 Fluid Temperature: 2 to 25 °C
 - .4 Pressure Rating: Minimum 175 PSI up to 300mm, 150 psi on 350 mm and larger
 - .5 Body: Cast Iron ASTM A126 Class B or Ductile Iron, ASTM A356
 - .6 Disc: Ductile Iron, Nylon 11 Coated, ASTM A536
 - .7 Shaft: 416 stainless steel, ASTM A582
 - .8 Shaft Seal: "O" ring seals
 - .9 Resilient Seat: EPDM
 - .10 NSF61 Certified
 - .11 Seal: EPDM
 - .12 Bearing: PTFE coated stainless steel
 - .13 Coatings: Polyester powder coated
 - .16 Accessories:
 - .1 N/A
- .6 Specified Valves: BUW 8103
 - .1 Supplier: Valmatic or approved equal
 - .2 Model: AWWA Butterfly Valve for Submerged applications
 - .4 Fluid Temperature: 2 to 25 °C
 - .5 Pressure Rating: 150 PSI
 - .6 Body: Cast Iron ASTM A126 Class B or Ductile Iron, ASTM A356
 - .7 Disc: Ductile Iron, ASTM A536
 - .8 Shaft: 304T stainless steel, ASTM A276 Heat fusion epoxy coated
 - .9 Shaft Seal: packing V-Type, Buna-N
 - .10 Resilient Seat: EPDM
 - .11 Mating Surface: Body Seat 316 Stainelss Steel ASTM A276
 - .12 Coatings: Internal and external fusion bonded epoxy coating
 - .13 Floor Stand:
 - .1 Floor Stand Operator
 - .1 FST 8103: BUW 8103
 - .2 Specified Equipment: FST 8103
 - .1 Manufacturer: Troy Valve or approved equal
 - .2 Model: A25650_SS (rising) or approved equal.
 - .3 Rising stem, non-indicating type Floor stand
 - .4 Counterclockwise operation.
 - .5 Stem lift to be generated from the rising stem of the valve.
 - .6 Distance from the base flange to the handwheel at closed position
 - .1 34 1/4".
 - .7 Material: 316 SS
 - .1 ductile iron grade 65-45-12 and meet ASTM-A536.
 - .2 Coated in a two part epoxy for corrosion resistance.
 - .8 Handwheel:
 - .1 13" diameter
 - .2 Stainless Steel

-
- .9 Turn Count for Stem: 83 (7 TPI)
 - .9 For applications where the floor is not directly over the valve and extensions stems, a cast floorstand mounting bracket shall be used. The mounting bracket must be coated in two part epoxy.
 - .10 Where required, the manufacturer shall provide valve operating stems, and stem guides as specified in the valve schedule or plans.
 - .11 Manufacturer shall show proof of ISO 9001:2008 certification.
 - .12 Accessories:
 - .1 Mounting Bracket
 - .2 Guide Stem
 - .3 Stainless steel mounting bracket
 - .1 Part #: A25675L by Troy Valve or approved equal
 - .4 316 stainless steel extension stem as required, refer to process drawings in Contract Drawings
 - .1 Stem Guide
 - .5 Gear Operator mounted on Valve
- .2 Materials: All materials used in the valves and hydraulic operators shall be first class in every respect and shall be incorporated into the assembly in a workmanlike manner. Materials shall be completely suitable for the service intended and selected and fabricated in accordance with the best engineering practice.
 - .3 Testing: At the request of the Engineer, the Supplier shall furnish certified copies of reports describing the procedures and results of the leakage test and hydrostatic test for each valve. Delivery of any valve will not be accepted unless certified copies of the above tests have been received.
 - .4 Shipping and Storage: The Supplier shall ensure that all units are properly protected from dust, grease, moisture and any other materials which may harmfully affect the valves during storage and/or shipping.
 - .5 Operators: Valves not having electric, hydraulic, or pneumatic operators shall be equipped with manual operators and position indicators. The location of the manual operator and position indicator shall be specified by the Owner. The maximum operator effort under any condition shall be 316 kg (80 pounds) pull and shall turn a clockwise direction to close. Valves 100 mm and smaller shall be hand levers. Valves 150 mm and larger shall be worm gear operated complete with wheel operator.
 - .6 Gear operator to be worm gear type, equipped with a hand wheel and a visual indicator of the valve position. Equip operators with adjustable, self-locking mechanical stop-limiting devices designed to hold the valve in any intermediate position between full open and full closed to prevent overtravel of the disc/ball in the open and closed positions. Gear operators to be grease lubricated. Where gear operators are intended for direct bury or submergence, seal units with food grade lubricant and shall be supplied with stainless steel fasteners.
 - .7 Tag #: BUV 5101A, BUV 5101B, BUV 5103, BUV 6001, BUV 6101, BUV 6102, BUV, 6201, BUV 6301, BUV 6302, BUV 6303, BUV 6310-1, BUV 6310-2, BUV 8101, BUV 8102, BUV 8103

2.7 PNEUMATIC ACTUATED BUTTERFLY VALVES

- .1 General:
 - .1 Limit switches and/or positioners are to come mounted to actuator, direct from supplier
 - .2 Actuator to be mounted on wall bracket/cantellivver and connected to valve with stem, direct from supplier.
 - .3 Valve shall be pre-tested to ensure proper operation prior to being shipped to site.
- .2 Applicable Equipment: FCV 4601-1, FCV 4601-2
 - .1 Liquid Type:
 - .1 Bioreactor Effluent: FCV 4601-1, FCV 4601-2, FV 5102
 - .2 Location:
 - .1 Treatment Area: FCV 4601-1, FCV 4601-2
 - .3 Size:
 - .1 200 mm: FCV 4601-1, FCV 4601-2, FCV 4601-3
 - .4 End Connection:
 - .1 Wafer: N/A
 - .2 Lugged: FCV 4601-1, FCV 4601-2
 - .3 Double Flange: N/A
 - .5 Specified Valve: FCV 4601-1, FCV 4601-2
 - .1 Supplier: Valmatic or approved equal
 - .2 Model: AWWA Butterfly Valve for Submerged applications
 - .4 Fluid Temperature: 2 to 25 °C
 - .5 Pressure Rating: 150 PSI
 - .6 Body: Cast Iron ASTM A126 Class B or Ductile Iron, ASTM A356
 - .7 Disc: Ductile Iron, ASTM A536
 - .8 Shaft: 304T stainless steel, ASTM A276 Heat fusion epoxy coated
 - .9 Shaft Seal: packing V-Type, Buna-N
 - .10 Resilient Seat: EPDM
 - .11 Mating Surface: Body Seat 316 Stainelss Steel ASTM A276
 - .12 Coatings: Internal and external fusion bonded epoxy coating
 - .14 Accessories:
 - .1 N/A
- .6 Specified Actuator: FCV 4601-1, FCV 4601-2
 - .1 Model: Bray Series 92 Rack & Pinion or approved equivalent
 - .2 Fail Position: Last
 - .3 Actuator: Pneumatic
 - .4 Operation: Double Acting
 - .5 Max Line Pressure: 15 psi

- .6 Control Air Pressure: 90 psi
- .7 Mounting Position: As per detailed drawings.
- .8 Type: Normally Closed Valve
- .9 Accessories:
 - .1 Positioner:
 - .1 POS 4601-1, POS 4601-2, POS 4601-3 (refer to section 13312)
 - .2 Travel Stops
 - .3 Tubing & Fittings:
 - .1 all service suitable tubing and fittings recommended by manufacturer to connect actuator to corresponding solenoid valve
 - .4 Declutchable Manual Operator
 - .5 Floor Stand support: FST 4601-1, FST 4601-2,
 - .1 Floor Stand
 - .1 FST 4601-1: BUV 4601-1
 - .2 FST 4601-2: BUV 4601-2
 - .2 Manufacturer: Bray or approved equal
 - .3 Distance from the base flange to the actuator
 - .1 33"
 - .4 Material: 316 SS or ductile iron grade 65-45-12 and meet ASTM-A536, coated in a two part epoxy for corrosion resistance.
 - .5 Where required, the manufacturer shall provide 316 SS valve operating stems, and stem guides as required. Refer to the IFC drawings.
 - .6 Manufacturer shall show proof of ISO 9001:2008 certification.
- .3 Tag #'s: FCV 4601-1, FCV 4601-2

2.8 PLUG VALVES

- .1 Applicable Equipment: PLV 1101, PLV 1102, PLV 2501, PLV 2501A, PLV 2501B, PLV 3101, PLV 3102, PLV 8101, PLV 8102, PLV 8191
 - .1 Liquid Type:
 - .1 Raw Sewage: PLV 1101, PLV 1102, PLV 2501, PLV 2501A, PLV 2501B,
 - .2 Waste Activated Sludge (1%): PLV 3101, PLV 3102
 - .3 Effluent: PLV 8101, PLV 8102, PLV 8191
 - .2 Location:
 - .1 Headworks Room: PLV 1101, PLV 1102, PLV 2501, PLV 2501A, PLV 2501B
 - .2 Treatment Area: PLV 3101, PLV 3102
 - .3 Effluent Chamber: PLV 8101, PLV 8102, PLV 8191
 - .3 Valve Type:
 - .1 Flanged: PLV 1101, PLV 1102, PLV 2501, PLV 2501A, PLV 2501B, PLV 3101, PLV 3102, PLV 8101, PLV 8102, PLV 8191

- .4 Valve Size:
 - .1 50mm: PLV 2501, PLV 3101, PLV 3102
 - .2 100mm: PLV 1101, PLV 1102, PLV 2501A, PLV 2501B, PLV 8101, PLV 8102, PLV 8191
- .5 Specified Equipment: PLV 1101, PLV 1102, PLV 2501, PLV 2501A, PLV 2501B, PLV 3101, PLV 3102, PLV 8101, PLV 8102, PLV 8191
 - .1 Manufacturer: Val-matic or approved equivalent
 - .2 Type: 100% Port Eccentric Plug Valve
 - .3 Model: Cam Centric Plug Valve
 - .4 Pressure Class: 125 lb.
 - .5 Body & Cover: Cast Iron ASTM A126 Class B
 - .6 Plug: Cast Iron ASTM A126 Class B or Ductile Iron, ASTM A536
 - .7 Flange: ANSI- B16.1, Class 125
 - .8 Radial Shaft and Bottom Thrust Bearings: 316 Stainless Steel
 - .9 Cover Bolts: Stainless steel
 - .10 Plug: resilient nitrile rubber coating, wear and corrosion resistant
 - .11 Actuator:
 - .1 75mm and under: lever actuated.
 - .2 100mm and greater: totally enclosed worm gear operator with position indicator and hand wheel.
 - .12 Coating:
 - .1 Exterior and Interior Coating: Fusion Bonded Epoxy
 - .13 Approved Alternate(s):
 - .1 Pratt
- .6 Tag #: PLV 1101, PLV 1102, PLV 2501, PLV 2501A, PLV 2501B, PLV 3101, PLV 3102, PLV 8101, PLV 8102, PLV 8191

2.9 PNEUMATIC ACTUATED BALL VALVES

- .1 General:
 - .1 Limit switches and/or positioners are to come mounted to actuator and valve direct from supplier.
 - .2 Valve shall be pre-tested to ensure proper operation prior to being shipped to site.
- .2 Applicable Equipment:, FV 7360
 - .1 Liquid Type:
 - .1 Polymer: FV 7360
 - .2 Location:
 - .1 Treatment Area Room: FV 7360
 - .3 Size:
 - .1 25mm: FV 7360,
 - .4 End Connection:

- .1 NPT Threaded or Socket: FV 7360
- .5 Specified Valve:, FV 7360
 - .1 Supplier: Chemline or approved equivalent
 - .2 Model: Type 21 True Union Ball Valve
 - .4 Fluid Temperature: 2 to 25 °C
 - .5 Pressure Rating: 230 psi
 - .6 Body: PVC
 - .7 Ends: Threaded
 - .8 Seats: Teflon PTFE
 - .9 Seals:
 - .1 EPDM: FV 7360
 - .2 BUNA-N (Nitrile): N/A
 - .3 Viton: N/A
- .6 Specified Actuator: FV 7360, FV
 - .1 Manufacturer: Chemline or Approved Equivalent
 - .2 Series: PA Series Double Acting
 - .3 Model: PADA-xx-xxx
 - .4 Torque: Standard Spring Set (4 Springs)
 - .5 Max Line Pressure: 100 psi
 - .6 Control Pressure: 25 psi
 - .7 Fail Position: Last
 - .8 Type: Normally Closed Valve (energize to open/close)
 - .9 Actuator: Pneumatic
 - .10 Mounting Position: vertical or horizontal.
 - .11 Accessories:
 - .1 Solenoid Valve:
 - .1 SV 7360
 - .1 Refer to Section 13312
 - .2 Travel Stops
 - .3 Tubing & Fittings:
 - .1 all service suitable tubing and fittings recommended by manufacturer to connect actuator to corresponding solenoid valve
- .7 Tag #'s: FV 7360

2.10 BALL CHECK VALVES

- .1 Applicable Equipment: CHV 1101, CHV 1102, CHV 8101, CHV 8102
 - .1 Liquid Type:
 - .1 Raw Sewage: CHV 1101, CHV 1102
 - .2 Effluent: CHV 8101, CHV 8102
- .2 Location:
 - .1 Wetwell: CHV 1101, CHV 1102
 - .2 Effluent Chamber: CHV 8101, CHV 8102
- .3 Valve Type:
 - .1 Flanged: CHV 1101, CHV 1102, CHV 8101, CHV 8102

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- .4 Valve Size:
 - .1 100mm: CHV 1101, CHV 1102, CHV 8101, CHV 8102
- .5 Installation:
 - .1 Vertical (Flow Up): CHV 1101, CHV 1102, CHV 8101, CHV 8102
- .6 Specified Equipment: CHV 1101, CHV 1102, CHV 8101, CHV 8102
 - .1 Manufacturer: HDL or approved equivalent
 - .2 Model: Type 5087A
 - .3 Pressure Class: 125 lb.
 - .4 Body and Cover: Ductile Iron, ASTM A356.
 - .5 Flange: ANSI- B16.1, Class 125
 - .6 Ball Core: Steel
 - .7 Ball Coating: NBR-Rubber encapsulated
 - .8 Gasket: Nitrile O-Ring
 - .9 Coating: Interior and Exterior – fusion bonded epoxy
 - .10 Approved Alternate:
 - .1 N/A
- .7 Tag #: CHV 1101, CHV 1102, CHV 8101, CHV 8102

2.11 AIR PRESSURE REGULATOR VALVE

- .1 Applicable Equipment: PRV 6019
 - .1 Fluid:
 - .1 Compressed Air: PRV 6019
 - .2 Location:
 - .1 Laboratory Room: PRV 6019
 - .3 End Detail:
 - .1 Threaded: PRV 6019
 - .4 Valve Size:
 - .1 6 mm: PRV 6019
 - .5 Specified Equipment: PRV 6019,
 - .1 Manufacturer: Parker, Watts, FluidAir or approved equivalent.
 - .2 Model:
 - .1 Series No. R119-02CG: PRV 6019
 - .3 Port Threads: NPT
 - .4 Reduced Pressure Range
 - .1 0 – 125 psig: PRV 6019
 - .5 Setpoint:
 - .1 50 psi: PRV 6019
 - .6 Accessories:
 - .1 Liquid Filled Pressure Gauge, (PI 6019)
 - .1 Measures Downstream Pressure

.6 Tag #: PRV 6019

2.12 COMBINATION AIR VALVES

.1 Applicable Equipment: CAV 2501, CAV 8101

.1 Liquid Type:

- .1 Raw wastewater: CAV 2501
- .2 Treated Effluent: CAV 8101

.2 Location:

- .1 Headworks Room: PLV 2501
- .2 Effluent Chamber: CAV 8101

.3 End Detail:

- .1 Flanged: PLV 2501, CAV 8101

.4 Valve Size:

- .1 50mm: CAV 2501, CAV 8101

.5 Specified Equipment: CAV 2501, CAV 8101

- .1 Manufacturer: ARI Flow Control Accessories or approved equivalent.
- .2 Model: D-025 "SAAR" Short Version
- .3 Outlet: (1 1/2") NPT.
- .4 Orifice Area: Automatic: 12 mm²; Kinetic: 804 mm²
- .5 Drainage Outlet: NSF 61 Certified Polypropylene
- .6 Float: NSF 61 Certified Foamed Polypropylene
- .7 Clamping Stem: NSF 61 Certified Reinforced Nylon
- .8 Body: NSF 61 Certified Reinforced Nylon
- .9 O-Ring: NSF 61 Certified Buna-N (NBR 70)
- .10 Base: NSF 61 Certified Reinforced Nylon
- .11 Working Pressure Range: 3-145 psi
- .12 Accessories:
 - .1 Plumb vent (outlet) to wet well with Sch 80 PVC

.7 Tag #: CAV 2501, CAV 8101

2.13 GLOBE VALVES

.1 Applicable Equipment: GLV 2126

.1 Liquid Type:

- .1 Plant Service Water: GLV 2126

.2 Location:

- .1 Treatment Area: GLV 2126

.3 Valve Pattern:

- .1 Globe: GLV 2126
- .2 Angle: N/A

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- .4 Valve Size:
 - .1 12 mm: GLV 2126
- .5 Specified Equipment: GLV 2126
 - .1 Manufacturer: Valve-Tek or approved equal.
 - .2 Model: VT-GL
 - .3 Valve Material: ASTM-A301-CF8M
 - .4 End Detail: Threaded, ANSI B 2.1, BS 21, DIN 259/2999, ISO228.
 - .5 Stainless steel class 200 inside screw and screwed bonnet, swivel disc integral seat, rising stem and hand wheel.
- .6 Tag #: GLV 2126

2.14 DOUBLE CHECK VALVE ASSEMBLY

- .1 Applicable Equipment: DCVA 4426, DCVA 7980
 - .1 Liquid Type:
 - .1 Potable Water: DCVA 4426, DCVA 7980
 - .2 Location:
 - .1 Pump Room: DCVA 4426, DCVA 7980
 - .3 Valve Size:
 - .1 25 mm (1"): DCVA 4426
 - .2 50 mm (2"): DCVA 7980
 - .4 Specified Equipment:
 - .1 Manufacturer: Wilkins or approved equivalent.
 - .2 Model: 350-S-SH
 - .3 AWWA C510 compliant
 - .4 Process connection: NPT.
 - .5 Installation: Vertical (up flow) or Horizontal
 - .6 Shutoff Valves: 50 mm (2") ball valves
 - .7 175 psi pressure rating
 - .8 Accessories:
 - .1 Lead Free Strainer
 - .2 Repair Kit
 - .5 Tag #: DCVA 4426, DCVA 7980

3. EXECUTION

3.1 SHIPMENT, PROTECTION AND STORAGE

- .1 Deliver valves to site using loading methods which do not damage casings or coatings.
- .2 Clearly tag valves, stating size, type, coatings and mating parts.
- .3 Store on site until ready for incorporation in the work using methods recommended by manufacturer to prevent damage, undue stresses, or weathering.

3.2 PREPARATION

- .1 Valve and piping arrangement indicated in the drawings is based on typical dimensions for valves of the specified type. Make the necessary modifications in piping to allow for discrepancies between valve dimensions shown and those supplied for the work.
- .2 Field measure and check all equipment locations, pipe alignments, and structural installation prior to installation of valves. Ensure that valve locations and orientations provide suitable access to manual operators and that sufficient space and accessibility is available for pneumatic and electric actuators.
- .3 Where conflicts are identified, inform the Engineer and initiate the necessary piping modifications at no cost to the Owner.

3.3 INSTALLATION

- .1 Install all equipment in strict accordance with manufacturer's and supplier's instructions.
- .2 Any damage resulting from either failure to observe the installation instructions or as a result of proceeding with the work without complete knowledge of how it is to be done will be the Contractor's responsibility.
- .3 Make equipment installation and connections by skilled tradesmen to the best standard.
- .4 Carry out work to produce a neat, accurate, secure, functional installation.
- .5 Repair at own expense, any damage done to the installation of materials while carrying out the work.
- .6 Install supports and bases in advance of equipment installation in accordance with manufacturer's instructions.
- .7 Generally pipe supports and hangers are not shown unless for indication purposes only.

3.4 VALVE EXTENSIONS

- .1 Install valve extensions where necessary to provide clearance from installation.

3.5 EQUIPMENT TESTING PROCEDURE

- .1 Submit a thorough description of the procedures to be employed in testing this equipment. The procedure will be reviewed by the Engineer for suitability and should be submitted 3 weeks prior to any testing.

3.6 FIELD TESTING

- .1 When equipment installation has been completed to the standards indicated by these specifications, arrange for the Engineer to review installation and operation.

3.7 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- .1 The equipment manufacturer's technical representative shall be familiar with the equipment supplied and shall come prepared with both knowledge and equipment to perform and interpret the test, inspections and procedures recommended by the manufacturer for the starting of equipment that has not previously been run.
- .2 The equipment manufacturer's technical representative shall, immediately after completion of the inspection, convey to the Engineer in writing, confirmation of the tests and inspections carried out and the result of this examination of the work.
- .3 If the inspection reveals defects in the work, correct as soon as possible and repeat the entire inspection procedure. Repeat until the work passes the inspection.
- .4 Document the results of the inspection by the equipment manufacturer's representative.
- .5 Ensure the installation meets all manufacturer's requirements for durable and trouble-free operation.

3.8 FIELD INSPECTION

- .1 The Engineer will request that the equipment be operated to demonstrate that it will perform as specified. The Engineer will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Engineer who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Engineer of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

END OF SECTION

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1. GENERAL

1.1 SCOPE

- .1 This section of the specifications refers to the supply, installation and testing of flow indicators used for visually indicating flow in a pipeline not requiring feedback to any electronic device.

1.2 RELATED REQUIREMENTS

- .1 Mechanical General Requirements: Section 15015.
- .2 Detailed Piping Specifications: Section 15020.

1.3 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1 for requirements pertaining to product options and substitutions.

1.4 UNIFORMITY OF EQUIPMENT

- .1 All flow indicators are to be supplied by one manufacturer throughout to the extent practical. Variations will be permitted only where the major supplier cannot supply a particular piece of equipment as specified.

1.5 SHOP DRAWINGS

- .1 Comply with requirements of Section 15015.
- .2 Submit equipment schedule before ordering.
- .3 Submit shop drawings in accordance with Section 01330 - Submittals.
- .4 Include a complete list of all tag identifications.

1.6 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790 - Operation and Maintenance Data.
- .2 Include the reviewed tag lists.

1.7 IDENTIFICATION

- .1 Indicators shall bear the following information permanently marked on body:
 - .1 Manufacturer's name or trademark.
 - .2 Pressure rating.
 - .3 Flow direction.
 - .4 Serial number

1.8 TAGGING

- .1 Provide each indicator with a tag stamped or engraved with the valve and equipment number.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick, plastic Romark "Ultra Suede", 8mm high alphanumeric characters, Helvetica font (01040 cutter), reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

1.9 MATERIALS – GENERAL

- .1 All materials to be new, free from defects and conforming to applicable reference standards.
- .2 All materials, linings and coatings in contact with water to be NSF approved for potable water.
- .3 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.

2. PRODUCTS

2.1 GENERAL

- .1 Isolation Valves
 - .1 Isolate all indicators from service to allow for removal and maintenance.
 - .2 Use 316 stainless steel ball valves on stainless steel and carbon steel piping, bronze body valves on copper piping, and PVC ball valves on PVC piping. Refer to Section 15020 – Detailed Piping Specifications.
 - .3 Isolation valves diameter are to match equipment process connections.
- .2 Equipment Description
 - .1 All instruments are given a description "Tag #". The Tag # refers to the description relative to the P & I drawings and mechanical drawings for reference.

2.2 FLOW INDICATORS

- .1 Applicable Equipment: FI 2126
 - .1 Liquid Type:
 - .1 Plant Service Water: FI 2126
 - .2 Location:
 - .1 Treatment Area: FI 2126
 - .4 Specified Equipment: FI 2126
 - .1 Manufacturer: Chemline
 - .2 Model: FSA00250
 - .3 Inlet: 12 mm (1/2") NPT.
 - .4 Outlet: 12 mm (1/2") NPT.
 - .5 Tube: PVC
 - .6 O-Rings: EPDM
 - .7 Scale Range: 25 to 250 l/hr (0.11 to 1.10 USgpm)
 - .6 Approved Alternates:
 - .1 Blue-White
 - .2 King Instrument
 - .3 OMEGA
 - .7 Tag #: FI 2126

3. EXECUTION

3.1 INSTALLATION

- .1 Install all equipment in strict accordance with manufacturer's and supplier's instructions.
- .2 Any damage resulting from either failure to observe the installation instructions or as a result of proceeding with the work without complete knowledge of how it is to be done will be the Contractor's responsibility.
- .3 Make equipment installation and connections by skilled tradesmen to the best standard.
- .4 Carry out work to produce a neat, accurate, secure, functional installation.
- .5 Repair at own expense, any damage done to the installation of materials while carrying out the work.
- .6 Install supports and bases in advance of equipment installation in accordance with manufacturer's instructions.

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3.2 EQUIPMENT TESTING PROCEDURE

- .1 Submit a thorough description of the procedures to be employed in testing this equipment. The procedure will be reviewed by the Engineer for suitability and should be submitted 3 weeks prior to any testing.

3.3 FIELD TESTING

- .1 When equipment installation has been completed to the standards indicated by these specifications, arrange for the Engineer to review installation and operation.

3.4 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- .1 N/A

3.5 FIELD INSPECTION

- .1 The Engineer will request that the equipment be operated to demonstrate that it will perform as specified. The Engineer will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Engineer who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Engineer of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

END SECTION

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1. GENERAL

1.1 SCOPE

- .1 This section of the specifications refers to the supply, installation and testing of pressure indicators used for visually indicating pressure in a pipeline not requiring feedback to any electronic device.

1.2 RELATED REQUIREMENTS

- .1 Mechanical General Requirements: Section 15015.
- .2 Detailed Piping Specifications: Section 15020.

1.3 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1 for requirements pertaining to product options and substitutions.

1.4 UNIFORMITY OF EQUIPMENT

- .1 All pressure indicators are to be supplied by one manufacturer throughout to the extent practical. Variations will be permitted only where the major supplier cannot supply a particular piece of equipment as specified.

1.5 SHOP DRAWINGS

- .1 Comply with requirements of Section 15015.
- .2 Submit equipment schedule before ordering.
- .3 Submit shop drawings in accordance with Section 01330 - Submittals.
- .4 Include a complete list of all tag identifications.

1.6 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790 - Operation and Maintenance Data.
- .2 Include the reviewed tag lists.

1.7 IDENTIFICATION

- .1 Indicators shall bear the following information permanently marked on body:
 - .1 Manufacturer's name or trademark.
 - .2 Pressure rating.
 - .3 Flow direction.

- .4 Serial number

1.8 TAGGING

- .1 Provide each indicator with a tag stamped or engraved with the valve and equipment number.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick, plastic Romark "Ultra Suede", 8mm high alphanumeric characters, Helvetica font (01040 cutter), reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

1.9 MATERIALS – GENERAL

- .1 All materials to be new, free from defects and conforming to applicable reference standards.
- .2 All materials, linings and coatings in contact with water to be NSF approved for potable water.
- .3 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.

2. PRODUCTS

2.1 GENERAL

- .1 Isolation Valves
 - .1 Isolate all indicators from service to allow for removal and maintenance.
 - .2 Use 316 stainless steel ball valves on stainless steel and carbon steel piping, bronze body valves on copper piping, and PVC ball valves on PVC piping. Refer to Section 15020 – Detailed Piping Specifications.
 - .3 Isolation valves diameter are to match equipment process connections.
- .2 Equipment Description
 - .1 All instruments are given a description "Tag #". The Tag # refers to the description relative to the P & I drawings and mechanical drawings for reference.

2.2 PRESSURE INDICATORS

- .1 Applicable Equipment: PI 1101, PI 1102, P 3131, PI 8101, PI 8102
 - .1 Liquid Type:
 - .1 Sewage: PI 1101, PI 1102
 - .2 Plant Supply Water: P 3131
 - .3 Treated Effluent: PI 8101, PI 8102,
 - .2 Location:
 - .1 Headworks: PI 1101, PI 1102
 - .2 Treatment Area: P 3131
 - .3 Effluent Chamber: PI 8101, P 8102
 - .3 Required Pressure Range:
 - .1 0 to 60 psi: PI 1101, PI 1102, P 3131, PI 8101, PI 8102
 - .4 Specified Equipment: PI 8101, PI 8102
 - .1 Manufacturer: Ashcroft or approved equivalent
 - .2 Model: 45-1279-AS-04L
 - .3 Accuracy: $\pm 0.5\%$ of span
 - .4 Dial Size: 115 mm (4")
 - .5 Fill Fluid: Silicone filled
 - .6 Case: Solid front black phenol turret case with blowout back
 - .7 Window: Polycarbonate
 - .8 Dial: Black figures on white background
 - .9 Pointer: Black, easily adjustable, self-locking micropointer; stainless steel rotary gear movement
 - .10 Bourdon Tube: "C" shaped phosphor bronze
 - .11 Bourdon Tip: Brass Tip, Silver Brazed
 - .12 Operating Temperature: -7 C to 65 C
 - .13 Connections: 12 mm NPT lower mount connection
 - .14 Accessories:
 - .1 Gauges to be complete with stainless steel body, TFE seat and seal, SS ball and stem, screwed ball valve. Refer to contract drawings.
 - .2 All connections as required
 - .3 Gauge isolators as per drawings and specifications
 - .5 Specified Equipment: PI 1101, PI 1102, P 3131
 - .1 Manufacturer: Ashcroft or approved equivalent
 - .2 Model: 63-1008AL-02L
 - .3 Accuracy: $\pm 3-2-3\%$ of span
 - .4 Dial Size: 63 mm (2.5")
 - .5 Case: 304 Stainless Steel
 - .6 Fill Fluid: Glycerin
 - .7 Ring: 304 Stainless Steel
 - .8 Window: Polycarbonate

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- .9 Dial: Black figures on white background
- .10 Pointer: Black, aluminum
- .11 Bourdon Tube: "C" shaped bronze
- .12 Operating Temperature: -7 C to 65 C
- .13 Connections: 6 mm NPT lower mount connection
- .14 Accessories:
 - .1 Gauges to be complete with stainless steel body, TFE seat and seal, SS ball and stem, screwed ball valve. Refer to contract drawings.
 - .2 All connections as required
 - .3 Gauge isolators as per drawings and specifications
- .6 Approved alternative: WIKA
- .7 Tag #: PI 1101, PI 1102, P 3131, PI 8101, PI 8102

2.3 GAUGE ISOLATORS

- .1 Applicable Equipment: GI 1101, GI 1102, GI 8101, GI 8102
 - .1 Liquid Type:
 - .1 Sewage: GI 1101, GI 1102
 - .2 Effluent: GI 8101, GI 8102,
 - .2 Location:
 - .1 Wetwell: GI 1101, GI 1102
 - .2 Effluent Chamber: GI 8101, GI 8102,
 - .3 Specified Equipment: GI 1101, GI 1102, GI 8101, GI 8102
 - .1 Manufacturer: Ashcroft or approved equivalent
 - .2 Model: 10-100SB-02T-CK
 - .3 Process Connection: Threaded – Female NPT
 - .4 Process Connection Size: 25 mm (1")
 - .5 Diaphragm Material: 316L Stainless Steel
 - .6 Bottom Housing Materials: Steel
 - .7 Instrument Connection: 1/2" NPT
 - .8 Filling Fluid: Silicone
 - .9 Accessories:
 - .1 All connections as required
 - .4 Approved alternative: Winters Instruments
 - .5 Tag #: GI 1101, GI 1102, GI 8101, GI 8102

3. EXECUTION

3.1 INSTALLATION

- .1 Install all equipment in strict accordance with manufacturer's and supplier's instructions.
- .2 Any damage resulting from either failure to observe the installation instructions or as a result of proceeding with the work without complete knowledge of how it is to be done will be the Contractor's responsibility.
- .3 Make equipment installation and connections by skilled tradesmen to the best standard.
- .4 Carry out work to produce a neat, accurate, secure, functional installation.
- .5 Repair at own expense, any damage done to the installation of materials while carrying out the work.
- .6 Install supports and bases in advance of equipment installation in accordance with manufacturer's instructions.

3.2 EQUIPMENT TESTING PROCEDURE

- .1 Submit a thorough description of the procedures to be employed in testing this equipment. The procedure will be reviewed by the Engineer for suitability and should be submitted 3 weeks prior to any testing.

3.3 FIELD TESTING

- .1 When equipment installation has been completed to the standards indicated by these specifications, arrange for the Engineer to review installation and operation.

3.4 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- .1 N/A

3.5 FIELD INSPECTION

- .1 The Engineer will request that the equipment be operated to demonstrate that it will perform as specified. The Engineer will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Engineer who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Engineer of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

END SECTION

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1. GENERAL

1.1 SCOPE

- .1 This section of the specifications refers to the supply, installation and testing of miscellaneous mechanical equipment not requiring feedback to any electronic device.

1.2 RELATED REQUIREMENTS

- .1 Mechanical General Requirements: Section 15015.
- .2 Detailed Piping Specifications: Section 15020.

1.3 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1 for requirements pertaining to product options and substitutions.

1.4 UNIFORMITY OF EQUIPMENT

- .1 All flow indicators are to be supplied by one manufacturer throughout to the extent practical. Variations will be permitted only where the major supplier cannot supply a particular piece of equipment as specified.

1.5 SHOP DRAWINGS

- .1 Comply with requirements of Section 15015.
- .2 Submit equipment schedule before ordering.
- .3 Submit shop drawings in accordance with Section 01330 - Submittals.
- .4 Include a complete list of all tag identifications.

1.6 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790 - Operation and Maintenance Data.
- .2 Include the reviewed tag lists.

1.7 IDENTIFICATION

- .1 Indicators shall bear the following information permanently marked on body:
 - .1 Manufacturer's name or trademark.
 - .2 Pressure rating.
 - .3 Flow direction.
 - .4 Serial number

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1.8 TAGGING

- .1 Provide each instrument with a tag stamped or engraved with the equipment number.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the P & I drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

1.9 MATERIALS – GENERAL

- .1 All materials to be new, free from defects and conforming to applicable reference standards.
- .2 All materials, linings and coatings in contact with water to be NSF approved for potable water.
- .3 Where any standard referenced has been superseded prior to bidding, the Contractor shall comply with the current standard.

2. PRODUCTS

2.1 GENERAL

- .1 Equipment Description
 - .1 All equipment has been given a description "Tag #". The Tag # refers to the description relative to the P & I drawings and mechanical drawings for reference.

2.2 STRAINERS

- .1 Applicable Equipment: STR 7141, STR 7341
 - .1 Liquid Type:
 - .1 Alum: STR 7141
 - .2 Polymer: STR 7341
 - .2 Location:
 - .1 Treatment Room: STR 7241, STR 7341
 - .3 End Detail:
 - .1 True Union (Socket or Threaded): STR 7241, STR 7341

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- .4 Specified Equipment: STR 7241, , STR 7341
 - .1 Manufacturer: Chemline Inc or approved equivalent.
 - .2 Model: "Y" Sediment Strainers
 - .3 Series: YSA
 - .4 Screens: 316 SS
 - .5 Outlet:
 - .1 25 mm: STR 7241, STR 7341
 - .6 Seals:
 - .1 EPDM: STR 7241, STR 7341,
 - .7 Mesh:
 - .1 26 (690 micron): STR 7241, STR 7341
- .5 Tag #: STR 7241, STR 7341

2.3 INJECTION QUILL

- .1 Applicable Equipment: INQ 7280, INQ 7960
 - .1 Fluid:
 - .1 Alum: INQ 7280
 - .2 Sodium Hypochlorite (12%): INQ 7960
 - .2 Location:
 - .1 Permeate Pump Room: 7280, INQ 7960
 - .3 End Detail:
 - .1 Threaded: INQ 7280, INQ 7960
 - .4 Solution Tube:
 - .1 12 mm: INQ 7280, INQ 7960
 - .5 Main Connection:
 - .1 25 mm: INQ 7280, INQ 7960
 - .6 Specified Equipment: INQ 7260, INQ 7960
 - .1 Approved Manufacturer:
 - .1 SAF-T-FLO Chemical Injection
 - .2 Model: SCH 80 PVC Injection Quill w/ SS ball Valve & SS Compression Gland
 - .3 Port Threads: NPT
 - .4 End Style: Bayonet
 - .5 Pressure Range: 0 – 125 psig
 - .6 Length: as per contract drawings
 - .7 Accessories:
 - .1 Flexible Hose Connection & SCH 80 PVC True Union Isolation Valve
 - .2 Spring loaded check valve
 - .8 Approved Alternates:
 - .1 INYO Process

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.2 Primary Fluid Solutions

.7 Tag #: INQ 7280, INQ 7960

3. EXECUTION

3.1 INSTALLATION

- .1 Install all equipment in strict accordance with manufacturer's and supplier's instructions.
- .2 Any damage resulting from either failure to observe the installation instructions or as a result of proceeding with the work without complete knowledge of how it is to be done will be the Contractor's responsibility.
- .3 Make equipment installation and connections by skilled tradesmen to the best standard.
- .4 Carry out work to produce a neat, accurate, secure, functional installation.
- .5 Repair at own expense, any damage done to the installation of materials while carrying out the work.
- .6 Install supports and bases in advance of equipment installation in accordance with manufacturer's instructions.

3.2 EQUIPMENT TESTING PROCEDURE

- .1 Submit a thorough description of the procedures to be employed in testing this equipment. The procedure will be reviewed by the Engineer for suitability and should be submitted 3 weeks prior to any testing.

3.3 FIELD TESTING

- .1 When equipment installation has been completed to the standards indicated by these specifications, arrange for the Engineer to review installation and operation.

3.4 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- .1 N/A

3.5 FIELD INSPECTION

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- .1 The Engineer will request that the equipment be operated to demonstrate that it will perform as specified. The Engineer will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Engineer who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Engineer of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

END SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Mechanical General Requirements: Section 15015.

1.2 SHOP DRAWINGS

- .1 Comply with requirements of Section 15015.
.2 Provide tank mounting details.

1.3 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
.2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
.3 The code lettering and number system shall be as shown on the drawings or as directed by the Engineer.
.4 Affix tags to equipment securely.

2. PRODUCTS

2.1 DOMESTIC HOT WATER EXPANSION TANK - BLADDER TYPE

- .1 Body Construction: steel pressure vessel outer tank, bladder type for permanent separation of air and water.
.2 Support: steel skirt for vertical floor support.
.3 Fittings: air side charge connection; water side inlet connection.

3. EXECUTION

3.1 INSTALLATION

- .1 Provide Isolations and Unions on all connected piping.
.2 Install in accordance to manufacturer's recommendations and in accordance with the National Plumbing Code.

3.2 DOMESTIC HOT WATER EXPANSION TANK

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- .1 Provide pressure relief valve; pipe discharge to drain. Set relief valve for tank rated pressure specified in schedule.
- .2 Provide valved tank drain; pipe to floor drain.
- .3 Support tank on metal frame mounted on wall adjacent to the indirect fired tank.
- .4 Operating temperature – 116° C Max.

3.4 TANK SCHEDULE

ET-101	
Manufacturer	Taco
Model	PAX30
Location	Mechanical Room
Service	DHW System
Capacity (L)	30
Diameter (mm)	356
Overall length (mm)	629
Working pressure (kPa)	862
Gas Input (BTU/hr)	--
Remarks	Vertical only

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 The hydrostatic and pressure testing procedures outlined in this section are applicable to all non-buried piping systems. Refer to Section 02520 – Hydrostatic Pressure Testing for buried piping system.
- .2 All water retaining or carrying pipes and structures, and all chemical solution components shall be tested for leakage.
- .3 Where work is undertaken within existing structures or piping, they shall be pressure tested and disinfected prior to being put back into operation.
- .4 All testing shall be as specified herein or elsewhere in these specifications or as directed by the Owner's Representative.
- .5 The Contractor shall furnish the suitable temporary service connections, testing plugs or caps, pressure pumps, pipe connections, gauges, thrust supports, and all other required equipment and labour necessary for filling the pipeline or structure, expelling air, pumping to the required test pressure, and dewatering the line or structure without additional compensation.

1.2 RELATED SECTIONS

- .1 Section 15015 – Mechanical General Requirements
- .2 Section 15020 – Detailed Piping Specifications
- .3 Section 15091 – Disinfection of Water Mains and Water Storage Facilities

1.3 REFERENCE STANDARDS

- .1 All materials, equipment, substances, etc. that will come in contact with potable water shall conform to ANSI/NSF standards 60/61 and the manufacturers shall be included on the list of approved manufacturers published by ANSI/NSF.
- .2 Hydrostatic testing procedures for PVC pipe systems, as outlined in *AWWA Manual M23 – PVC Pipe – Design and Installation*, latest edition.
- .3 Hydrostatic testing procedures for steel pipe systems, as outlined in *AWWA Manual M11 – Steel Pipe – A Guide for Design and Installation*, latest edition.

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2. PRODUCTS

2.1 WATER

- .1 All water used for the hydrostatic and pressure testing will be supplied by the Owner from the distribution system at no cost to the Contractor. All water required for retesting, following the failure of the initial test, will be supplied by the Owner at the Contractor's expense. The water rate will be based on current residential rates.
- .2 The Contractor shall be responsible for the supply and installation of all temporary pipework, pumps, water trucks or other equipment required to transport the water from the point of supply to the structure or piping to be tested.
- .3 The Contractor shall provide the Owner and Owner's Representative with 48 hours of notice of his requirement for water for testing.

3. EXECUTION

3.1 CLEANING

- .1 Prior to hydrostatic or pressure testing, all water retaining structures, pipework and conduits shall be thoroughly cleaned. All dirt and loose material shall be removed.

3.2 HYDROSTATIC TESTING OF FIBERGLASS AND OTHER PREFABRICATED RESERVOIRS

- .1 An initial hydrostatic test shall be undertaken by the supplier prior to shipping and a certificate supplied to the Owner. A second hydrostatic test shall be completed after installation. Test duration shall be for 24 hours.
- .2 The Owner's Representative shall be notified at least 48 hours before any testing begins, and the procedures and leak detection method shall be submitted in writing to the Owner's Representative for his review. Perform test in the presence of Owner's Representative.
 - .1 If any test shows leakage, or if leaks or persistently damp patches are visible, the structure shall be emptied, carefully examined, and all defects repaired by the method outlined elsewhere in these specifications or by other means approved by the Owner's Representative. Such tests shall be repeated until no leak or persistently damp patches are present.

3.3 HYDROSTATIC TESTING OF WATER RETAINING CONCRETE STRUCTURES

- .1 Hydrostatic testing shall be carried out only after the structures have been completely constructed and structural concrete has achieved (28-day) design strength.

- .2 Backfilling or damp proofing shall not be started until testing has shown the structures to be watertight.
- .3 Prior to commencing the hydrostatic testing of structures, the Contractor shall repair all visible cracks in the walls, roof and floor.
- .4 The Owner's Representative shall be notified at least 72 hours before any testing begins, and the procedures and leak detection method shall be submitted in writing to the Owner's Representative for his review. Perform test in the presence of Owner's Representative.
- .5 The Contractor shall ensure that the exterior surface of the water retaining structures which are being hydrostatically tested are maintained at a minimum temperature of 5 degrees Celsius during the entire testing period. The cost of heating and hoarding (if required) to achieve this minimum testing temperature shall be borne by the Contractor.
- .6 Fill the water retaining structure to overflow level (which will be designated by a mark scored on the tank wall) at a rate of not more than 600mm (2 ft) per day. The test shall begin once the level is at overflow level and continue for 48 hours. There shall be no persistent damp areas on exterior walls or visible leakage at any point on the structure and no lowering of the water level during the test period. The Owner's Representative shall provide the sole determination for evaporation allowance.
- .7 If any test shows leakage or if leaks or persistently damp patches are visible, the structure is to be emptied, carefully examined, and all defects repaired by the method outlined elsewhere in these specifications, or by other means approved by the Owner's Representative. Such tests to be repeated until no leak or persistently damp patches are present.
- .8 Upon mutual agreement between the Contractor and the Engineer, the reservoir may be backfilled completely before the leakage test is undertaken. The leakage test is to then be performed by filling the structure to overflow elevation and monitoring water level for a period of not less than 48 hours. During this period, there shall be no lowering of the water level. If water level is found to drop during the test period, the Contractor is responsible for all costs incurred to bring the leakage within the allowable limits, including any excavation and backfilling required to facilitate repairs, if necessary.

3.4 PRESSURE TESTING OF PIPING

- .1 Pressure testing shall be conducted on the piping to the pressures and durations as follows (or the maximum rated pressure of the pipeline, whichever is less):
 - .1 Steel pipe systems:
 - .1 Test Pressure: 125% of design operating pressure
 - .2 Test Duration: 2 Hours
 - .2 PVC pipe systems:
 - .1 Test Pressure: 150% of design operating pressure
 - .2 Test Duration: 1 Hour

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- .2 Where any section of piping is provided with concrete thrust blocks, do not conduct tests until at least 5 days after placing concrete or 2 days if high early strength concrete is used.
- .3 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied, if necessary.
- .4 Thoroughly examine exposed parts while under pressure and correct for leakage as necessary. Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.
- .5 The amount of leakage during the test period shall be zero. Repeat hydrostatic test until all defects have been corrected and no loss of water is observed.

3.5 INSTRUMENTATION PROTECTION

- .1 All instruments that have a maximum range of less than the hydrostatic or pneumatic test pressure noted above shall be removed or isolated during the pressure tests. On successful completion of the system test, the pressure shall be lowered to a pressure within the range of the instruments, and the isolated or removed instruments shall then be tested in accordance with other sections of these specifications.

3.8 SAFETY RELIEF VALVES

- .1 All safety relief valves for water services shall be supplied with test gauges for hydrostatic testing purposes. Upon completion of the hydrostatic testing, the Contractor shall remove the test gauges and repressure the system to the relieving pressure of the relief valves to ensure that the valves are relieving at their setpoint.

3.8 DEFECTS AND REPAIRS

- .1 Defects disclosed in the work shall be made good and retested or the work replaced without additional cost to the Owner.
- .2 Repairs to the piping systems shall be made with new material. No caulking of screwed joints, cracks or holes will be accepted. Where it becomes necessary to replace pieces of pipe, such replacements shall be the same lengths as the defective pieces. Where the repairs are required to PVC pipe, the pipe shall be replaced as far as the first detachable fitting in each direction from the defect. Under no circumstances shall a new section of pipe be installed with solvent welded couplings.
- .3 Tests shall be repeated after any work has been replaced if, in the judgement of the Owner's Representative, it is necessary.
- .4 All pressure testing shall be done in the presence of the Engineer or Owner's Representative.

END OF SECTION

1. GENERAL

1.1 INTENT

- .1 The disinfection procedures outlined in this section are applicable to water storage facilities and all non-buried piping systems. Refer to Section 02521 – Flushing and Disinfection for buried pipe systems.
- .2 Where work is undertaken within existing structures or piping, they shall be pressure tested and disinfected prior to being put back into operation.
- .3 All testing and disinfection shall be as specified herein or elsewhere in these specifications or as directed by the Owner's Representative.
- .4 The Contractor shall furnish the disinfecting chemicals, suitable temporary service connections, testing plugs or caps, pressure pumps, pipe connections, gauges, thrust supports, and all other required equipment and labour necessary for filling the pipeline or structure, expelling air, and dewatering the line or structure without additional compensation

1.2 RELATED SECTIONS

- .1 Section 15015 – Mechanical General Requirements
- .2 Section 15020 – Detailed Piping Specifications
- .3 Section 15090 – Hydrostatic and Pressure Testing

1.3 REFERENCE STANDARDS

- .1 All materials, equipment, substances, etc. that will come in contact with potable water shall conform to ANSI/NSF standards 60/61 and the manufacturers shall be included on the list of approved manufacturers published by ANSI/NSF.
- .2 ANSI/AWWA C6561-05 – Disinfecting Water Mains, latest revision.
- .3 ANSI/AWWA C652-02 – Disinfection of Water-Storage Facilities, latest revision.
- .4 AWWA Manual M12 – Simplified Procedures for Water Examination, latest revision.

2. PRODUCTS

2.1 WATER

- .1 All water used for the initial disinfection will be supplied by the Owner from the distribution system at no cost to the Contractor. All water required for retesting,

following the failure of the initial test, will be supplied by the Owner at the Contractor's expense. The water rate will be based on current residential rates.

- .2 The Contractor shall be responsible for the supply and installation of all temporary pipework, pumps, water trucks or other equipment required to transport the water from the point of supply to the structure or piping to be disinfected.
- .3 Where the Contractor obtains water through a connection to the distribution system, appropriate measures should be undertaken to ensure there is no possibility of cross contamination, including the use of suitable backflow prevention devices.
- .4 The Contractor shall provide the Owner and Owner's Representative with 48 hours of notice of his requirement for water for testing.

2.2 CHLORINE

- .1 Chlorine used in disinfection to be calcium hypochlorite or sodium hypochlorite which conforms to AWWA B300-10 – Hypochlorites, latest revision.

3. EXECUTION

3.1 CLEANING

- .1 Prior to disinfection, all water retaining structures, pipework and conduits shall be thoroughly cleaned. All dirt and loose material shall be removed to the satisfaction of the Owner.

3.2 DISINFECTION OF WATER MAINS

- .1 The Contractor is to perform disinfection of potable water mains to the specifications herein, with reference to ANSI/AWWA C651-05, latest revision.
 - .1 All water mains shall undergo hydrostatic testing prior to disinfection. Refer to Section 15190 – Hydrostatic and Pressure Testing.
 - .2 Where required, the Contractor shall measure the concentration of free chlorine using approved methods, as detailed in AWWA Manual M12, latest revision.
 - .3 Chlorination:
 - .1 Pipework shall be disinfected by adding chlorine or a chlorine compound to the water to produce an initial concentration of not less than 25 mg/L free chlorine. Chlorine concentration is to be measured at regular intervals.

- .2 Heavily chlorinated water shall be retained in the pipework for a period of 24 hours. During the 24 hour period, all valves in the piping system shall be operated to ensure all appurtenances have been contacted with the chlorine solution.
- .3 Upon the conclusion of the 24 hour period, the Contractor shall measure the chlorine concentration. Measurements shall indicate a concentration of not less than 10 mg/L free chlorine.
- .4 Flushing:
 - .1 Method for system flushing is to be reviewed with the Engineer and approved by the Owner prior to implementation by the Contractor.
 - .2 At the conclusion of the 24 hour period, the system is to be flushed so as to prevent damage to piping systems which may result from extended periods of contact with the heavily chlorinated solution. Water used for the test shall not be permitted to be used for plant production. The water shall be pumped gradually to the sanitary sewer system so that the rate of discharge is within the capacity of the sewer. If the chlorine residual is above 5 mg/L then it shall be reduced to below 5 mg/L before discharge.
 - .3 Alternately, chlorinated water used for disinfection may be dechlorinated using sodium bisulfite, or other suitable neutralization chemical. The Contractor shall measure the chlorine concentration to ensure that the chlorine is sufficiently neutralized. Water is then suitable for discharge to storm sewer system. A list of suitable neutralization chemicals is provided as an appendix to ANSI/AWWA C651-05, latest revision.
- .5 Bacteriological Testing:
 - .1 At the completion of disinfection and system flushing, the water main is to be filled with potable water by the Contractor before bacteriological tests are carried out by the Owner.
 - .2 The Owner shall obtain samples from the disinfected piping system and shall submit to Saskatchewan Health Services for testing, at the Owner's expense. Should the Contractor require immediate results and request that samples be taken to a private, recognized laboratory, the costs associated with bacteriological tests shall be borne by the Contractor.
 - .3 Do not put system into service until a certificate stating that the water is free from contamination has been issued by Saskatchewan Health Services or a recognized laboratory.

- .4 If there is any indication of contamination, the Contractor shall be required to repeat disinfection. This shall be done by the Contractor at his expense under the supervision of the Owner's Representative in accordance with this specification.

3.3 DISINFECTION OF WATER STORAGE FACILITIES

- .1 The Contractor is to perform disinfection of potable water storage facilities to the specifications herein, with reference to ANSI/AWWA C652-02, latest revision.
 - .1 All water storage facilities shall undergo hydrostatic testing prior to disinfection. Refer to Section 15190 – Hydrostatic and Pressure Testing.
 - .2 Where required, the Contractor shall measure the concentration of free chlorine using approved methods, as detailed in AWWA Manual M12, latest revision.
 - .3 Chlorination:
 - .1 One of the three chlorination methods outlined in this section shall be selected by the Contractor. The Contractor is to review the preferred option with the Engineer prior to implementation.
 - .2 Chlorination Method 1:
 - .1 The potable water storage facility is to be filled with potable water to the overflow elevation. The Contractor is to add chlorine to the storage facility such that the free chlorine concentration in the entire facility is not less than 10 mg/L, after a retention period of not less than 24 hour.
 - .2 Suitable methods for dosing chlorine to the potable water storage facility are outlined in ANSI/AWWA C652-02, latest revision.
 - .3 Chlorination Method 2:
 - .1 All interior surfaces of the potable water storage facility and all permanent equipment and piping that will be in contact with potable water when the storage facility is filled to overflow elevation are to be disinfected by spraying or swabbing the surfaces with a concentrated chlorine/water solution. The chlorine content of water used for spray disinfection shall be 200 mg/L.
 - .2 Potable water is to be introduced into the water storage facility, up to the overflow elevation.
 - .3 The Contractor shall sample water and results shall indicate a free chlorine concentration of not less than 10 mg/L.
 - .4 The water storage facility shall remain full to overflow level, in contact with the chlorine solution for a period of not less than 30 minutes.

- .4 Chlorination Method 3:
 - .1 A solution of 50 mg/L free chlorine shall be added to the potable water storage facility, to a level that equates to 5% of the total storage facility volume.
 - .2 The solution shall be retained in the storage facility for a period of not less than 6 hours.
 - .3 Potable water is to be introduced to the water storage facility, up to the overflow elevation.
 - .4 The solution shall be retained in the storage facility for a period of not less than 24 hours.

- .4 Flushing:
 - .1 Method for system flushing is to be reviewed with the Engineer and approved by the Owner prior to implementation by the Contractor.
 - .2 At the conclusion of the retention periods indicated for each of the chlorination methods, the potable water storage facility is to be flushed to purge the chlorinated water. Water used for the test shall not be permitted to be used for plant production. The water shall be pumped gradually to the sanitary sewer system so that the rate of discharge is within the capacity of the sewer. If the chlorine residual is above 5 mg/L then it shall be reduced to below 5 mg/L before discharge.
 - .3 Alternately to .2, chlorinated water used for disinfection may be dechlorinated using sodium bisulfite, or other suitable neutralization chemical. The Contractor shall measure the chlorine concentration to ensure that the chlorine is sufficiently neutralized. Water is then suitable for discharge to storm sewer system. A list of suitable neutralization chemicals is provided as an appendix to ANSI/AWWA C651-05, latest revision.

- .5 Bacteriological Testing:
 - 1 At the completion of disinfection and flushing, the water storage facility is to be filled with potable water by the Contractor before bacteriological tests are carried out by the Owner.
 - .2 The Owner shall obtain samples from the disinfected storage facility and shall submit to Saskatchewan Health Services for testing, at the Owner's expense. Should the Contractor require immediate results and request that samples be taken to a private, recognized laboratory, the costs associated with bacteriological tests shall be borne by the Contractor.
 - .3 Do not put system into service until a certificate stating that the water is free from contamination has been issued by Saskatchewan Health Services or a recognized laboratory.

- .4 If there is any indication of contamination, the Contractor shall be required to repeat disinfection. This shall be done by the Contractor at his expense under the supervision of the Owner's Representative in accordance with this specification.

3.4 ENTRY INTO EXISTING OR PREVIOUSLY DISINFECTED POTABLE WATER STORAGE STRUCTURES

- .1 Where entry is required either into existing potable water retaining structures or piping, or into previously disinfected new structures, the Contractor shall ensure that the following measures are taken.
 - .1 All personnel shall wear clean, dirt free protective overalls and disinfected, clean rubber footwear. Such footwear shall be reserved solely for use within the affected areas and shall not be worn in undisinfected areas.
 - .2 All tools and equipment shall be clean, grease free and spray disinfected before use. Equipment which shows evidence of fuel, oil or grease leakage shall not be used.
 - .3 The immediate area surrounding the access point for the structures concerned shall be cleaned and spray disinfected prior to the start of work. All previously disinfected footwear, tools or equipment removed outside this area of the affected structures shall be redisinfected on return.
 - .4 Disinfection of footwear, tools, equipment and access area shall be by spraying with a 200 mg/L concentrated chlorine/water solution.
 - .5 Personnel who show signs of illness shall not work within the affected structures or surrounding access area.

3.5 INSTRUMENTATION PROTECTION

- .1 All instrumentation installed on potable water piping systems shall be removed or isolated from the system during the disinfection process. On successful completion of the system disinfection and flushing, the isolated or removed instruments shall then be reintroduced to the system and tested in accordance with other sections of these specifications.

END OF SECTION

1. GENERAL

1.1 INTENT

- .1 Provide hot water heaters as shown on the drawings, with the properties as described below.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01340.
- .2 Shop drawings and product data to include the following:
 - .1 Outline and arrangement drawings.
 - .2 Materials of construction.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790.
- .2 Maintenance data to include the following:
 - .1 Manufacturer's name, type, year fabricated, capacity and serial number.
 - .2 Details of operation, servicing, and maintenance.
 - .3 Recommended spare parts list with names and addresses.

1.4 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

1.5 CERTIFICATES

- .1 Submit inspection certificate for tanks that require inspection under the Saskatchewan Safety Codes Act, Design, Construction and Installation of Boilers and Pressure Vessels Regulations.

2. PRODUCTS

2.1 INDIRECT DOMESTIC WATER HEATER

- .1 Body Construction: closed type pressure vessel, welded steel.
- .2 Coating: Baked white enamel finish.

- .3 Insulation: 2" CFC-free foam insulation for energy efficiency.
- .4 Lining: Glass-lined inner tank and sacrificial magnesium anodes.
- .5 Accessories:
 - .1 Thermometer.
 - .2 Chlorine resistant stainless steel screwed fittings.
- .6 Tappings: HWS inlet, HWR outlet, drain pressure relief valve, DHW outlet, and water make-up.

3. EXECUTION

3.1 INSTALLATION

- .1 Provide Isolations and Unions on all connected piping.
- .2 Install in accordance to manufacturer's recommendations and in accordance with the National Plumbing Code.

3.2 INDIRECT DOMESTIC WATER HEATER

- .1 Provide pressure relief valve; pipe discharge to drain. Set relief valve for tank rated pressure specified in schedule.
- .2 Provide thermometer on inlet and discharge pipes.
- .3 Provide valved tank drain; pipe to floor drain.
- .4 Support tank on steel saddle directly to floor.

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3.4 HOT WATER HEATER SCHEDULE

HWH-101	
<hr/>	
Manufacturer	A.O. Smith
Model	BTX80
Type	Vertical, automatic hot water heater and tank
Location	Mechanical Room
Service	DHW System
Capacity (L)	189
Diameter (mm)	560
Overall length (mm)	1810
Gas Input (BTU/hr)	76,000
Electrical	120 VAC / 60 Hz
Remarks	Supply with 100 mm venting and concentric vent kit.

END OF SECTION

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1. GENERAL

1.1 REFERENCE DOCUMENTS

- .1 Plumbing fixtures shall meet or exceed CAN/CSA-B45 Series-02, Plumbing Fixtures.

1.2 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Section 01621 for requirements pertaining to product options and substitutions.

1.3 REGULATORY REQUIREMENTS

- .1 Plumbing fixtures shall be approved by the authority having jurisdiction.

1.4 CERTIFICATIONS

- .1 Plumbing fixtures shall be tested, certified and labeled in accordance with a certification program accredited by the Standards Council of Canada. Where a product is not so labeled, provide written approval by the authority having jurisdiction.

1.5 SOURCE OF SUPPLY

- .1 Each of the following products shall be by a single manufacturer:
 - .1 Fixtures of the same type or group.
 - .2 Fittings of the same type.

1.6 COORDINATION

- .1 Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

2. PRODUCTS

2.1 FIXTURE BRASS AND ACCESSORIES

- .1 Visible parts of fixture brass and accessories shall be heavily chrome plated.

2.2 WATER CLOSET WITH FLUSH TANK (WC-1) QUANTITY OF 1

- .1 **Bowl:** Vitreous China, ultra-low consumption (4.8 Lpf), round front siphon action jetted bowl, ADA compliant **American Standard, CADET PRO RIGHT HEIGHT 3517A 101 ELONGATED TOILET.**
- .2 **Close-coupled tank:** Flush valve with chemical resistant flapper, ADA compliant, **4188A 104 Unlined Tank with Right Hand Trip Lever.**

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- .3 **Seat:** Open front seat with cover, complete with easy to clean sustaining hinge, ADA compliant **American Standard #5725019**.

2.3 BATHROOM LAVATORY (LAV-1) QUANTITY OF 1

- .1 **Bowl:** ADA compliant self-rimming countertop 521x448mm minimum vitreous china lavatory, drilling on 100mm centres, overflow, seal of putty, caulking or concealed vinyl gasket, **American Standard, Colony 0346-403**
- .2 **Trim:** ADA compliant chrome plated cast brass 100mm centre set, **Delta, 21C143**.

2.4 SHOWER – (SH-1) QUANTITY OF 1

- .1 **Trim:** **Symmons ‘SAFETY MIX’ 1-100-2.0 Shower Valve**, C.P. heavy duty pressure balancing, all brass and stainless steel body design, maximum temperature limit stop, service stops, metal escutcheon plate, heavy duty spindle with single control metal lever handle, with “super” shower head with arm & flange, 7.6 L/min (2.0 gpm) flow restrictor.
- .2 **Enclosure:** **Ella Freedom, 6032 SH IS 3P 4.0 L-WH FRDM**, dimensions, 33” x 60” x 77” (838mm x 1524mm x 1956mm) fiberglass reinforced shower enclosure with white finish, built in drain with strainer, left seat, polished chrome grab bars with covered flange, tempered glass sliding shower door, obscure design with chrome finish.

2.5 SINGLE COMPARTMENT STAINLESS STEEL SINK (SK-1) QUANTITY OF 1

- .1 **Bowl** 650x560x300 mm O.D., Type 20 Gauge, 18-8SS, self rimming, single compartment with undercoating, 3 hole drill-in in ledge-back with 100mm centers, **Kindred QSL2225/12**.
- .2 **Trim:** Polished chrome plated finish with swing spout, 2 leavers, **Delta, 26C3122**.

2.6 MOP SINK (SK-2) QUANTITY OF 1

- .1 **Sink:** Floor mounted, janitor sink service, mop brackets, vinyl bumper guards, stainless steel wall guards, and wall mounted service faucet: **Fiat MSB 3624, 830 AA**.

3. EXECUTION

3.1 INSTALLATION

- .1 Install each fixture with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.
- .2 Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers and escutcheons.

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- .3 Rigidly attach floor mounted water closets to floor with lag screws. Lead flashing shall not hold closet in place.
- .4 Install hose and faucets and hose connections with vacuum breakers.
- .5 Provide on lab sinks polyethylene or PVC-DWV drain and vent lines with glass 450 mL bottle trap. Run plastic drain to floor and approved piping under slab. Run plastic vents to main header on roof terminal.
- .6 For island fixtures, provide a passive dry vent pipe in addition to the drain line below the slab. Air admittance devices, or Cheater vents will not be accepted.
- .7 For hand washing fixtures on systems where the domestic hot water temperature is above 122deg F, supply thermostatic mixing valves for scald protection.

3.2 PROTECTION

- .1 Protect fixtures against use and damage during construction.

3.3 FIXTURES ROUGH-IN SCHEDULE

- .1 Rough-in fixture piping connections in accordance with following table of minimum sizes or as required for particular fixtures.

Product	Hot Water mm	Cold Water mm	Waste mm	Vent mm
Service Sinks	15	15	50	40
Floor Drains	--	--	100	40
Shower	15	15	30	30
Water Closet	--	15	100	50
Sink	15	15	40	40
Lavatory	15	15	40	40
Hose Bibbs	20	20	--	--
Emergency Shower (to mixing valve)	20	20	40	--

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.
- .2 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01340.

2. PRODUCTS

2.1 CLEAN-OUTS AND CLEAN-OUT ACCESS COVERS

- .1 Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted coverplate clean-outs on vertical rainwater leaders only. Ensure ample clearance at clean-out for rodding of drainage system.
- .2 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

2.2 WATER HAMMER ARRESTERS

- .1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20 mm minimum, and minimum 450 mm long.
- .2 Install stainless steel bellows type water hammer arresters on water lines connected to solenoid valves, flush valves and to fixture or group of fixtures complete with accessible isolation valve. Model: **Zurn Shoktrol Water Hammer Arrestors** or approved alternate.

2.3 HOSE BIBS

- .1 **Interior Hot/Cold Hose Bibb:** 20mm diameter of powder coated die cast aluminum with built in Vent float style vacuum breaker to CAN/CSA B64, hose thread spout, composition disk. Provide heavy duty aluminum hose rack at each hose bib location. Model: **Woodford Freezeless Hot & Cold Wall Faucet Model C22** or approved alternate.
- .2 **Interior Cold Only Hose Bibb:** 20mm diameter of stainless-steel construction, ¼ turn, threaded hose spout, PTFE seat material. Provide heavy duty aluminum hose rack at each hose bib location. Model: **Boshart Hose Bibb Model SSHB52-07** or approved alternate.

- .3 **Exterior Hose Bibb:** 20mm diameter automatic draining, freezeless wall hydrant with hose connection Anti-Siphon Vacuum Breaker and housed in a tamper resistant brass box. Provide heavy duty aluminum hose rack at each hose bib location. Model: **Woodford Cold Freezeless Wall Hydrant Model B65** or approved alternate.

2.4 EMERGENCY EYE WASH STATION

- .1 Applicable Equipment: EW-1
 - .1 Location:
 - .1 Lab/Control Room: EW-1
 - .2 Specified Equipment EW-1
 - .1 Manufacturer: Guardian or approved equivalent.
 - .2 Model: G1893
 - .3 Eye/Face Wash: Deck mounted 90-degree swivel, stainless steel. Opens orifice and activates water flow by flag handle.
 - .4 Thermostatic Mixing Valve (MX-1):
 - .1 Model: G3600LF
 - .2 Flow Capacity: 0.38 L/s
 - .3 Hot Water Inlet: 12 mm
 - .4 Cold Water Inlet: 12 mm
 - .5 Mixed Outlet: 12 mm
 - .3 Tag #: EW-1, MX-1

2.5 SAFETY STATION WITH EYEWASH, HAND AND FOOT CONTROL

- .1 Applicable Equipment: ESH-101, ESH-102
 - .1 Location:
 - .1 Treatment Room: ESH-101, ESH-102
 - .2 Specified Equipment: ESH-101, ESH-102
 - .1 Manufacturer: Guardian or approved equivalent.
 - .2 Model: G1902P-HFC
 - .3 Eye Wash: Twin ABS eye/face wash head c/w protective dust cover which releases with water pressure, push flag and foot operated, chrome plated ball valve, plastic bowl, automatic flow control and filter.
 - .4 Drench Shower: ABS shower head, fast acting, chrome plated brass stay-open ball valve.
 - .5 Thermostatic Mixing Valve (MX-101, MX-102):
 - .1 Model: G3800LF
 - .2 Flow Capacity: 2.78 L/s
 - .3 Hot Water Inlet: 25 mm
 - .4 Cold Water Inlet: 25 mm
 - .5 Mixed Outlet: 32 mm

.3 Tag #: ESH-101, ESH-102, MX-101, MX-102

2.6 REDUCED PRESSURE ZONE ASSEMBLY

.1 Applicable Equipment: RPZ-101

.1 Liquid Type:

.1 Potable Water: RPZ-101

.2 Location:

.1 Mechanical Room: RPZ-101

.3 End Detail:

.1 Threaded: RPZ-101

.4 Valve Size:

.1 20 mm (3/4"): RPZ-101

.5 Specified Equipment: RPZ-101

.1 Manufacturer: Watts or approved equivalent.

.2 Series: 009

.3 Model: 009-QT

.4 Installation: Horizontal

.5 Shutoff Valves: ball valves

.6 Accessories:

.1 Air Gap and Drain Line

.6 Tag #: RPZ-101

3. EXECUTION

3.1 INSTALLATION

- .1 Install all equipment in strict accordance with manufacturer's and supplier's instructions.
- .2 Lubricate clean-out plugs with mixture of graphite and linseed oil. Prior to building turnover remove clean-out plugs, re-lubricate and reinstall using only enough force to ensure permanent leak proof joint.
- .3 Install vacuum breakers on plumbing lines where contamination of domestic water may occur. Generally necessary on boiler make-up lines, hose bibs and flush valves.
- .4 Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 550 kPa.

END OF SECTION

1. GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.
- .2 Provide water and drainage connections to equipment furnished in other sections of this specification and by the Owner.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01340.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into maintenance manual.
- .2 Maintenance data to include the following:
 - .1 Manufacturer's name, type, model year, capacity and serial number.
 - .2 Details of operation, servicing, and maintenance.
 - .3 Recommended spare parts list with names and addresses.

2. PRODUCTS

2.1 TRAP PRIMER

- .1 Provide and install trap primers to prevent the backflow of sewer gas into the building.
- .2 Provide common header with solenoid valve, and pipe to each floor drain. Connect header to domestic cold water line.
- .3 Trap primer shall be Zurn, model Z1020, electronic trap primer, surface mount box and cover, 15 mm inlet connection, brass ball type stop valve, slow closing 24 VAC solenoid valve with integral strainer, 120 – 24 VAC transformer, brass atmospheric vacuum breaker, PEX waterway, and anti-scaling multi-port manifold with five outlet connections.

2.2 FLOOR DRAINS

- .1 Floor drains shall have lacquered cast iron body with double drainage flange, weep holes combined two-piece body reversible clamping device, low profile drains where depth is limited and adjustable nickel/bronze strainer.
- .2 Floor drains shall have polished bronze funnel type strainer.

2.4 HUB DRAINS

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- .1 Hub drains shall have lacquered cast iron body with double drainage flange, weep holes combined two-piece body reversible clamping device and 100mm high lacquered cast iron high hub.

2.5 FLOOR DRAIN (FD-1)

- .1 Location:
 - .1 FD-1 : Headworks Room
- .2 Liquid Type:
 - .1 Water, Sewage: FD-1
- .3 Conditions:
 - .1 Temperature: 2-25°C (60°F)
- .4 Approved Product: FD-1
 - .1 Manufacturer: Zurn Industries or approved equal
 - .2 Model: Z319 THOROFLUSH DRAIN LARGE CAPACITY
- .5 Trap Primer: For FD-1
 - .1 Approved Manufacturer: Watts Industries, Inc. or approved equal
 - .2 Model: Series A200 – “Flow Through”
 - .3 Materials:
 - .1 Bronze Body
 - .2 Celcon seat and disc
 - .3 Size: 15 mm

2.7 FLOOR DRAIN (FD-2)

- .1 Location:
 - .1 FD-2: Treatment Room, Headworks Room, Pump Room, Laboratory, Mechanical Room, Washroom
- .2 Liquid Type:
 - .1 Water, Sewage: FD-2
- .3 Conditions:
 - .1 Temperature: 2-25°C (60°F)
- .4 Approved Product: FD-2
 - .1 Manufacturer: Zurn Industries or approved equal
 - .2 Model: Z-221 MEDIUM- DUTY FLOOR DRAIN
- .5 Trap Primer: For FD-2
 - .1 Approved Manufacturer: Watts Industries, Inc. or approved equal
 - .2 Model:
 - .1 Series A200 – “Flow Through”
 - .3 Materials:
 - .1 Bronze Body

- .2 Celcon seat and disc
- .3 Size: 15 mm

3. EXECUTION

3.1 APPLICATION

- .1 The trench drain system shall be installed in accordance with the manufacturer's installation instructions and recommendations.
- .2 Surface drainage system installation shall be reviewed by Engineer prior to casting concrete.

3.2 INSTALLATION

- .1 Install all equipment in strict accordance with manufacturer's and supplier's instructions.
- .2 Where floor drains are located over occupied areas, provide waterproof installation.
- .3 Install trap primer where required by Codes and/or where indicated on drawings.
- .4 Drainage lines shall grade 2 mm per 100 mm unless otherwise indicated on drawings.
- .5 Any damage resulting from either failure to observe the installation instructions or as a result of proceeding with the work without complete knowledge of how it is to be done will be the Contractor's responsibility.
- .6 Make equipment installation and connections by skilled tradesmen to the best standard.
- .7 Carry out work to produce a neat, accurate, secure, functional installation.
- .8 Repair at own expense, any damage done to the installation of materials while carrying out the work.
- .9 Refer to structural and mechanical drawings for installation and placements of supports in concrete for drainage system.
- .10 Refer to structural drawings for approved supports and concrete reinforcing details. Ensure trough drains do not float or shift during concrete pour.
- .11 Finished level of concrete must be level or to 1/8" above top edge of channel to protect exposed edges.
- .12 Prior to casting concrete, appropriately sized plywood, must be placed in channels with spacer to ensure proper clearance for grate removal.
- .13 Where required, openings, fittings and joints may be filled with appropriate material.

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 This section refers to the supply, installation and satisfactory operation of terminal heat transfer units.

1.2 REFERENCE DOCUMENTS

- .1 Comply with requirements of CSA C22.2 No. 46-M1988.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01340.
- .2 Shop drawings and product data to include the following:
 - .1 Outline and arrangement drawings.
 - .2 Materials of construction.

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790.
- .2 Maintenance data to include the following:
 - .1 Manufacturer's name, type, model year, capacity and serial number.
 - .2 Details of operation, servicing, and maintenance.
 - .3 Recommended spare parts list with names and addresses.
 - .4 As-built wiring diagrams.

1.5 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

2. PRODUCTS

2.1 GENERAL

- .1 Factory apply baked primer coat on metal surfaces of enclosure or cabinet.

2.2 NATURAL GAS UNIT HEATERS – (UH)

- .1 Provide separate combustion, natural gas-fired, fan-type, power-vented unit heater.
- .2 Units to be supplied with factory installed orifices for high altitude surface and field installed vertical vent terminal kit.
- .3 Cabinet to be heavy gauge galvanized steel c/w hinged access door and individually adjustable louvres.
- .4 Heat exchanger and burner to be stainless steel construction.
- .5 Fan to be propeller type c/w fan guard - driven by 120 VAC motor c/w internal overload protection.
- .6 Units to include direct spark ignition with 100% shutoff, single-stage combination gas valve, high temperature limit control, combustion air pressure switch to verify flow, 24 VAC control voltage transformer
- .7 Units to include vent/inlet air terminal and concentric adaptor.

2.3 ELECTRIC UNIT HEATERS – (EUH)

- .1 Self-contained, ceiling mounted, factory-assembled unit complete with 20-gauge steel cabinet, louvered grill, and high-limit temperature control with automatic reset.
- .2 Units shall come with adaptor for ceiling mount installation and control circuit and wall mount thermostat.
- .3 Units shall have CSA approval.

3. EXECUTION

3.1 INSTALLATION

- .1 Unit heaters to be installed in locations shown on the drawings in accordance with manufacturer's recommendations. Mounting location shall not interfere with equipment or operation.

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3.2 NATURAL GAS UNIT HEATER SCHEDULE

	UH-101	UH-102	UH-103	UH-201
Location	Treatment Room	Treatment Room	Treatment Room	Pump Room
Manufacturer	Reznor	Reznor	Reznor	Reznor
Model	UDAS-100	UDAS-100	UDAS-100	UDAS-60
Heat Input (kW/h)	30.8	30.8	30.8	17.6
Rated Heat Output (kW/h)	25.5	25.5	25.5	14.6
Fan Output (l/s)	635	635	635	359
Electrical (Volt / Ph.)	120 / 1	120 / 1	120 / 1	120 / 1
Motor (Watts)	276	276	276	155
Motor RPM	1050	1050	1050	1550
Accessories	-Wall Mount 24 VAC Thermostat (T-101) Display in °C -Combustion Air/Vent Kit c/w Concentric Adapter	-Wall Mount 24 VAC Thermostat (T-102) Display in °C -Combustion Air/Vent Kit c/w Concentric Adapter	-Wall Mount 24 VAC Thermostat (T-103) Display in °C -Combustion Air/Vent Kit c/w Concentric Adapter	-Wall Mount 24 VAC Thermostat (T-201) Display in °C -Combustion Air/Vent Kit c/w Concentric Adapter

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3.2 NATURAL GAS UNIT HEATER SCHEDULE - CONTINUED

UH-202	
Location	Pump Room
Manufacturer	Reznor
Model	UDAS-60
Heat Input (kW/h)	17.6
Rated Heat Output (kW/h)	14.6
Fan Output (l/s)	359
Electrical (Volt / Ph.)	120 / 1
Motor (Watts)	155
Motor RPM	1550
Accessories	-Wall Mount 24 VAC Thermostat (T-202) Display in °C -Combustion Air/Vent Kit c/w Concentric Adapter

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3.3 ELECTRIC UNIT HEATER SCHEDULE

	EUH-101	EUH-110
Location	Headworks Room	Stairwell
Manufacturer	Reznor	Ouellet
Type	Suspended Unit Heater	Wall Fan Heater
Model	EXUB15AK8E	OAC04008-T
Heat Output (kW)	15.0	4.0
Fan Output (CFM)	1200	160
Electrical (Volt / Ph.)	600 / 3	208 / 1
Accessories	- Explosion Proof - Wall mounting bracket - Wall Mount explosion proof thermostat (T-105)	--
Notes	--	Install recessed in wall

3. EXECUTION

3.1 INSTALLATION

- .1 Unit heaters to be installed in locations shown on the drawings in accordance with manufacturer's recommendations. Mounting location shall not interfere with equipment or operation.
- .2 Any damage resulting from either failure to observe the installation instructions or as a result of proceeding with the work without complete knowledge of how it is to be done will be the Contractor's responsibility.
- .3 Make equipment installation and connections by skilled tradesmen to the best standard.
- .4 Carry out work to produce a neat, accurate, secure, functional installation.
- .5 Repair at own expense, any damage done to the installation of materials while carrying out the work.

3.2 FIELD INSPECTION

- .1 The Engineer will request that the equipment be operated to demonstrate that it will perform as specified. The Engineer will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Engineer who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Engineer of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

END OF SECTION

1. GENERAL

1.1 INTENT

- .1 This section refers to the supply, installation and satisfactory operation of forced air furnace units.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01340.
- .2 Shop drawings and product data to include the following:
 - .1 Outline and arrangement drawings.
 - .2 Materials of construction.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790.
- .2 Maintenance data to include the following:
 - .1 Manufacturer's name, type, year fabricated, capacity and serial number.
 - .2 Details of operation, servicing, and maintenance.
 - .3 Recommended spare parts list with names and addresses.

1.4 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

2. PRODUCTS

2.1 TYPE

- .1 Provide up-flow type with natural gas burner and electric refrigeration.
- .2 Provide self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, air filter, refrigerant cooling coil and outdoor package containing compressor, condenser coil and condenser fan.

2.2 CONSTRUCTION

- .1 Cabinet: Heavy gauge galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber reflective liner.
- .2 Heat Exchanger: Stainless steel construction.
- .3 Supply Fan: Centrifugal type rubber mounted with belt drive, adjustable variable pitch motor pulley, rubber isolated hinge mounted 1750 r/min motor.
- .4 Air Filters: 25 mm thick fibrous glass disposable type arranged for easy replacement.
- .5 Options: concentric venting kit

2.3 BURNER

- .1 Gas Burner: Induced draft type with adjustable combustion air supply, equipped with combination gas valve and pressure regulator incorporating manual shut-off, solid state igniter.
- .2 Gas Burner Safety Controls: Thermocouple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.

2.4 BURNER OPERATING CONTROLS

- .1 Low voltage, adjustable room thermostat, controls burner operation to maintain room temperature setting.
- .2 High limit control, with fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature and energizes burner when temperature drops to lower safe value.
- .3 Control supply fan in accordance with bonnet temperatures independent of burner controls. Include manual switch for continuous fan operation.

2.5 EVAPORATOR COIL

- .1 Mount in furnace supply plenum stainless steel tube aluminum fin coil assembly, with galvanized drain pan, drain connection, refrigerant piping connections.
- .2 Factory installed thermostatic expansion valve.

2.6 REFRIGERATION PACKAGE

- .1 Compressor: Hermetic, 3600 r/min maximum, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier.

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- .2 Air Cooled Condenser: Aluminum fin and stainless steel tube coil, direct drive axial propeller fan resiliently mounted, galvanized fan guard, c/w hail guard.

2.7 REFRIGERATION OPERATING CONTROLS

- .1 Low voltage, adjustable room thermostat controls compressor, condenser fan and supply fan to maintain room temperature setting.
- .2 Include thermostat system selector switch (heat-cool-off) and fan control switch (on-auto).
- .3 Timed off circuit shall limit number of compressor starts to 12 per hour.
- .4 Provide refrigerant pressure switch to cycle condenser fan.

2.8 PROGRAMMABLE THERMOSTAT

- .1 Applicable Equipment: T-120
- .2 Equipment: Heating / Cooling Programmable Thermostat.
- .3 Location:
 - .1 Lab/Control Room: T-120
- .4 Specified Equipment:
 - .1 Manufacturer: Honeywell
 - .2 Model: TH8110R1008
 - .3 Features: Programmable thermostat, positions for system: HEAT-OFF-COOL-AUTO
 - .4 Temperature Range: Heat: 4.5°C to 32°C, Cool: 10°C to 37°C
 - .5 Electrical: 30 VAC maximum.
 - .6 Mounting: Wall Mount
- .5 Tag #: T-120
- .6 Interlock wiring: Interlock operation of HRV system with fan setting on thermostat. Provide relays as required.

3. EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with the manufacturer's instructions and in accordance with all applicable codes and requirements.
- .2 Mount air cooled condenser-compressor package on south side of building as shown in contract drawings and as per manufacturer's recommendations. Condenser to be wall

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mounted. Wall mounting brackets to be Jeacent Innovations, model: MB12ALB-1 or equivalent.

3.2 PERFORMANCE

- .1 Provide one (1) forced air furnace complete with evaporator and condensing unit. Condenser to be installed on building roof.
- .2 Provide remote thermostat, refrigerant tubing, gas connections, wires and accessories for a fully functional system.
- .3 Refer to Furnace Schedule. (Gas heating capacities are sea level ratings.)

3.3 FURNACE SCHEDULE

TAG	F-101
Location	Mechanical Room
Manufacturer	Carrier
Furnace Model	59SC5B-060-E14-12
Heating Input (Btu/hr)	60,000
Heating Output (Btu/hr)	56,000
Capacity (CFM)	1155
External S.P. (in. WC)	0.5
Fan Speed (RPM)	500 – 1150
Motor (HP)	0.3
Furnace Power Supply	120 VAC / 1 PH / 60 Hz
Cooling Coil Model	CNPVP3614ALA
Cooling Output (Ton)	3.0
Condenser Model	24ABB336ABN3 (AC-101)
Condenser Power Supply	208 VAC / 1 PH / 60 Hz

END OF SECTION

1. GENERAL

1.1 QUALITY ASSURANCE

- .1 Comply with local and Provincial Regulations and have CSA approval.
- .2 Factory test to check construction, controls and operation of unit and provide certification.
- .3 Operationally test after installation.

1.2 REFERENCE DOCUMENTS

- .1 National Research Council of Canada (NRC):
 - .1 MNECB 1997, Model National Energy Code for Buildings

2. PRODUCTS

2.1 GENERAL CONSTRUCTION

- .1 Construct heater casing and components of 1.3 mm steel panels, reinforced with structural angles and channels to ensure rigidity under normal handling. Provide access panels to burner and blower motor assemblies from either side of unit.
- .2 Locate observation port on burner section for observing main and pilot flames.
- .3 Insulate inlet components to burner profile plate with 25 mm neoprene faced fibrous glass insulation.
- .4 Finish casing and components with heat resistant baked enamel.
- .5 For suspended installations, provide service platforms complete with handrails and access ladder.
- .6 For outdoor installation, provide weatherproofed casing with intake louver or hood.

2.2 FILTERS

- .1 Provide filter section complete with removable 50 mm thick high velocity permanent filters in metal frames.

2.3 BURNER

- .1 Provide raw gas burner suitable for natural gas and capable of modulating turn down ratio of 25:1. Burner assembly and gas piping arrangement to include electric modulating main gas valve, motorized shutdown valve, main and pilot gas regulators, pilot electric gas valve, manual shut-off valve, and pilot adjustment valve.

- .2 Furnish gas burner with electrically ignited supervised pilot. Pilot automatically ignited by spark rod through high voltage ignition transformer.
- .3 Provide motorized damper complete with end switch to prove position before burner will fire.

2.4 FAN

- .1 Provide statically and dynamically balanced centrifugal fan mounted on solid steel shaft with heavy duty self-aligning pre-lubricated ball bearings and V-belt drive with matching motor sheaves and belts.

2.5 CONTROLS

- .1 Pre-wire unit completely so connection of power supply and field wiring from unit to remote control panel shall make unit operative.
- .2 Remote control panel shall contain on-off, auto switch, supply temperature setpoint control potentiometer, summer-winter switch, room temperature override, indicating lights for supply fan and exhaust fan, pilot operation, burner operation, clogged filter indication and lockout indication.
- .3 Interlock make up air units with corresponding exhaust fan. Interlock burner to operate when flow switch located in exhaust duct proves flow.
- .4 Fan discharge thermostat shall control modulating gas valve to maintain supply air temperature. Provide room thermostat to reset discharge thermostat minimum of three temperature levels.
- .6 Provide safety controls to provide correct air flow before energizing pilot and to sense pilot ignition before activating main gas valve.
- .7 Provide manual reset low and high limit controls to maintain supply air temperature between set points and shut fan down if temperatures are exceeded.
- .8 Provide purge period timer to delay burner ignition and automatically bypass low limit control.

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3. EXECUTION

3.1 PERFORMANCE

- .1 Provide exterior mounted unit with 18°C delivery temperature based on 50°C temperature rise. (Gas heating capacities are sea level ratings).

Direct Fired Unit Tag	MUA - 101
-----------------------	-----------

Service Location	South of Building
Manufacturer	Engineered Air
Model	HE 100/O
Gas Input (kW)	290
Weight (kg)	908
Supply Fan air flow (l/s)	3,100
Supply Fan - ESP (Pa)	249
Motor RPM	916
Motor (kW)	5.6
Voltage (V / Ph / Hz)	600 / 3 / 60

END OF SECTION

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1. GENERAL

1.1 PRODUCT DESCRIPTION

- .1 Unit is designed to be used as a stand alone heat recovery ventilator in a dedicated HVAC system.

1.2 QUALITY ASSURANCE

- .1 Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the (C)UL or (C)ETL label of approval.
- .2 Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.
- .3 Airflow data shall comply with AMCA 210 method of testing.

2. PRODUCTS

2.1 GENERAL EQUIPMENT

- .1 Heat recovery ventilator should come as a prepackaged unit consisting of two twin high pressure blowers for supply and exhaust complete with bypass and controls.
- .2 Unit shall have one filter on incoming air and one filter on outgoing air to protect core.
- .3 Unit should come with a non-electric defrost cycle feature which prevent frost and ice buildup within the heat recovery core.
- .4 Unit is to be interlocked with furnace (F-101) blower.

2.2 CONSTRUCTION

- .1 Cabinet: 20 gauge galvanized steel with baked enamel finish, easily removed and secured access doors.
- .2 Fans: The fans shall be direct-drive, forward-curved centrifugal type with statically and dynamically balanced impellers with variable speed operations.
- .3 Filters: The supply and exhaust air streams shall be filtered prior to entering the heat exchanger core by means of a multidirectional fibrous filter.
- .4 Mounting: Accessories for ceiling mounting to be provided with unit.

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3. EXECUTION

3.1 PERFORMANCE

- .1 Refer to Heat Recovery Ventilator schedule for performance data.

3.2 HEAT RECOVERY VENTILATOR SCHEDULE

Tag	HRV 101
Location	Mechanical Room
Manufacturer	Lifebreath
Model	Metro 120F
Fan	Centrifugal Blower
Capacity (L/s)	64
S.P. (Pa)	50
Motor (W)	154
Voltage	120 VAC / 1 Ph / 60 Hz
Accessories	Ceiling Mount Kit

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 This section refers to the supply, installation and satisfactory operation of ductless air conditioning units.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01340.
- .2 Shop drawings and product data to include the following:
 - .1 Outline and arrangement drawings.
 - .2 Materials of construction.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790.
- .2 Maintenance data to include the following:
 - .1 Manufacturer's name, type, year fabricated, capacity and serial number.
 - .2 Details of operation, servicing, and maintenance.
 - .3 Recommended spare parts list with names and addresses.

1.4 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

2. PRODUCTS

2.1 TYPE

- .1 Condensing unit shall be self-contained, packaged, factory assembled, precharged with refrigerant and prewired suitable for outdoor use consisting of casing, compressor, condensing coil and fan, integral sub-cooling coil, controls, screens, crankcase heater, tubing package, control transformer. Condensing unit shall be suitable for cold weather operation to -30°C.

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- .2 Fan coils shall be ceiling mounted unit complete with cooling coil, fan, fan motor, condensate pump, microprocessor controls system, and integral temperature sensing. Unit cabinet shall be fully insulated for improved thermal and acoustical performance. Discharge and inlet grilles shall be attractively styled, high impact polystyrene.

2.2 COMPRESSOR

- .1 Provide fully hermetic reciprocating or scroll type suitable for R-22 refrigerant, resiliently mounted with positive lubrication, crankcase heater, motor overload protection. Scroll compressor shall have high discharge gas temperature protection.
- .2 Reciprocating compressor shall be equipped with crankcase heater.
- .3 Compressor shall have internal spring isolation.

2.3 CONDENSER

- .1 Coil: Seamless copper tubing with mechanically bonded aluminum fins.
- .2 Fans: Horizontal discharge, direct drive propeller fans. Shaft and fan blades shall have inherent corrosion resistance.
- .3 Motors: Permanently lubricated sleeve bearing motors with built-in thermal and overload protection.
- .4 Cabinet: Construct of heavy gauge galvanized steel with baked enamel finish, easily removed access doors or panels, c/w hail guard.
- .5 Fan and coil shall have PVC coated protection grille.
- .6 Low Ambient Kit: Oversized accumulator, head pressure control valve, suitable for condenser operation with ambient air at -33°C.

2.4 CONTROLS AND SAFETIES

- .1 Provide high and low pressure switches for compressor and low ambient lockout.
- .2 A time delay control sequence provided through the fan coil board, thermostat or controller.
- .3 Automatic outdoor fan motor protection.
- .4 Compressor motor current and temperature overload protection.
- .5 Fan coil (ceiling or under ceiling mounted) shall have coil freeze protection and be operated by a wall mounted thermostat with 3 fan speed selections and have "auto/manual" switch.
- .6 Provide fan coil condensate pump to remove condensate from the drain pan when gravity drainage cannot be used. Pump design for quiet operation.

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3. EXECUTION

3.1 INSTALLATION

- .1 Coordinate installation of ductless air conditioning unit with other equipment in spaces. Provide mounting hardware as required for coordinated mounting. Supply and install precast concrete blocks with foam bases for roof mounted condensers.
- .2 Provide adequate drainage connections for humidifier flushing system.
- .3 Coat piping to reduce corrosion where exposed to H2S environments.
- .4 Insulate both gas and liquid piping with closed cell elastomeric insulation, 25 mm thick with fully sealed joints to minimize atmospheric exposure. Provide aluminum recovery where exposed to sunlight. Provide wall penetrations to suit building walls on piping.

3.2 START-UP AND TESTING

- .1 Supply and charge with the initial charge of refrigerant and oil for each refrigeration system. Losses of oil or refrigerant prior to acceptance of equipment or due to defects covered under guarantee shall be replaced. Supply to the Owner, one complete charge of refrigerant and lubricating oil in addition that placed in the system.
- .2 Test entire system for leaks after completion of installation, repair leaks, put system into operation and test equipment performance.

3.3 PERFORMANCE

- .1 Provide one (1) under-ceiling, air cooled ductless air conditioning unit with matched air cooled condensing unit. Condenser to be installed on building exterior mounted to building wall.
- .2 Provide remote thermostat, refrigerant tubing, wires and accessories for a fully functional system.

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3.4 DUCTLESS AIR CONDITIONER SCHEDULE

TAG	AC-102
LOCATION	Electrical Room
MANUFACTURER	Carrier
INDOOR UNIT	
MODEL	40MAQB36B-3
CAPACITY (Ton)	3
FAN OUTPUT (CFM)	870
FAN MOTOR (HP)	1/6
POWER SUPPLY	208 VAC / 1 PH / 60 Hz
OUTDOOR UNIT	
MODEL	38MAQB36R-3
CAPACITY (Ton)	3
FAN MOTOR (HP)	1/4
POWER SUPPLY	208 VAC / 1 PH / 60 Hz
ACCESSORIES	<ul style="list-style-type: none"> - Condensate pump, model 53DS-900-118 - Remote Thermostat (T-112), model KSACN0401AAA - Wall mounting brackets (Jeacent Innovations, model: MB12ALB-1 or equivalent)

END OF SECTION

1. GENERAL

1.1 ALTERNATIVES

- .1 Size round ducts installed in place of rectangular ducts indicated from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration of sizes permitted except by written permission.

1.2 DEFINITIONS

- .1 Low Pressure: Static pressure in duct less than 0.5 kPa and velocities less than 10 m/s.
- .2 Medium Pressure: Static pressure in duct less than 1.5 kPa and velocities greater than 10 m/s.
- .3 High Pressure: Static pressure over 1.5 kPa and less than 2.5 kPa and velocities greater than 10 m/s.
- .4 Duct Sizes: Inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.3 SUBMITTALS

- .1 Submit shop drawings and samples of duct fittings for approval, including particulars such as thicknesses, welds and configurations prior to start of work.
- .2 Submit shop drawings for fibrous glass ducts including manufacturers fabrication and installation manual.
- .3 Submit written inspection report of manufacturers acceptance of fabrication and installation of fibrous glass ductwork. Confirm ductwork has been fabricated and installed in accordance with recommendations and SMACNA standards. Inspection shall occur at beginning of installation.

1.4 QUALITY ASSURANCE

- .1 Ductwork shall meet the requirements of NFPA 90A-1996, Air Conditioning and Ventilating Systems.
- .2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

2. PRODUCTS

2.1 MATERIALS

- .1 Hazardous Areas: Aluminum lock forming quality. Size in accordance with SMCNA guides for industrial facilities, Thickness charts in this section are for galvanized ductwork.

- .2 All Other Ducts: Galvanized steel lock forming quality, having galvanized coating to ASTM A653M-96, G90 designation for both sides.
- .3 Fasteners: Use rivets and bolts throughout; stainless steel sheet metal screws accepted on low pressure ducts, stainless steel on aluminum ducts.
- .4 Sealant: Water resistant, fire resistive, compatible with mating materials.
- .5 Flexible Ducts: Corrugated aluminum, supported by helically wound steel wire or flat steel strips.

2.2 FABRICATION

- .1 Complete metal ducts with themselves with no single partition between ducts. Where width of duct exceeds 450 mm cross break for rigidity. Open corners are not acceptable.
- .2 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.
- .3 Construct tees, bends, and elbows with radius of not less than 1 1/2 times width of duct on centre line. Where not possible and where rectangular elbows used, provide approved type air foil turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fiberglass inside.
- .4 Increase duct sizes gradually, not exceeding 15 degree divergence wherever possible. Maximum divergence upstream of equipment to be 30 degree and 45 degree convergence downstream.
- .5 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.
- .6 Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two ducts maintaining original duct area.
- .7 Provide necessary baffling in mixed air plenums to ensure good mixed air temperature with variations of not more than $\pm 15^{\circ}\text{C}$ under all operating conditions.
- .8 Fabricate continuously welded medium pressure round and oval duct fittings of one gauge heavier than gauges indicated for duct size. Joints shall be 100 mm cemented slip joint, brazed or electric welded. Prime coat welded joints. Fabricate elbows of five piece construction. Provide standard 45° take-offs unless otherwise indicated where conical 90° tee take-off connections may be used. Adequately brace with truss couplings or comparison angle flanges with asbestos gaskets bolted at 150 mm centers.
- .9 Fabricate plenums and casings to configurations shown on drawings. Construct plenums of galvanized panels joined standing seams on outside of casing riveted or bolted on approximately 300 mm centers. Reinforce with suitable angles and provide diagonal bracing as required. Tightly fit at apparatus and caulk with sealant.

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- .10 Reinforce door frames with angle iron tied to horizontal and vertical plenum supporting angles. Install hinged access doors where shown, specified or where required for access to equipment for cleaning and inspection.
- .11 Fabricate acoustic plenums of galvanized steel. Provide 1.6 mm back facing and 0.8 mm perforated front facing with 3 mm diameter holes on 4 mm centers. Construct panels 75 mm thick packed with 72 kg/m³ minimum fibrous glass media, on inverted channels of 1.6 mm.
- .12 Provide turning vanes for all square ductwork elbows to minimize static losses in the ductwork.

3. EXECUTION

3.1 INSTALLATION

- .1 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pivot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- .2 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.
- .3 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .4 Set plenum doors 150 mm to 300 mm above floor. Arrange door swings so that fan static holds door in closed position.
- .5 Connect terminal units to medium pressure ducts with 300 mm maximum length of flexible duct. Do not use flexible duct to change direction.
- .6 Connect diffusers to low pressure ducts with 1.5 m maximum length of flexible duct. Hold in place with caulking compound and strap or clamp.

3.2 LOW PRESSURE DUCT THICKNESSES (MINIMUM)

.1 Rectangular Ducts	
Maximum Width	mm
Up to 300 mm	0.6
330 mm to 760 mm	0.8
790 mm to 1370 mm	0.8
1400 mm to 2130 mm	1.0
2160 mm and Over	1.2

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.2	Round Ducts	
	Duct Diameter	mm
	Up to 330 mm	0.6
	350 mm to 550 mm	0.8
	580 mm to 1270 mm	0.8
	890 mm to 910 mm	1.0
	1300 mm to 1520 mm	1.2
	1550 mm to 2130 mm	1.6

3.3 MEDIUM PRESSURE DUCT THICKNESS

.1	Rectangular Ductwork	
	Maximum	mm
	Up to 460 mm	0.8
	480 mm to 1220 mm	0.8

3.4 MEDIUM & HIGH PRESSURE DUCT THICKNESSES

		Spiral Lock Seam	Longitudinal Seam
.1	Round Ducts	mm	mm
	Up to 200 mm	0.6	0.8
	230 to 560 mm	0.8	0.8
	580 to 910 mm	0.8	1.0

3.5 OVAL DUCTWORK (FACTORY MADE WITH SPIRAL LOCK SEAMS)

.1	Maximum Width	mm	Centers	Reinforcement
	Up to 500 mm	0.8		none
	280 to 500 mm	0.8	1220 mm	L50 x 50 x 3 mm
	530 to 1020 mm	1.2	760 mm	L50 x 50 x 5 mm

3.6 PLENUM GAUGES

- .1 Fabricate fan plenums and plenums downstream of fan in accordance with duct gauges.
- .2 Fabricate plenums upstream of fan between apparatus of 1.6 mm.
- .3 Fabricate plenums upstream of filters of 1.2 mm

END OF SECTION

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1. GENERAL

1.1 SUBMITTALS

- .1 Submit shop drawings for Engineer review.

1.2 QUALITY ASSURANCE

- .1 Fire dampers shall be UL listed and constructed in accordance with CAN/ULC-S112-1990, Fire Test of Fire Damper Assemblies.
- .2 Fusible links on fire dampers shall be constructed to ULC S505-1974.
- .3 Demonstrate resetting of fire dampers to authorities having jurisdiction.
- .4 Access doors shall be UL labelled.
- .5 Accessories shall meet the requirements of NFPA 90A-1996, Installation of Air Conditioning and Ventilating Systems.
- .6 Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

2. PRODUCTS

2.1 ACCESS DOORS

- .1 Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Install minimum 25 mm thick insulation with suitable sheet metal cover frame for insulated ductwork.
- .2 Fabricate with two butt hinges and two sash locks for sizes up to 450 mm, two hinges and two compression latches with outside and inside handles for sizes up to 600 x 1200 mm .

2.2 FIRE DAMPERS

- .1 Fabricate of galvanized steel or prime coated black steel weighted to close and lock in closed position when released by fusible link.
- .2 Fire dampers in low pressure ductwork may be multi-blade, offset butterfly or curtain type.
- .3 Fabricate combination fire and balancing dampers with linkage readily adjustable in open position.
- .4 Fire dampers in medium and high pressure ductwork shall be curtain type.
- .5 Curtain type fire dampers shall have blades retained in a recess so free area of connecting ductwork is not reduced.
- .6 Fusible links shall be set for 72°C.

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- .7 For PVC and other combustible plastic vents and ducts, fire dampers shall be accomplished intumescent fire blocking systems suitable for the piping where they are installed. Supply with color system installed in accordance with the manufacturer's recommendations.

2.3 BALANCING DAMPERS

- .1 Fabricate of galvanized steel, minimum 1.6 mm, and provide with quadrants or adjustment rod and lock screw.
- .2 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.
- .3 Construct damper blades for medium pressure systems to block air passage 70% maximum. Provide complete with locking type handles.

2.4 FLEXIBLE CONNECTIONS

- .1 Fabricate of approved neoprene coated flameproof fabric approximately 50 mm wide tightly crimped into metal edging strip and attach to ducting and equipment by screws or bolts at 150 mm intervals.

3. EXECUTION

3.1 INSTALLATION

- .1 Provide adequately sized access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Review locations prior to fabrication.
- .2 Provide 100 x 100 mm quick opening access doors for inspection at balancing dampers.
- .3 Provide fire dampers at locations indicated on drawings. Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings, and hinges.
- .4 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.
- .5 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct as required for proper air balancing.
- .6 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and where indicated on the drawings.
- .7 For connections to medium and high pressure fans, install 12 mm thick neoprene pad over fabric and hold in place with additional metal straps.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 General Mechanical Starting and Testing Requirements: Section 15951.
- .2 Mechanical Equipment Starting and Testing: Section 15952.

1.2 PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Division 1.
- .2 Substitute products shall not decrease motor wattage, increase noise level, increase tip speed by more than 10%, or increase inlet air velocity by more than 20%, from that specified.

1.3 SUBMITTALS

- .1 Submit with shop drawings acoustical data and fan curves showing fan performance with fan and system operating point plotted on curves.

1.4 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

2. PRODUCTS

2.1 GENERAL

- .1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.
- .2 Provide balanced variable sheaves for motors 10 kW and under and fixed sheave to 15 kW and over.
- .3 Fans shall be capable of accommodating static pressure variations of $\pm 10\%$ with no objectionable operating characteristics.

- .4 Coordinate discharge damper sites for all sidewall fans.
- .5 Coordinate damper size requirements for all exhaust fans. Continuous service fans to come with gravity dampers.

2.2 SIDEWALL MOUNTED FANS

- .1 Provide V-belt drives with fan and motor mounted to main housing through neoprene anti-vibration pads.
- .2 Heavy aluminum dome type housings shall be reinforced as necessary on sizes with 500 mm wheel and larger.
- .3 Provide with multi-blade, rattle free, backdraft damper with felt lined blade edges, birdscreen, disconnect switch and curb caps.

2.3 CENTRIFUGAL FANS

- .1 Fabricate with multi-blade wheels in heavy gauge steel housing reinforced for service encountered.
- .2 Provide V-belt drives with fan and motor mounted on reinforced, rigid steel base with adjustable motor mount.
- .3 Provide heavy duty, self-aligning, anti-friction bearings with external lubrication.
- .4 Provide where indicated variable inlet vanes.
- .5 Provide access door and drain connection to scroll.
- .6 Except for packaged air units, belted vent sets and as otherwise noted, centrifugal fans over 430 mm diameter shall have die formed air foil blades welded to side and back plate.

2.4 PROPELLER FAN

- .1 Directly connect steel or aluminum blade fans with heavy hubs to motor.
- .2 Motor shall have self-aligning ball or sleeve bearings with adequate lubricating arrangements.
- .3 Mountings shall be cast or die formed to smooth curves. Supply size to fit openings provided.
- .4 Provide safety screens in inlet.
- .5 Use neoprene vibration isolation between fan assembly and mounting plate.

2.5 CEILING EXHAUST FANS

- .1 Provide ceiling mounted exhaust fans. Fans shall be the models scheduled with the capacities indicated.
- .2 Fans shall have maximum operating temperatures at 54.4 degrees Celsius, and UL/cUL listed for above bathtub exhaust.
- .3 The fan motor shall be direct drive and shall operate at 120V and 60 Hz. Fan motor shall be mounted on vibration isolators and be accessible for maintenance, and shall have thermal overload protection.

3. EXECUTION

3.1 PERFORMANCE

- .1 Fan performance based on sea level conditions.
- .2 Refer to Fan Schedule.

3.2 INSTALLATION

- .1 Where inlet or outlet is exposed, provide safety screen.
- .2 Provide belt guards on belt driven fans.
- .3 Supply and install sheaves as necessary for final air balancing.

3.3 PRIMING

- .1 Prime coat fan wheels and housing factory inside and outside. Prime coating on aluminum parts is not required.

3.4 STARTING AND TESTING

- .1 Start and test fans as specified in Section 15991 and 15992.

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3.5 FAN SCHEDULE

TAG	EF-101	EF-102	EF-201
Location	Treatment Room	Headworks Room	Treatment Room
Manufacturer	Greenheck	Greenheck	Continental Fan
Model	CWB-300	CWB-300	AXC200A-ES
Type	Sidewall Exhaust	Sidewall Exhaust	Inline Centrifugal
AIR FLOW L/s (CFM)	3,100 (6,569)	735 (1,557)	142 (300)
ESP Pa (in. Wc)	187 (0.75)	31 (0.125)	50 (0.2)
RPM	605	1410	2500
Motor kW (HP)	1.12 (1.5)	0.19 (0.25)	0.08 (0.11)
Voltage/Phase	600/3	600/3	120/1
Notes	- Provide air proving switch (Interlock with MUA-101)	- Explosion Proof Motor	- Mounting Clamps

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3.5 FAN SCHEDULE - CONTINUED

TAG	SF-201	SF-202	SF-203
Location	West of Building	Treatment Room	Headworks Room
Manufacturer	Continental Fan	Continental Fan	Continental Fan
Model	AIB-15	AIB-15	AIB-15
Type	Inline Axial	Inline Axial	Inline Axial
AIR FLOW L/s (CFM)	1,534 (3,250)	1,550 (3,284)	1,012 (2,145)
ESP Pa (in. Wc)	124 (0.5)	124 (0.5)	124 (0.5)
RPM	2370	2393	1643
Motor kW (HP)	1.12 (1.5)	1.12 (1.5)	1.12 (1.5)
Voltage/Phase	208/1	208/1	208/1
Notes	<ul style="list-style-type: none"> - Vertical Mounting Brackets - 316 Stainless Steel Construction - To be suitable for outdoor installation 	<ul style="list-style-type: none"> - Vertical Mounting Brackets - 316 Stainless Steel Construction 	<ul style="list-style-type: none"> - Explosion Proof Motor - Vertical Mounting Brackets - 316 Stainless Steel Construction

END OF SECTION

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1. GENERAL

1.1 QUALITY ASSURANCE

- .1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes and ASHRAE standards.
- .2 Unit ratings shall be approved by ADC.
- .3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

2. PRODUCTS

2.1 GENERAL

- .1 Base air outlet application on space noise level of NC 35 maximum.
- .2 Provide supply outlets with sponge rubber seal around the edge.
- .3 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.
- .4 Provide plaster frame for diffusers located in plaster surfaces.
- .5 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

2.2 RECTANGULAR SUPPLY GRILL

- .1 Sidewall supply grilles shall have streamlined and individually adjustable blades, depth of which exceeds 20 mm maximum spacing. Provide spring tension or other device to set blades. Provide units with vertical face, double deflection bar style grilles.
- .2 Provide 32 mm margin frame with countersunk screw holes.
- .3 Fabricate of aluminum with 1.0 mm minimum frames and 1.0 mm minimum blades, or heavy aluminum extrusions.
- .4 Provide grilles with integral, gang-operated opposed blade dampers with removable key operator, operable from face.
- .5 Finish in factory baked enamel finish.

2.3 RETURN AND EXHAUST GRILLES

- .1 Sidewall and ceiling exhaust grilles shall have streamlined blades, depth of which exceeds 20 mm spacing. Provide spring tension or other device to set blades. Provide units with vertical face.
- .2 Provide 32 mm margin frame with countersunk screw holes.
- .3 Fabricate of aluminum with 1.0 mm minimum frames and 0.8 mm minimum blades.
- .4 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed blade dampers with removable key operator, operable from face.
- .5 Finish in factory baked enamel finish.

2.4 GRID CORE TRANSFER AND EXHAUST GRILLES

- .1 Fabricate fixed grilles of 12 x 12 x 12 mm louvres.
- .2 Provide 32 mm margin frame with countersunk screw holes.
- .3 Fabricate of aluminum.
- .4 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed bladedampers with removable key operator, operable from face.

2.5 RECTANGULAR SUPPLY DIFFUSER

- .1 Provide rectangular, adjustable pattern, stamped, multi-core type diffuser to discharge air in 360° pattern with sectorizing baffles where indicated or required.
- .2 Diffusers shall have inverted T-bar type frame.
- .3 Fabricate of aluminum with baked enamel white finish.
- .4 Provide radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.6 GOOSENECKS

- .1 Fabricate goosenecks of standard weight galvanized steel.
- .2 Mount on minimum 300 mm high curb base where size exceeds 230 x 230 mm.
- .3 Provide and install bird screen.

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3. EXECUTION

3.1 INSTALLATION

- .1 Positions indicated on drawings are approximate only. Check location of outlets and make necessary adjustments in position to conform to architectural features, symmetry and lighting arrangement.

3.2 SIZING

- .1 Size outside air openings as indicated on drawings.
- .2 Size air outlets as indicated on drawings.

3.3 AIR OUTLET SCHEDULE

TAG	S-1	S-2	E-1
Service/type	Double Deflection Supply	Square Cone Diffuser	45 Degree Deflection Return
Manufacturer	Price	Price	Price
Model	620/F/S/A	SCD/3C/B12	635/F/S/A
Size (mm)	610 x 310	600 x 600	610 x 310
Location	Treatment Room, Headworks Room, Pump Room	Lab/Control Room, Office, Washroom, Mechanical Room, Electrical Room	Treatment Room, Headworks Room, Pump Room
Notes	Complete with balance damper	For installation in t-bar	Complete with balance damper

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3.3 AIR OUTLET SCHEDULE CONTINUED

TAG	E-2	R-1
Service/type	Egg Face Crate Return	Egg Face Crate Return
Manufacturer	Price	Price
Model	80DAL/F/A/B12	80DAL/F/A/B12
Size (mm)	300 x 300	300 x 300
Location	Washroom, Mechanical Room	Lab/Control Room, Office, Electrical Room
Notes	For installation in t-bar	For installation in t-bar

END OF SECTION

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1. GENERAL

1.2 SUBMITTALS

- .1 This section refers to the supply, installation and satisfactory operation of louvers and dampers

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01340.
- .2 Shop drawings and product data to include the following:
 - .1 Outline and arrangement drawings.
 - .2 Materials of construction.

1.3 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into the manual specified in Section 01790.
- .2 Maintenance data to include the following:
 - .1 Manufacturer's name, type, year fabricated, capacity and serial number.
 - .2 Details of operation, servicing, and maintenance.
 - .3 Recommended spare parts list with names and addresses.

1.4 TAGGING

- .1 Provide each piece of equipment with a tag stamped or engraved with the appropriate equipment number, as listed in this Specification.
- .2 Tags to be 20mm high, 75mm long, and 1.5mm thick Lamecoid with 10 mm high alphanumeric characters, Helvetica font, reverse engraved. Characters to be white on coloured background. Background colour to be red.
- .3 The code lettering and number system shall be as shown on the drawings or as directed by the Engineer.
- .4 Affix tags to equipment securely.

2. PRODUCTS

2.1 GENERAL

- .1 Factory apply baked primer coat on metal surfaces of enclosure or cabinet.

2.2 FIXED LOUVERS

- .1 Construction: welded with exposed joints ground flush and smooth.

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- .2 Material: extruded aluminum alloy 6063-T5
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill, and jamb: 100 - 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at maximum 1500 mm centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 12 mm exhaust, 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louver in formed U-frame.
- .8 Finish: factory applied enamel, prime coated. Colour to match building trim.
- .9 Dimensions:
 - .1 150 mm x 150 mm: L-1 (Quantity: 3)
 - .2 200 mm x 200 mm: L-201
 - .3 400 mm x 400 mm: L-102, L-202, L-203
- .10 Specified Product: Price DE635.

2.3 FIRE DAMPERS

- .1 Frame: 108mm wide, 22gage roll formed G-60 galvanized steel.
- .2 Blades: Curtain type interlocking blades, 22 gage roll-formed G-60 galvanized steel.
- .3 Fabricate combination fire and balancing dampers with linkage readily adjustable in open position.
- .4 Fire dampers in medium and high pressure ductwork shall be curtain type.
- .5 Specified Product: Nailor Model 0120V.
 - .1 Fusible link: 74°C standard.
 - .2 Spring: Stainless Steel.

2.4 DAMPERS - GRAVITY

- .1 Applicable Equipment: DM-EF-201, DM-SF-202, DM-SF-203
 - .1 Location:
 - .1 Treatment Room: DM-EF-201, DM-SF-202
 - .2 Headworks Room: DM-SF-203

- .2 Specified Equipment: DM-EF-201, DM-SF-202, DM-SF-203
 - .1 Manufacturer: Greenheck
 - .2 Model: WD-400 Series
 - .3 Dimensions:
 - .1 200 mm x 200 mm: DM-EF-201
 - .2 400 mm x 400 mm: DM-SF-202, DM-SF-203
 - .4 Airflow Direction: Horizontal
 - .5 Material:
 - .1 Frame: Galvanized Steel
 - .2 Blade: Aluminum
 - .6 Accessories: Provide Counterbalance Weights to adjust opening pressure if required during balance testing
- .3 Tag #: DM-EF-201, DM-SF-202, DM-SF-203

2.5 DAMPERS – ACTUATED

- .1 Applicable Equipment: DM-102, DM-EF-101, DM-EF-102
 - .1 Location:
 - .1 Treatment Room: DM-EF-101
 - .2 Headworks Room: DM-102, DM-EF-102
 - .2 Specified Equipment: DM-102, DM-EF-101, DM-EF-102
 - .1 Manufacturer: Greenheck
 - .2 Model: ICD-45
 - .3 Dimensions:
 - .1 300 mm x 300 mm (To suit Exhaust Fan EF-102): DM-EF-102
 - .2 400 mm x 400 mm: DM-102
 - .3 750 mm x 750 mm (To suit Exhaust Fan EF-101): DM-EF-101
 - .4 Low Leakage, thermally insulated
 - .5 Closed / full open
 - .6 Spring Return, Direct coupled
 - .7 UL listed and CSA certified
 - .8 c/w actuators and all required accessories
 - .3 Specified Actuators: DM-102, DM-EF-101, DM-EF-102
 - .1 Manufacturer: Belimo
 - .2 Model: AF-120
 - .3 Power supply: 120 VAC, 60 Hz
 - .4 Torque: 133 in-lb
 - .5 Running time: 150 sec. constant
 - .6 Spring return fail closed, direct coupled
 - .4 Explosion Proof Housing: DM-102, DM-EF-102
 - .1 Manufacturer: Belimo
 - .2 Model: ZS-260
 - .3 Housing Material: Cast aluminum

.5 Tag #: DM-102, DM-EF-101, DM-EF-102

3. EXECUTION

3.1 INSTALLATION

- .1 Supply and install louvers and dampers to the sizes indicated on the design drawings, frame thickness appropriate to the wall in which it is installed.
- .2 Install in accordance with manufacturers instructions.
- .3 Fire dampers of 22 gauge galvanized steel integral sleeve shall be of the same gauge or heavier as the duct to which is attached. Gauges shall conform to SMACNA or ASHRAE duct standards.

3.2 OPERATION

- .1 Install dampers as required to operate in accordance with Section 15830 and Division 13.
- .2 Verify fail position of damper
- .3 All moving parts of the fire dampers must be inspected and cycled at intervals not greater than every six months and in accordance with the latest edition of NFPA.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Contractor Start-Up Report Forms: Division 1.
- .2 Mechanical Equipment Starting and Testing: Section 15952.
- .3 Mechanical System Starting and Testing: Section 15953.
- .4 Balancing and Adjusting of Mechanical Equipment and Systems: Section 15954.

1.2 OWNER'S WITNESSING OF TESTS

- .1 Owner may witness selected starting, testing, adjusting, balancing and cleaning procedures.
- .2 Advise the Owner in advance that starting, testing, adjusting, balancing or cleaning processes are ready to commence. Provide advanced notice prior to commencement of each procedure or series of procedures to allow Owner to arrange for witnessing of tests.

1.3 STARTING AND TESTING COSTS

- .1 Pay costs associated with starting, testing, adjusting, balancing and cleaning, including supply of instruments, equipment, supplies, and consumable materials.

1.4 START-UP REPORTS

- .1 Submit Start-Up reports as part of Operation and Maintenance Manual.

1.5 REPORTS

- .1 Submit Contractor Start-Up Report forms documenting starting and testing procedures performed, and observed tests results obtained.

1.6 QUALITY ASSURANCE

- .1 Use personnel for starting, testing, adjusting and balancing procedures who have experience in mechanical equipment and systems commissioning, and are able to interpret results of readings and tests and report state of systems in a clear and concise manner.

1.7 MANUFACTURER'S RECOMMENDATIONS

- .1 Prior to starting equipment or systems, obtain and review manufacturer's installation, starting and operating instructions. Read in conjunction with procedures specified herein.
- .2 Use manufacturer's and supplier's trained personnel where necessary to maintain validity of manufacturer's warranty.

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- .3 Compare actual installation with manufacturer's recommended installation. Record discrepancies. Correct deviations detrimental to equipment performance prior to starting equipment.

1.8 REGULATORY REQUIREMENTS

- .1 To facilitate expedient turnover of facility at Interim Acceptance of the Work, arrange for regulatory authorities to witness those specified starting procedures that duplicate tests required by regulatory authorities.
- .2 Obtain certificates of approval and for compliance with regulations from authorities having jurisdiction. Include copies of certificates with start-up reports.

2. PRODUCTS

2.1 TESTING INSTRUMENTS AND EQUIPMENT

- .1 Provide testing instruments and equipment and ancillary equipment such as two-way radios and ladders required to perform starting, testing, adjusting and balancing of mechanical equipment and systems.
- .2 Use instruments supplied or calibrated by approved laboratory or manufacturer.
- .3 Recalibrate instruments at frequency recommended by instrument manufacturer or, in absence of manufacturer's recommendations, as required by Associated Air Balance Council (AABC).
- .4 Use testing instruments and equipment which meet following accuracy requirements:

Device	Range	Accuracy
Air Temperature	-40 to 75°C	±0.10°C
Hydronic temperature	-40 to 120°C	±0.10°C
Stack Temperature	-40 to 300°C	±1.00°C
Air Velocity Pressure	0 to 250 Pa	±2% of reading
Air Pressure	0 to 2500 Pa	±12.5 Pa
Hydraulic Pressure	0 to 1400 KPa	±2% of gauge
Air Velocity	0.1 to 20 m/s	±2% of gauge
Sound Meter	35 to 130 dB	ANSI S 1.4 Type 2
Octave Band Filters	63 to 8000 Hz	ANSI S 1.11
		Class II
Humidity	10 to 90% RH	±3.0%

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.5 Following testing instruments and equipment makes and models are also acceptable:

Equipment	Make	Model
Sound Level Meter	Quest	2700
Octave Band Filters	Quest	OB-50
Flue Gas Analyzer	Kane May	KM 9002
Stack Thermometer	Bacharach	12-7018
Tachometer (contact)	Ono-Sokki	HT-331
Tachometer (strobe)	Ono-Sokki	HT 441
Belt Tension Tester	Woods	
Inclined Manometer	Dwyer	400-10
Air Pressure Gauge	Magnahelic	
	-125 to 125 Pa	2300-250 Pa
	0 to 250 Pa	2000-250 Pa
	0 to 1000 Pa	2000-1 KPa
Fluid Pressure Gauge	Marsh	0 to 60 psi
	Marsh	0 to 160 psi
	Marsh	30"Hg - 60 psi
Thermometer	Palmer	MS-13
Digital Thermometer	Fluke Multi-meter	8062A with 80T-150 surface probe 80PK-5 piercing
Digital Anemometer	ITM Instruments	DA 4000
Micromanometer	Shortridge	8420
Flow Hood	Shortridge	8400 with 8420 meter
Air Quality Monitor	Armstrong	AMC-1013P

3. EXECUTION

3.1 USE OF INSTRUMENTS SUPPLIED UNDER CONTRACT

- .1 Use "Calibrated Air Flow Measuring Stations" to measure air flow during system balancing and coil performance testing.
- .2 Use balancing valve pressure tappings, orifice plates, pitot tube fittings, etc. to measure fluid flow rates.
- .3 Calibrated temperature, humidity and pressure sensors may be used to gather Contractor Start-up Program system performance data provided, confirms that sensor calibrations have been completed and approved.

3.2 INSPECTION

- .1 Do not conceal or cover equipment or systems until inspected, tested and approved by Owner.

3.3 COMPLIANCE WITH DEFINED PROCEDURES

- .1 Failure to follow specified instructions pertaining to correct starting procedures may result in re-evaluation of equipment by independent testing agency selected by the Owner at Contractor's expense. Should results reveal equipment has not been started in accordance with specified requirements, equipment may be rejected. If rejected, remove equipment from site and replace. Replacement equipment will also be subject to full starting procedures, using same procedures specified for originally installed equipment.

3.4 CHECK SHEETS, FIELD REPORTS AND DATA

- .1 Record all data gathered on site on start-up report forms.
- .2 Make copies of all starting and testing data before equipment and system start-up personnel leave site. Maintain one copy of all data taken during starting on site.
- .3 Maintain one copy of all final starting, testing, adjusting and balancing reports on site up for reference purposes.

3.5 COORDINATION

- .1 Prior to commencement of each particular testing procedure, coordinate all sub-trades, manufacturers, suppliers and other specialties to ensure all phases of work are properly completed. Establish necessary manpower requirements.

3.6 STARTING AND TESTING PHASES

- .1 Starting and testing program generally consists of following five distinct phases:
 - .1 Pre-Starting: visual inspection
 - .2 Starting: actual starting procedure.
 - .3 Post-Starting: operational testing, adjusting or balancing and equipment run-in phase.
 - .4 Pre-Interim Acceptance of the Work: final cleaning, re-testing, balancing and adjusting and maintenance.
 - .5 Post-Interim Acceptance of the Work: retesting and fine-tuning of system to prove all deficiencies have been corrected.
- .2 After each distinct phase of work has been completed, correct deficiencies before commencing the next phase.

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3.7 SPECIALTY AGENCIES AND TESTING LABORATORIES

- .1 Arrange for reports prepared by special testing agencies and testing laboratories to be submitted directly to the Owner. Include a copy of each report in Contractor Start-Up Program report.
- .2 Agencies and testing laboratories shall have facilities and qualifications acceptable to the Owner.

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 Inspect, start and test each piece of mechanical equipment. Verify that equipment has been properly installed and is operating at a level which meets specified requirements.

1.2 RELATED SECTIONS

- .1 Contractor Start-Up Report Forms: Division 1
- .2 Mechanical General Requirements: Section 15015
- .3 General Mechanical Starting and Testing Requirements: Section 15951
- .4 Balancing and Adjusting of Mechanical Equipment and Systems: Section 15954

1.3 FACTORY TRAINED REPRESENTATIVES

- .1 Use factory trained representatives and submit manufacturer's check sheets for starting following specialty equipment:
 - .1 Air handling unit.
 - .2 Control components.
 - .3 Air cooled condensing unit.
- .2 Use manufacturers factory trained personnel where required to maintain manufacturer's warranty.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 AIR HANDLING EQUIPMENT - AIR HANDLING UNITS

- .1 Pre-Starting:
 - .1 Check that installation is as drawn and specified and in accordance with manufacturer's recommendations.
 - .2 Complete manufacturer's installation and start-up check sheets including following:
 - .1 Air blender, mixing baffles.
 - .2 Fresh, Exhaust and Recirculation air motorized dampers, operation and size.
 - .3 Filters.
 - .4 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.
 - .5 Special features, access doors, liners, inlet vanes, labels.

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- .6 For variable volume systems, ensure variable volume/speed controller is operational.
 - .7 Ensure silencers are installed.
- .3 Lubricate bearings on fans as recommended by manufacturer. Ensure fan wheels rotate in correct direction without binding. Adjust belts to proper alignment and tension.
- .4 Vacuum clean air systems.
- .5 Ensure temporary filters are installed. **Never** operate system without filters installed.
- .6 Ensure all balancing and fire dampers are open and ductwork is complete. For VAV systems ensure at least 60% of boxes are open.
- .7 Ensure all coils are in operation. If outside air temperature is less than 2°C ensure coils are dry or filled with glycol.
- .8 On parallel fan systems ensure backdraft dampers are installed.
- .9 Ensure electrical connections are complete and system disconnects are within sight of unit.
- .10 Ensure controls are operational.
- .11 Ensure inlet and discharge duct geometry is correct.
- .2 Starting:
 - .1 Follow manufacturer's recommendations.
- .3 Post-Starting:
 - .1 Start fan, for variable speed fans run up to maximum speed, and check for vibration free operation.
 - .2 Check for correct static deflection of unit vibration isolators, and that start-up and shut down deflection is within resilience limits.
 - .3 Run for one day and check filters, coils, and humidifier for bypass. Seal as required.
 - .4 Check that bearings are not overheating.

3.2 AIR HANDLING EQUIPMENT - FANS

- .1 Pre-Starting:
 - .1 Check that installation is as drawn and specified and in accordance with manufacturer's recommendations.
 - .2 Complete manufacturer's installation and start-up check sheets including following:
 - .1 Motorized dampers.
 - .2 Accessories.
 - .3 Special features.
 - .4 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.
 - .3 Lubricate bearings on fans as recommended by manufacturer.
 - .4 Ensure fan wheels rotate in correct direction without binding.
 - .5 Adjust belts to proper alignment and tension.
 - .6 Ensure ductwork and fan casing is free of dirt or foreign material.
 - .7 Ensure electrical connections are complete and disconnect is within sight of fan.
 - .8 Ensure inlet and discharge duct geometry is correct.
- .2 Starting:
 - .1 Follow manufacturer's recommendations.
- .3 Post-Starting:
 - .1 Start fan, for variable speed fans run up to maximum speed, and check for vibration free operation.
 - .2 Check for correct static deflection of unit vibration isolators, and that start-up and shut down deflection is within resilience limits.
 - .3 Check that bearings are not over heating.

3.3 AIR COOLED CONDENSERS

- .1 Pre-Starting:
 - .1 Check that installation is as drawn and specified and in accordance with manufacturer's recommendations.
 - .2 Complete manufacturer's installation and start-up check sheets including following:
 - .1 No physical damage to unit has occurred.
 - .2 All access doors move freely and are weathertight.
 - .3 Unit is free of foreign debris.
 - .4 All bolts, screws are tight.
 - .5 Condenser base vibration isolation and flexible connections on refrigerant pipes are properly installed.
 - .6 Controls complete.
 - .7 Check acoustic insulation.

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- .8 Fan guards are installed.
- .3 Lubricate bearings on fans as recommended by manufacturer.
- .4 Ensure fan wheels rotate in correct direction without binding.
- .5 Adjust belt to proper alignment and tension.
- .2 Starting:
 - .1 Start in accordance with manufacturer's instructions.
 - .2 Complete manufacturers starting check sheet.
- .3 Post-Starting:
 - .1 Ensure all fan guards are tight.
 - .2 Check air flows over coils.
 - .3 Check operation of condenser capacity control device.
 - .4 Ensure vibration isolation and flexible connections to unit properly damp vibration transmission to structure.

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 Inspect, start-up and commission each system to prove that each system meets its specified operating criteria.

1.2 RELATED SECTIONS

- .1 Construction Schedules: Division 1.
- .2 Contractor Start-up Report Forms: Division 1.
- .3 General Mechanical Starting and Testing Requirements: Section 15951.
- .4 Mechanical Equipment Starting and Testing: Section 15952.
- .5 Balancing and Adjusting of Mechanical Equipment and Systems: Section 15954.
- .6 Pressure Testing: Section 15955.

1.3 FACTORY TRAINED REPRESENTATIVES

- .1 Use manufacturers' representatives where required to maintain manufacturers' warranties.

2. PRODUCTS

Not Used.

3. EXECUTION

3.1 OPERATIONAL TESTS

- .1 Conduct operational tests after mechanical installations have been completed and pressure tested to demonstrate that equipment and systems meet specified performance requirements. Conduct these tests as soon as conditions permit. Make changes, repairs, adjustments, and replacements required as tests may indicate.
- .2 Conduct pre-operational tests, processes and inspections in presence of the Owner.
- .3 Conduct final operational tests in presence of the Owner. Vary loads to illustrate start-up and shut down sequences. Simulate emergency conditions for safety shut downs, with automatic and manual reset. Repair and retest defects until satisfactory results are achieved. Make final adjustments to suit exact building conditions.

3.2 AIR SYSTEMS

- .1 Inspect air systems including ductwork layout, support, and vibration isolation before pressure testing any section of ductwork. Notify Owner when work is ready for inspection.
- .2 Pressure test sections of ductwork, in accordance with Section 15955, prior to application of insulation or concealment.
- .3 Test drop fire dampers in accordance with Section 15954. Notify Owner two working days prior to fire damper testing.
- .4 Air Handling Unit: start-up and performance verification using manufacturer's representative. Provide two working days notice to the Owner.
- .5 Start up coil circulators, exhaust air systems, etc.
- .6 Demonstrate operation of mixing section, blender, filters, freeze protect, fire alarm interlocks, etc.
- .7 Performance test fans, coils, etc. in accordance with Section 15954.
- .8 Balance air systems in accordance with Section 15954. Complete and submit Air Systems balance report to Owner.
- .9 If necessary change pulley drives to correct volume up or down on constant volume systems, and to correct volume up on variable volume systems.
- .10 Perform acoustic survey in accordance with Section 15954. Rectify any noise problems encountered.
- .11 Conduct Mechanical Systems Demonstration and Instruction.

3.3 DOMESTIC WATER SYSTEMS

- .1 Inspect domestic water systems including piping layout, pipe support, expansion provisions, and slope for draining and venting, before pressure testing any section of pipework.
- .2 Pressure test sections of pipework, in accordance with Section 15955, prior to application of insulation or to concealment.
- .3 Pressure test each completed system, in accordance with Section 15955, before any equipment is started.
- .4 Start domestic hot water systems' circulator pumps.
- .5 Domestic hot water heating appliance: perform start-up and performance verification. Provide two working days notice to the Owner.
- .6 Balance Domestic Hot Water system return circulation circuits by temperature drop measurement.

- .7 Ensure all air chambers and expansion compensators are properly installed.
- .8 Ensure entire system can be completely drained.
- .9 Check operation of water hammer arrestors. Let one outlet run for ten seconds, then shut water off quickly. If water hammer occurs, replace water hammer arrestor. Repeat for each outlet and flush valve.
- .10 Complete and submit Domestic Water systems Start-up report as specified in Section 15951.
- .11 Conduct Mechanical Equipment and Systems Demonstration and Instruction.

3.4 PLUMBING DRAINAGE SYSTEMS

- .1 Inspect plumbing drainage systems including above ground drainage piping layout, pipe support, slope, venting, before pressure testing or concealing any section of the work.
- .2 Hydraulically test above ground installations within buildings in accordance with Section 15955.
- .3 Ensure all traps are fully primed.
- .4 Ensure all fixtures are properly anchored and connected to system.
- .5 Flush each valve, drain each sink and operate each fixture to ensure drainage and trap anti-siphon venting is effective.
- .6 Open each cleanout, cover with linseed oil and reseal each cleanout. Ensure each cleanout is fully accessible and access doors are properly installed.
- .7 Ensure roof drain metal domes are installed. Ensure storm piping is free of debris or roof insulation ballast. Remove caps as required. Verify insulation on piping is as specified in Section 15082.
- .8 Complete and submit Drainage systems Start-up report as specified in Section 15951.
- .9 Conduct Mechanical Equipment and Systems Demonstration and Instruction.

END OF SECTION

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1. GENERAL

1.1 INTENT

- .1 Test, adjust and balance mechanical equipment and systems so that entire system produces the results for which it was designed.

1.2 RELATED SECTIONS

- .1 Operation and Maintenance Data: Division 1.
- .2 General Mechanical Starting and Testing Requirements: Section 15951.
- .3 Mechanical Equipment Starting and Testing: Section 15952.
- .4 Mechanical Systems Starting and Testing: Section 15953.

1.3 TESTING/ADJUSTING/BALANCING REPORT DATA

- .1 Organize balancing data in accordance with AABC - Associated Air Balancing Council, report format. Report data in SI units.
- .2 Air Systems: Include both specified and measured data.
 - .1 Air Handling Equipment:
 - .1 Maximum air flow volume.
 - .2 Fan total pressure.
 - .3 Motor volts, amps and power.
 - .4 Minimum outside air volume.
 - .5 Fan rotational speed.
 - .6 Fan Power, calculate fan efficiency.
 - .7 Inlet and outlet dry and wet bulb temperatures.
 - .8 Equipment static pressure profile.
 - .2 Duct Air Quantities - Mains and Branches:
 - .1 Duct size.
 - .2 Number of pressure/velocity readings per traverse.
 - .3 Sum of velocity measurements.
 - .4 Average velocity.
 - .5 Duct air flow volume.
 - .6 Barometric pressure and duct air temperature.
 - .3 Air Outlets:
 - .1 Outlet location and designation.
 - .2 Manufacturers catalogue identification and type.
 - .3 Air outlet flow factors. Use 1.0 when flowhood is used.
 - .4 Air flow volumes.
 - .5 Deflector vane or diffuser cone settings.

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- .4 Emergency Generator:
 - .1 Air flow volume. Air flow volume includes cooling plus combustion air.
 - .2 Static pressure profile.
- .3 Hydronic Systems: Include both specified and measured data.
 - .1 Pumps:
 - .1 Discharge and suction pressures, at design flow and no flow.
 - .2 Fluid flow rate. Calculate from pump curves if metering not provided.
 - .3 Motor volts, amps, power.
 - .2 Heating Equipment:
 - .1 Equipment type, location and designation.
 - .2 Fluid used. Identify fluid used; water, % water/ethylene glycol mixes, steam, etc.
 - .3 Fluid flow rate.
 - .4 Fluid Specific Heat, at mean temperature.
 - .5 Fluid Specific Gravity, at mean temperature.
 - .6 Fluid entering and leaving temperatures and pressures.
 - .7 Heat transfer rate.
 - .3 Heat Exchanger:
 - .1 Heating fluid used. Identify fluid used; water, % water/ethylene glycol mixes, steam, etc.
 - .2 Heating fluid flow rate.
 - .3 Heating fluid Specific Heat, at mean temperature.
 - .4 Heating fluid Specific Gravity, at mean temperature.
 - .5 Heating fluid entering and leaving temperatures and pressures
 - .6 Primary side heat transfer rate.
 - .7 Heated fluid used. Identify fluid used; water, % water/ethylene glycol mixes, etc.).
 - .8 Heated fluid flow rate.
 - .9 Heated fluid Specific Heat, at mean temperature.
 - .10 Heated fluid Specific Gravity, at mean temperature.
 - .11 Heated fluid entering and leaving temperatures and pressures.
 - .12 Secondary side heat transfer rate.
 - .4 Air Heating and Cooling Coils:
 - .1 Coil type and identification, location and designation.
 - .2 Entering and leaving air dry and wet bulb temperatures.
 - .3 Air static pressure drop.
 - .4 Air flow volume.
 - .5 Barometric pressure.
 - .6 Air side heat transfer rate.
 - .7 Fluid used. Identify fluid used; water, % water/ethylene glycol mixes, steam, etc.
 - .8 Fluid flow rate.
 - .9 Fluid Specific Heat, at mean temperature.
 - .10 Fluid Specific Gravity, at mean temperature.
 - .11 Fluid entering and leaving temperatures and pressures
 - .12 Fluid side heat transfer rate.

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- .5 Unit and Cabinet Heater:
 - .1 Start unit and check for noise or vibration.
 - .2 Check unit performance for each fan speed:
 - .1 Air flow and temperature rise.
 - .2 Water temperature drop.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 BALANCING AND ADJUSTING PREPARATION

- .1 Perform testing, adjusting and balancing work after equipment and systems starting procedures have been properly completed in accordance with Sections 15952 and 15953.
- .2 Perform balancing during heating and cooling season of first year of operation, to ensure proper settings of controls under both summer and winter peak load conditions.
- .3 Vary load to verify operation of system under partial load conditions. Test start-up, shut-down, emergency conditions, safety controls operation and automatic and manual resets and interlocks.
- .4 Perform work using measuring instrumentation conforming to requirements specified in Section 15951.

3.2 GENERAL PROCEDURES

- .1 Perform balancing to following accuracy:
 - .1 Air - terminal outlets ± 10%
 - .2 Air - central equipment ± 5%
 - .3 Hydronic - terminal outlets ± 10%
 - .4 Hydronic - pumps and central equipment ± 5%
- .2 Permanently mark settings on splitters, valves, dampers or other adjustment devices.
- .3 Subsequent to correcting work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.

3.3 FIRE DAMPER/FIRE STOP FLAP VERIFICATION

- .1 Visually inspect all fire dampers/fire stop flaps to verify that:
 - .1 Installation is straight and level.
 - .2 Wall angles are properly installed.
 - .3 Duct has break away connection.

- .4 Fire stopping material, where used, is properly installed.
- .5 Access is adequate.
- .6 Adequate clearance exists between sleeve and wall.
- .7 ULC label is visible.
- .8 Blades are out of air stream.
- .9 Temperature rating of linkages are correct.
- .2 Inspect and clean all fire damper blades and tracks prior to function test.
- .3 Function test each damper, by detaching fusible link chain. Verify that damper blade drops properly and is tightly sealed within frame. Reset each damper.
- .4 If fire damper does not close properly, repair installation and retest.
- .5 All fire damper tests shall be witnessed by two parties, certified by Contractor and endorsed by testing personnel.
- .6 Write to authority having jurisdiction prior to testing dampers. Invite authority to witness tests as required.

3.4 AIR SYSTEM PROCEDURE

- .1 Perform testing, adjusting and balancing only after all suspended ceilings and partitions are complete, with doors and windows in place and closed.
- .2 Adopt following procedures for central systems:
 - .1 Test drop and reset all fire dampers.
 - .2 Verify that dampers and volume control devices are in fully open position.
 - .3 Initially balance central plant to $\pm 10\%$ air flow.
 - .4 Calibrate air flow measuring stations.
 - .5 Balance mains and branches to $\pm 10\%$ air flow.
 - .6 Recheck central plant.
 - .7 Balance all terminal air outlets to $\pm 10\%$.
 - .8 Rebalance central plant to $\pm 5\%$.
 - .9 Recheck all air outlets.
 - .10 Measure performance of coils and humidifier.
 - .11 Measure air pressure change across each component of central plant.
 - .12 Take sound pressure level readings.
- .3 Take air flow measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. Take the number of readings as set out in ASHRAE Fundamentals Chapter 13 "Measurement and Instruments". If readings are inconsistent across duct, relocate by two duct diameters / widths and redo traverse.

- .4 Following precedence applies to air flow measuring devices and methodology:
 - .1 Pitot tube traverses in straight sections of duct have precedence over anemometer or velometer traverses of filters, coils, ducts, etc.
 - .2 Micromanometer flowhood measurements at air outlets have precedence over anemometer or velometer readings at air outlets.
 - .3 A pitot tube traverse in a straight duct section at inlet to a variable volume box has precedence over a box air flow sensor reading.
 - .4 Variable volume box air flow sensor may be used to set up box maximum and minimum air volumes but, unless otherwise agreed with the Minister, the sum of micromanometer flowhood readings at all air outlets has precedence over a box flow sensor reading.
- .5 Use volume control devices at air outlets to regulate air quantities only to extent that adjustments do not create objectionable air motion or noise. Effect volume control primarily by duct internal devices such as dampers and splitters.
- .6 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- .7 Balance air systems at design minimum supply air temperature.
- .8 When balancing constant volume systems:
 - .1 Rough balance furthest outlet and then balance sequentially back to source,
 - .2 Fine balance furthest outlet back to source.
- .9 When balancing variable air volume systems:
 - .1 Check factory settings and reset each box maximum and minimum air volumes as necessary.
 - .2 Measure inlet static pressure to box at maximum volume.
 - .3 Individually set each box to maximum, rough balance furthest outlet and then balance sequentially back to box.
 - .4 Fine balance from furthest outlet back to box.
 - .5 Check damper stroke over box range, minimum to maximum.
 - .6 With all boxes at minimum volume progressively open boxes in a clockwise direction until maximum design air volume is achieved, or until branch static pressure can no longer be maintained. Check that each opened box is delivering specified maximum volume by checking and recording if the inlet static pressure is adequate to operate the box at maximum volume. Record airflow measuring station volume. Determine minimum duct static pressure at sensor that will provide adequate inlet pressure at every box.
 - .7 With all boxes at maximum volume, progressively close boxes in a clockwise direction until branch static pressure is achieved. Check that each opened box is delivering specified maximum volume. Record system volume. Determine minimum duct static pressure at sensor that will provide adequate inlet pressure at every box.

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- .10 Upon completion of balancing, recheck and record data from central Air Handling Unit (refer to Section 15952) including following:
 - .1 Motor data.
 - .2 Coil, filter, humidifier data.
 - .3 Static pressure profile across all components.
 - .4 Damper controls.
- .11 Final balanced condition of each area shall include testing and adjusting of pressure conditions. Test, adjust and record building and zone pressurization levels. For variable volume systems check pressurization throughout full range of fan delivery for both heating and cooling conditions. For multi-story buildings test pressure conditions at ground, intermediate and upper levels. Check front doors, exits and elevator shafts for air flow so that exterior conditions do not cause excessive or abnormal pressures. Document abnormal building leakage conditions noted.
- .12 Complete balancing to achieve positive building pressure unless otherwise instructed.

3.5 MISCELLANEOUS AIR HANDLING DEVICES

- .1 Motorized and Gravity/Barometric Dampers:
 - .1 Review installation to ensure:
 - .1 No cracks around damper frame.
 - .2 Blades close and seals engage completely.
 - .3 Damper strokes fully open to fully closed with no binding of blades at any part of stroke.
 - .4 Suitable access and identification.
- .2 Air Outlets:
 - .1 Review installation to ensure:
 - .1 Air outlet is clean.
 - .2 Air outlet is located as shown on drawings.
- .3 Balancing Dampers:
 - .1 Check installation to ensure:
 - .1 Damper can open and close fully.
 - .2 Access is clearly marked.
 - .3 Damper is not located in a turbulent air stream.

3.6 BALANCING AND ADJUSTING OF DOMESTIC WATER SYSTEMS

- .1 Adjust PRV on main line to 570 kPa maximum.
- .2 Balance domestic hot water circulating system piping to ensure flow from all points in system. Ensure all hot and cold supply shut off valves are fully open.

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3.7 BALANCING AND ADJUSTING OF EMERGENCY GENERATOR SYSTEMS - AIR SIDE

- .1 Adjust air flows to design.
- .2 Measure air flows, static pressure drops.
- .3 Measure discharge air temperature.

3.8 BALANCING REPORT

- .1 Provide three copies of final report for inclusion in Operation and Maintenance Manual.
- .2 Include types, serial number and dates of calibration of instruments.
- .3 Submit with report, fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and manufacturer's flow factors.
- .4 Organize report as follows:

Air Systems

- .1 Summary
- .2 Procedure
- .3 Instrumentation
- .4 Drawings
- .5 Equipment Summary
- .6 Fan Data Sheets
- .7 Fan Curves
- .8 Air Handling Unit Profile Data
- .9 Air Flow Measuring Station Data
- .10 Traverse Data and Schedule
- .11 Terminal Unit Summary
- .12 Outlet Data Summary and Schematic, per system
- .13 Building Pressurization Data
- .14 Diagnostic

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Operation and Maintenance Manuals: Division 1.
- .2 General Mechanical Starting and Testing Requirements: Section 15951.

1.2 QUALITY ASSURANCE

- .1 Pressure test ducts, piping, equipment and systems where required by specification or by authority having jurisdiction to demonstrate that equipment and systems are safe to operate.
- .2 Use pressure test procedures published by ASME, ASHRAE, and other industry recognized organizations.

1.3 CERTIFICATIONS

- .1 Obtain certificates of approval or compliance with rules and regulations from authorities having jurisdiction. Provide copies for inclusion in the Operating and Maintenance Manuals.
- .2 Provide a certificate for each test. Provide copies of certificate for inclusion in Operation and Maintenance Manuals.
- .3 Include following information on pressure test certificate:
 - .1 Project name and location.
 - .2 System, sub-system or portion of system tested.
 - .3 Time and date.
 - .4 Test pressure and duration of test.
 - .5 Results of test.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 PRESSURE TESTS

- .1 Provide equipment, materials, testing media and labour for pressure testing and pay all expenses. Use pressure test instruments meeting requirements specified in Section 15951.

3.2 PRESSURE TESTING OF PIPED SYSTEMS

- .1 Verify that:

- .1 All valves are accessible.
- .2 Instrument tapings are accessible, and adequate clearance has been provided to attach instruments.
- .3 Major pieces of equipment are serviceable and connected to system with flanges or unions, etc.
- .4 All pipe expansion has been allowed for.

- .2 Carry out pipe and system pressure tests for 8 hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and retest.

- .3 Heating water/glycol system: test to minimum of 1.5 times maximum working pressure or 1050 kPa water pressure at lowest point of system/section being tested.

- .4 Domestic water system: test to minimum of 1.5 times maximum working pressure or 1050 kPa water pressure at lowest point of system/section being tested.

- .5 Drainage systems: test by filling with water to produce water pressure of 30 kPa minimum and 75 kPa maximum. Use ball test to check for proper grade and that system is free of obstructions.

- .6 Gas piping: test as required by authorities having jurisdiction.

- .7 Fuel oil piping: test piping to 1050 kPa pressure with air. Maintain pressure for 24 hours with maximum 10 kPa pressure drop.

- .8 Compressed air: test piping to 1050 kPa pressure with air. Maintain pressure for 24 hours with maximum 10 kPa pressure drop.

- .9 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air or nitrogen test medium and halide torch for refrigerant medium.

- .10 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct defects. Correct leaks by remaking joints in screwed fittings, cutting out and re-welding welded joints, remake joints in copper lines. Do not caulk.

3.3 PRESSURE TESTING OF DUCT SYSTEMS

- .1 Low pressure - test for tightness such that leakage is inaudible and not detectable by feel.

- .2 Medium pressure - test for tightness as specified by SMACNA manuals, with maximum leakage of not more than 0.5% of maximum design volume at 3 kPa static pressure. Ensure system is free of audible leaks.

END OF SECTION

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1. INTENT

- .1 Provide instruction and demonstration sessions to familiarize the Owner with the building's mechanical systems.

2. DEMONSTRATIONS

- .1 Demonstrate specific starting and general maintenance requirements for each piece of equipment. Ensure all labelling and identification is completed.
- .2 Demonstrate following systems:
 - .1 Air Systems
 - .2 Controls Systems
 - .3 Cooling Systems
 - .4 Heating Systems
 - .5 Plumbing Systems
- .3 Demonstrate following pieces of equipment:
 - .1 Furnace
 - .2 Condensers
 - .3 Air Handling Units
 - .4 Exhaust Fans

3. SITE TOURS

- .1 Provide a series of guided tours of facility to allow operators to familiarize themselves with building's mechanical systems.
- .2 Coordinate timing of tours with the Owner. Allow for tours at approximately the following times:
 - .1 95% complete stage or three weeks prior to Total Performance of the Work.

END OF SECTION

1. GENERAL REQUIREMENTS

- .1 This specification is to be considered applicable for all electrical drawings and specification related to these contract documents.

2. REGULATORY REQUIREMENTS

- .1 Comply with Safety Codes Act and rules and regulations made pursuant thereto, including the Canadian Electrical Code.
- .2 Unless otherwise indicated, all references to "Canadian Electrical Code" or "CEC" shall mean the edition of the Canadian Electrical Code, Part I, CSA C22.1, and the variations made thereto by Alberta regulation, which are in force on the date of bid closing for the Contract.
- .3 All electrical products shall be tested, certified and labeled in accordance with a certification program accredited by the Standards Council of Canada (at a minimum, STANDATA Section 2 – Electrical System Equipment). Where a product is not so labeled, provide written approval by the authority having jurisdiction.
- .4 Submit to authority having jurisdiction and Utility Company, necessary number of drawings and specifications for examination and approval prior to commencement of electrical work. Pay associated fees.
- .5 Submit to Owner, copy of electrical permit obtained from authority having jurisdiction.
- .6 If authority having jurisdiction conducts an electrical inspection, submit copy of certificate of acceptance provided by authority having jurisdiction.
- .7 All equipment supplied to have 75°C termination ratings.
- .8 All cable ampacities in the drawings and specifications are based on equipment termination ratings of 75°C. Should equipment be provided with a different rating it is the Contractors responsibility to size cable accordingly to meet the electrical code requirements.

3. SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- .1 Submit shop drawings, product data and samples of equipment and materials. Shop drawings to include but not be limited to the following:
 - .1 Complete product part numbers for each piece of equipment
 - .2 Corresponding equipment tag numbers with part numbers
 - .3 Product specification sheets indicating product features and options
 - .4 Dimensions in metric measurement (mm or meters)
 - .5 Weights in metric measurement
 - .6 Wiring/interconnection diagrams with manufacturer terminals numbers

- .7 Any additional information requested by Owner or Owners representative

4. OPERATION AND MAINTENANCE DATA

- .1 Provide the following for all systems and components:
 - .1 Manufacturer's product data, including performance curves, schematics, and wiring diagrams for all electrical control systems.
 - .2 Manufacturer's installation instructions.
 - .3 Manufacturer's operation instructions.
 - .4 Manufacturer's maintenance instructions, including complete parts list for all serviceable components.
- .2 Provide a comprehensive list of subcontractors and suppliers who supplied and installed systems and components.
- .3 Provide copies of all inspection certification reports from authorities having jurisdiction.
- .4 Refer to section 01790 Operation and Maintenance Manuals for additional information.

5. RECORD DRAWINGS

- .1 Record actual locations of all pull boxes, panelboards, luminaires, feeders, electrical equipment and electrical site services.
- .2 Record any changes to circuit designations.
- .3 Include on record drawings, revisions due to engineering change orders, site alterations, additions and field ordered changes made during construction.
- .4 Record any changes to control circuit wiring including but not limited to terminal numbering, wire and cable labels, interconnect wiring between equipment.
- .5 Record any changes to schedules including panel, luminaire, mechanical, and conduit/cable schedules.

6. COORDINATION

- .1 Coordinate work specified in Division 16 with work specified in other Divisions. Ensure that proper arrangements and provisions are made for work specified in Division 16.

7. SOURCE OF SUPPLY

- .1 All like materials shall be by a single manufacturer.

8. REFERENCE STANDARDS

- .1 Comply with standards of following organizations:
 - .1 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
 - .2 National Electrical Manufacturers Association. (NEMA).
 - .3 Institute of Electrical and Electronic Engineers (IEEE).
 - .4 Insulated Power Cable Engineers Association (IPCEA).

9. PRODUCT OPTIONS AND SUBSTITUTIONS

- .1 Refer to Section 01621 for requirements pertaining to product options and substitutions.

10. TESTING

- .1 Prior to energizing any portion of the electrical system, perform megger tests on all parts of the distribution system. Results shall meet the requirements of the CEC, authority having jurisdiction and the Contract Documents.
- .2 Test results shall be consolidated into a typed report and included in the Operation and Maintenance Manuals.

11. COMMISSIONING

- .1 Commission all instruments as described in Section 01810 - Startup and Commissioning.
- .2 Retain the services of the equipment Manufacturers Technical Representative as required in each specification section.
- .3 Upon completion of construction, all circuits are to be operational and all instruments operating within manufacturer's specifications.
- .4 Prior to notifying Owner's Representatives Commissioning Team to begin commissioning activities, verify all control logic, inputs, and outputs, and complete Record Drawings as described in this section.
- .5 Electrical controls, circuits and systems shall be tested by trial operation of control equipment after all wiring is completed to see that each interlock and control function

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operates in accordance with the contract drawings and the description of operation for the equipment. Where field conditions prevent actual equipment functioning during testing, the contractor shall simulate the intended operating condition in the associated control circuits.

- .6 The contractor shall locate the cause of any malfunction and make the necessary wiring and / or equipment changes or corrections to obtain the particular systems intended operation as defined by the contract drawings. Such changes shall be included in the test report.
- .7 Control Panels shall be operated through all design functions. This shall include remote operation of all equipment and actuation of alarms and indicating devices according to design requirements.
- .8 Complete operation tests shall be given to all relays, and control devices to show that the equipment performs all design functions and meets design and procurement specifications.
- .9 During start-up, assist Commissioning Team in debugging system operation and correct any deficiencies and omissions which appear.

12. AMBIENT ENVIRONMENT

- .1 Unless otherwise indicated, supply equipment enclosures, boxes, electrical materials and products suitable for ambient environment of the following areas:

	Area	General Classification	Equipment Enclosure Type	Cable / Raceway
1.	Electrical Room	Dry, Clean	NEMA 12	Note 1
2.	Pump Room	Wet	NEMA 4X	Note 1
3.	Outdoor Areas	Wet	NEMA 4X	Note 1
4.	Treatment Room	Wet	NEMA 4X	Note 1
5.	Headworks	Zone 2 Category 2 (Class 1 Zone 2)	NEMA 7, 4X	PVC coated Rigid Aluminum / TECK, Notes 2 and 3
5.	Office Areas	Dry, Clean	NEMA 12	EMT, Note 4

Note 1 Install conduit type as per drawings.

Note 2 All areas within 900mm radius of ventilated openings (ie. vents etc.) are to be considered classified area. Blower heaters and sealed hatch lids are not considered ventilated openings.

Note 3 Seal all conduits with poured EYS conduit seals (or similar).

13. SPECIAL REQUIREMENTS

- .1 Delivery, Storage and Handling (Products, Waste Management, Disposal, etc.): Equipment delivered to site to be protected from all-weather elements. Should equipment be exposed to physical or environmental conditions that the equipment is not rated for, it

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is the contractor's responsibility to ensure the conditions are identified to the manufacturer and remedial action is undertaken according to manufacturer instructions. Contractor to ensure equipment is site tested to confirm equipment still meets all manufacturer and relevant standard requirements.

14. SYSTEM ADJUSTMENT

- .1 Touch-up paint to repair any damaged surfaces using manufacturer-furnished paint. Leave remaining touch-up paint with owner.

END OF SECTION

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1. GENERAL

- .1 Not applicable.

2. PRODUCTS

2.1 MATERIALS

- .1 Ground Rods: 20 mm x 3 m copper clad
- .2 Ground Conductors: as specified in Section 16121
- .3 Waste Water Treatment Plant Grounding Grid
 - .1 Perimeter: 3 ground rods in triangular configuration
 - .2 Rows: n/a
 - .3 Columns: n/a
 - .4 Spacing: 3 meters apart
 - .5 No. of ground rods: 3- 20mm x 3000mm Copper Clad
 - .6 Interconnect conductors: As Specified in 16121
 - .7 Grounding conductor: 1 continuous No. 6 awg insulated copper wire (as per 2.1.4.1.6) between the ground grid and system neutral point (grounded conductor).
 - .8 System bonding jumper: As per CEC – Table 16

3. EXECUTION

3.1 INSTALLATION

- .1 Comply with requirements of CSA C22.2 No. 0.4-M1982 and Canadian Electrical Code.
- .2 Install complete permanent grounding system including electrodes, conductors, connectors and accessories.
- .3 Protect exposed ground conductors from mechanical injury.
- .4 Make buried connections, and connections to electrodes using thermite welding.
- .5 Use mechanical connectors for ground connection to equipment provided with lugs.
- .6 Do not solder joints.
- .7 Install bonding wire in flexible metal conduit connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw.
- .8 Install separate insulated bonding conductor in conduit runs installed in concrete which is subject to moisture penetration and underground.

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- .9 Install a separate insulated bonding conductor in all RPVC conduit runs.
- .10 Install insulated copper bonding conductor in all cable tray, mechanically fixed to the trays at a minimum of 2 meter intervals.

3.2 SYSTEM GROUNDING

- .1 Provide ground grid with one ground conductor from grid through the system neutral point and connected to the Main Ground Bus Bar

3.3 GROUND AND BONDING CONDUCTORS

- .1 Use bare copper conductors for the following:

Size

- | | | |
|----|--------------------|----|
| .1 | Service Entrance | #6 |
| .2 | Ground Grid | #6 |
| .3 | Cable tray bonding | #6 |

- .2 Use green insulated conductors for the following:

Size

- | | | |
|----|----------------------------|--------------------------|
| .1 | Circuit Bonding Conductors | #14 min
CEC table 16A |
| .2 | Bonding Jumpers | #6 |
| .3 | Lightning Arrestor | #6 |

- .1 Ground and bond system as per CEC 22.1-2018 requirements with the intent to provide single point grounding.
- .2 Coordinate system bonding jumper and grounding conductor connection points with authority having jurisdiction prior to construction.
- .3 Provide separate, insulated bonding conductor in all nonmetallic conduits (ie. RPVC, ENT, DBii, etc...)
- .4 Bond all metal parts of building structure and mechanical equipment including piping systems.

END OF SECTION

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1. GENERAL

- .1 Not applicable.

2. PRODUCTS

2.1 IDENTIFICATION MATERIALS

- .1 Lamacoid Nameplates: 3 mm thick plastic engraving sheet, black face, white core (lettering), mechanically attached, sizes as follows:
 - .1 Size 1: 12 mm high with 5 mm high letters.
 - .2 Size 2: 20 mm high with 8 mm high letters.
 - .3 Size 3: 25 mm high with 12 mm high letters.
- .2 Wire Identification Materials: Use one of the following:
 - .1 Heat shrink sleeves, blank.
 - .2 Clear plastic tape wrap-on strips with white writing section.
 - .3 Wrap-on strips, pre-numbered.
 - .4 Slip-on identification bead markers or sleeves, blank or pre-numbered.
- .3 Colour Banding Tape: Adhesive backed plastic tape, integrally coloured.
- .4 Receptacle Circuit Designations: Clear Adhesive tape with machine printed black lettering.
- .5 Armoured Cable Materials:
 - .1 Lamacoid nameplates with holes drilled at each end to accept zip ties and attached with two zip ties

3. EXECUTION

3.1 COLOUR IDENTIFICATION OF EQUIPMENT

- .1 Electrical equipment shall be prefinished in coded colours designating voltage or system, as indicated in Equipment Identification Schedule.
- .2 Voltage colour identification for line voltage equipment shall be as follows:

	Voltage	Colour
.1	120/208 V or 120/240 V:	Grey
.2	277/480 V:	Grey
.3	347/600 V:	Grey
.4	High voltage (above 750 V):	Brown

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3.2 NAMEPLATE IDENTIFICATION OF EQUIPMENT

- .1 Identify equipment with lamacoid nameplates, as indicated in Equipment Identification Schedule.

3.3 PANELBOARD DIRECTORIES

- .1 Identify loads controlled by each overcurrent protective device in each panelboard, by means of a typewritten panelboard directory.

3.4 COLOUR IDENTIFICATION OF WIRING

- .1 Identify No. 2 AWG wiring and smaller by continuous insulation colour.
- .2 Identify wiring larger than No. 2 AWG by continuous insulation colour or by colour banding tape applied at each end and at splices.
- .3 Colour coding shall be in accordance with Canadian Electrical Code, and as follows:

	Voltage	Colour
.1	120/208 V, 3 phase:	Red, black and blue.
.2	120/208 V emergency:	Red, black and blue with yellow tracer.
.3	347/600 V 3 phase:	Red, black and blue.
.4	347/600 V emergency:	Red, black and blue with Yellow tracer

- .4 Where multi-conductor cables are used, use same colour coding system for identification of wiring throughout each system.
- .5 Maintain phase sequence and colour coding throughout each system.

3.5 RECEPTACLE IDENTIFICATION

- .1 Identify the panel and circuit number(s) of all the new and existing receptacles by attaching a type written label to the top portion of the cover plate.

3.6 MULTIPLE VOLTAGE SOURCES

- .1 Where multiple voltage sources are present in one panel, junction box, electrical compartement etc. Provide and install a lamacoid lable indicating each voltage and the source panel of that voltage.

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3.7 EQUIPMENT IDENTIFICATION SCHEDULE

Equipment	Colour	Nameplate Identification	Lamicoid Nameplate Size
Main Distribution Centre	Voltage Colour	<ul style="list-style-type: none"> - Building name, consulting engineer, date installed, amperage, voltage 3 - Main breaker 2 - Metering cabinet 2 - Instrument transformer enclosure 2 - Loads controlled by each overcurrent protective device 1 - Metering devices 1 	
Distribution Centres	Voltage Colour	<ul style="list-style-type: none"> - Distribution centre designation, amperage, and voltage 2 - Loads controlled by each overcurrent protective device 1 	
Panelboards	Voltage Colour	<ul style="list-style-type: none"> - Panelboard designation 2 	
Motor Control Centres	Voltage Colour	<ul style="list-style-type: none"> - M.C.C. designation, amperage and voltage 2 - Motors or loads controlled by each unit and mnemonics 1 - Relay terminal and transformer compartments 1 	
Manual Motor Starters	N/A	<ul style="list-style-type: none"> - Load controlled and mnemonics 1 	
Ground Bus	N/A	<ul style="list-style-type: none"> - System Ground 1 	
On/Off Switches	N/A	<ul style="list-style-type: none"> - Load controlled 1 	

cont'd

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3.7 EQUIPMENT IDENTIFICATION SCHEDULE (Cont'd)

Equipment	Colour	Nameplate Identification	Lamicoid Nameplate Size
Disconnect Switches, Magnetic Motor Starters and Contactors:	Voltage Colour	- Voltage and equipment controlled and mnemonics	2
Transformers	Voltage Colour	- Transformer designation, secondary and primary voltages capacity,	2
Emergency Power Equipment	Voltage Colour	- Designation and voltage	2
Wireways	N/A	- Voltage and system designation	2
Line Voltage Cabinets and Enclosures	Voltage Colour	- Designation and voltage	2
Low Voltage Cabinets and Enclosures	System Colour	- System name; system name and number if more than one cabinet or enclosure	2
		- Major components within cabinets and enclosures	1
Communication Outlet and Outlet Assemblies	N/A	- Outlet Designation	1
Communication Panels	N/A	- Panel Designation	1
Communication Ports	N/A	- Port Designation	1

END OF SECTION

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1. GENERAL

1.1 REFERENCES

- .1 IEEE C2 – National Electrical Safety Code.
- .2 CAN / CSA C22.2 No. 131-M89
- .3 NEMA WC 70 – Non-shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- .4 ANSI/TIA/EIA-568 (latest version), ISO/IEC 11801 - Structured Cabling standards

1.2 SUBMITTALS

- .1 Product Data: Submit for cable, terminations, and accessories.
- .2 Test Reports: Indicate results of cable test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time at 30 second intervals at maximum voltage.
- .3 Operation and Maintenance Data: Submit instructions for testing and cleaning cable and accessories.
- .4 Cable temperature analysis report: Submit reports for 1/0 AWG and larger underground wire and cable installations. Temperature analysis report shall be completed using Neher-McGrath method and respective overcurrent device trip setting.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Protect cable ends from entrance of moisture. Cables affected by moisture ingress shall not be used.

1.4 SPECIAL CONSIDERATIONS

- .1 Where conductors are installed in a plenum (combustible or non-combustible) the conductor insulation rating shall be FT-6.

2. PRODUCTS

2.1 BUILDING WIRING

- .1 Building Wiring: to CSA C22.2 No. 75-M1983 and as follows:
 - .1 Conductors: stranded or solid copper for No. 10 AWG and smaller, stranded copper for No. 8 AWG and larger.
 - .2 Insulation: RW90 X-link.
 - .3 Insulation Rating: 600V.
 - .4 Sizes: as indicated in Conduit and Cable Schedule.

2.2 CABLES

- .1 Type 600V TECK 90 Cable: to CSA C22.2 No. 131-M89 and as follows:
 - .1 Conductor: copper.
 - .2 Insulation: cross linked polyethylene (XLP).
 - .3 Rating: 600V.
 - .4 Size: as indicated.
 - .5 Configuration: as indicated.
 - .6 Inner Jacket: PVC -40°C.
 - .7 Armour: interlocking aluminum.
 - .8 Outer Jacket: PVC -40°C, sunlight resistant.
 - .9 Approvals: hazardous location (HL) rated where required by CEC
- .2 Control Cable for Class 2 Remote Control and Signal Circuits:
 - .1 Conductor: copper.
 - .2 Insulation: 300 V insulation, rated 60°C.
 - .3 Configuration: individual conductors twisted together, shielded, and covered with a PVC jacket.
 - .4 Flame Rating: FT-6
- .3 Type (Tray Cable) TC Cable: to CSA C22.2 No. 230 and as follows:
 - .1 Conductor: copper.
 - .2 Insulation: cross linked polyethylene (XLP).
 - .3 Rating: 1000V.
 - .4 Size: as indicated.
 - .5 Configuration: as indicated.
 - .6 Outer Jacket: PVC -40°C.
- .4 Portable Power Cable – Type W: To CSA C22.2 No.96 and as follows:
 - .1 Conductor: copper.
 - .2 Insulation: EP rubber.
 - .3 Rating: 2000V.
 - .4 Size: as indicated.
 - .5 Configuration: as indicated.
 - .6 Inner Jacket: PVC -40°C.
 - .7 Armour: n/a
 - .8 Outer Jacket: PVC -40°C.
- .5 Ethernet Communications Cable – Type Category 6: To TIA/EIA-568 (latest version) and ISO 11801 and as follows:
 - .1 Conductor: copper.
 - .2 Rating: 10/100/1000BASE-T, characterized to 250MHz.
 - .3 PoE compliance: IEEE 802.3af and 802.3at
 - .4 Configuration: as indicated.
 - .5 Outer Jacket: blue, flame retardant PVC.
 - .6 Shielded: Yes

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- .7 Typical Applications: Ethernet communications, Power over Ethernet (POE), etc...
- .2 Type 600V ACIC instrument Cable: to CSA C22.2 No. 239-M91 and as follows:
 - .1 Conductor: copper.
 - .2 Insulation: cross linked polyethylene (XLP).
 - .3 Rating: 600V.
 - .4 Size: as indicated.
 - .5 Configuration: Individually foil Shielded Pairs with Overall Shielding
 - .6 Inner Jacket: PVC -40°C.
 - .7 Armour: interlocking aluminum.
 - .8 Outer Jacket: PVC -40°C.

2.3 CONNECTORS

- .1 Provide factory fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated.

3. EXECUTION

3.1 WIRING, GENERAL

- .1 Splice only in junction or outlet boxes.
- .2 Conductor length for parallel circuits shall be identical.
- .3 Neatly train and lace conductors inside cabinets, equipment and panelboards.
- .4 Provide protection for exposed cables where subject to damage.

3.2 WIRING INSTALLATION IN RACEWAYS

- .1 Swab raceway system before installing wiring.
- .2 Use pulling lubricant for conductors No. 4 AWG and larger.
- .3 Support horizontal runs on cable tray complete with spacers and clamps.
- .4 Support vertical runs on channels complete with spacers and clamps.
- .5 Use stranded conductors for all connections to motors and vibrating equipment.

3.3 WIRING INSTALLATION IN CABLE TRAYS

- .1 All teck cable shall be installed in the cable trays as indicated on the drawings and according to the Canadian Electrical Code.

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- .2 When running 120VAC and higher cables in the same cable tray as 4-20mA signals, 24VAC, 24VDC and general data cables the 120VAC and greater cables shall be separated from the lower voltage cables via a grounded cable tray barrier.
- .3 4-20mA signal cables shall be separated from the 24VAC and 24VDC cables via a grounded cable tray barrier.
- .4 Cables of unlike signals and voltages shall cross at 90 degree angles to each other.
- .5 Teck cable drops to equipment shall be supported by vertical cable tray risers. Single or double teck cable drops may be run in vertical cantruss.
- .6 All power and lighting cables shall be separated in the cable tray according to the Canadian Electrical Code. It will be the responsibility of the Contractor to de-rate and upsize the conductors if the ventilation spacing requirements are not met.

3.4 WIRE CONNECTIONS AND TERMINATIONS

- .1 Use solderless pressure connectors with insulated covers for copper wire splices and taps, No. 8 AWG and smaller.
- .2 Use insulated spring wire connectors with plastic caps for conductors No. 10 AWG and smaller.
- .3 Use split bolt connectors for copper wire splices and taps, No. 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150% of insulation value of conductor.
- .4 For high voltage termination provide approved terminations installed in accordance with manufacturers recommendations.
- .5 Below grade ground grid connections shall be made by a thermite weld (Cadweld) or equivalent process.

3.5 WIRE SIZE SCHEDULE

- .1 Lighting Circuits: No. 12 AWG minimum.
- .2 Power Circuits: No. 12 AWG minimum.
- .3 Motor Circuits: No. 12 AWG minimum, except as otherwise indicated on drawings or in schedules.
- .4 Feeder Circuits: as indicated on drawings or in schedules.

3.6 TESTING PRIOR TO ENERGIZING

- .1 See section 16971.

END OF SECTION

1. GENERAL**1.1 RELATED SECTIONS**

- | | | |
|----|--------------------------------|----------------|
| .1 | Basic Electrical Requirements: | Section 16005. |
| .2 | Electrical Identification: | Section 16075. |
| .3 | Wire and Cable: | Section 16121. |
| .4 | Cabinets and Enclosures | Section 16136. |

1.2 COORDINATION

- .1 Coordinate with other work including wire and cable, boxes and fittings and panel work, as necessary to interface installation of conduit with other work.
- .2 Coordinate installation of conduit in concrete with work specified in Division 3.
- .3 Coordinate installation of conduit in masonry with work specified in Division 4.
- .4 Coordinate installation of conduit which penetrates roof or waterproofing membranes with work specified in Division 7.

2. PRODUCTS**2.1 CONDUIT, GENERAL**

- .1 Except where otherwise required by Canadian Electrical Code (CEC), provide conduit of types specified in Conduit Installation Schedule and sizes indicated on drawings or specified.
- .2 Conduit embedded in concrete floors shall be maximum 50 mm size.
- .3 Where sizes are not indicated, select proper sizes to suit intended use, fulfill wiring requirements, and comply with Canadian Electrical Code (CEC).

2.2 METAL CONDUIT AND TUBING

- .1 Rigid Metal Conduit: to CSA C22.2 No. 45-M, and as follows:
 - .1 Galvanized Rigid Steel Conduit: zinc coated steel.
 - .2 Fittings: same material as conduit.
- .2 Rigid Aluminum Conduit: to CSA C22.2 No. 45-M, and as follows:
 - .1 Rigid Aluminum Conduit: Aluminum.
 - .2 Fittings: same material as conduit.

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- .3 PVC coated Rigid Aluminum Conduit: to CSA C22.2 No. 45-M, and as follows:
 - .1 Rigid Aluminum Conduit: PVC coated,.
 - .2 Fittings: same material as conduit.
 - .3 Approved manufacturers: Plasti-Bond, Perma-Cote, KorKap or equal
- .4 Electrical Metallic Tubing (EMT): to CSA C22.2 No. 83-M, with fittings as follows:
 - .1 Fitting Material for 25 mm size Conduit and Smaller: zinc alloy or zinc coated steel.
 - .2 Fitting Material for Conduit Larger than 25 mm Size: zinc coated steel.
 - .3 Type: compression, liquid tight for all areas.
- .5 Flexible Metal Conduit: to CSA C22.2 No. 56-1977, and as follows:
 - .1 Liquid-Tight Flexible Metal Conduit: continuous interlocked and double-wrapped steel, zinc coated inside and outside, coated with liquid-tight jacket of flexible PVC, minimum 12 mm diameter.
 - .2 Liquid-Tight Flexible Metal Conduit Fittings: cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings.
- .6 Miscellaneous Fittings: locknuts, bushings, reducers, chase nipples, 3 piece unions, split couplings, plugs, and expansion fittings specifically designed for their particular application.

2.3 NON-METALLIC CONDUIT

- .1 Rigid PVC (Unplasticized) Conduit: to CSA C22.2 No. 211.2-M1984.
- .2 Rigid PVC (DB2) Conduit: to CSA C22.2 No. 211.2-M1984.

2.4 FIBERGLASS REINFORCED

- .1 FRE Conduit: to CSA C22.2 No. 211.3

3. EXECUTION

3.1 INSTALLATION OF CONDUIT, GENERAL

- .1 Install conduit concealed, in walls, floors, ceilings, above suspended ceilings, and underground for all conduits within the Office area and Laboratory area.
- .2 Where required to be concealed, install conduit neatly and close to building structure so as to minimize need for furring.
- .3 Installed conduit shall be free from dents, bruises and other damage.
- .4 Plug conduit ends to prevent entry of dirt and moisture.

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- .5 Seal conduit with duct seal compound where conduit leaves heated area and enters unheated area.
- .6 Provide necessary flashing and pitch pockets, making watertight joints where conduit passes through roof or waterproofing membranes.
- .7 Provide necessary modular link type piping seals, making watertight seal where conduit passes through concrete walls below grade, enters reservoirs or below grade vaults. Holes are to be cored, not drilled as necessary to provide a suitable clean hole for modular piping seal and conduit. Install as per manufacturers recommendations.
 - .1 Seals shall consist of a series of interlocking, molded synthetic rubber links suitable for the environment, with heavy-duty plastic pressure plates, and corrosion resistant stainless steel nuts and bolts.
 - .2 Acceptable Manufacturers
 - .1 Link Seal
 - .2 Metraflex
 - .3 Roxtec
 - .4 or approved equal
- .8 Where conduit crosses building expansion joints, install expansion fitting approved by authority having jurisdiction, complete with grounding jumper. Provide bend or offset in conduit adjacent to building expansion joint where conduit is installed above suspended ceilings.

3.2 INSTALLATION OF METAL CONDUIT AND TUBING

- .1 Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
- .2 Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

3.3 INSTALLATION OF RIGID METAL CONDUIT

- .1 Cut conduit straight, properly ream, cut threads and brush threads clean.
- .2 Fasten conduit terminations in sheet metal enclosures with two locknuts and terminate with bushing. Install locknuts inside and outside enclosure.
- .3 Conduit installed underground shall be painted with two coats of corrosion inhibiting compound before backfilling.

3.4 INSTALLATION OF NON-METALLIC CONDUIT

- .1 Make field bends and solvent cemented joints in accordance with manufacturer's instructions.

3.5 INSTALLATION OF EXPOSED AND SEMI-CONCEALED CONDUIT

- .1 Comply with the following when installing conduit exposed in service areas, unfinished areas, finished areas, and in accessible spaces behind ceilings, walls and floors:
 - .1 Install conduit to conserve headroom and cause minimum interference in spaces through which conduit passes.
 - .2 Install conduit so as not to interfere with ceiling inserts, luminaires or ventilation ducts or outlets.
 - .3 Alter routing to avoid structural obstructions, keeping crossovers to a minimum.
 - .4 Install exposed conduit and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls and structural members.
 - .5 Run conduit for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.

3.6 INSTALLATION OF LIQUID TIGHT FLEXIBLE METAL CONDUIT

- .1 Liquid tight conduit is only permitted to be installed as a final connection to a device and when connecting to motors or other equipment subject to vibration.
- .2 The length of the liquid tight conduit shall be limited to 1.5 meters in length unless otherwise noted in the specifications or drawings.
- .3 The conduit shall be constructed of metal armoured conduit with an exterior PVC jacket

3.7 INSTALLATION OF CONDUIT IN CONCRETE SLABS

- .1 Place conduit between bottom reinforcing steel and top reinforcing steel.
- .2 Separate conduit by not less than diameter of largest conduit to ensure proper concrete bond.
- .3 Ensure minimum 20 mm concrete cover.
- .4 EMT conduit is unacceptable in concrete slabs.
- .5 Provide rigid steel conduit minimum 100mm below and 300mm above all vertical conduit floor slab penetrations.

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3.8 CONDUIT SCHEDULE

Conduit Type	Locations
Rigid Steel (RS)	Where exposed and subject to mechanical damage on building interior. This includes all conduit runs penetrating above concrete slabs and conduits exiting building walls, electrical service. Exposed conduits outdoors.
PVC Coated Rigid Aluminum (RA)	Area's designated as hazardous.
Rigid PVC (RPVC)	Filter plant areas, areas with liquid piping/filters, underground. Except where otherwise indicated, install all wiring in RPVC conduit.
Flexible metal (FM)	Connections to luminaires, motors and subject to vibration. Allowed only as final connection to device. To be not more than 1.5 meters in length except with permission from Owners representative.
Electric Metal Tubing (EMT)	Recessed in wall, in ceilings, surface mount in electrical rooms (if no other type is indicated in the drawings)
DB2	Concrete encased duct banks
Liquid Tight (LT)	Final connections to equipment. To be not more than 1.5 meters in length except with permission from Owners representative.

END OF SECTION

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1. GENERAL

1.1 COORDINATION

- .1 Coordinate with other work, including wire and cable, boxes and fittings and panel work, as necessary to interface installation of electrical raceways and components with other work.
- .2 Coordinate installation of cable trays and wireways which pass through fire rated walls, floors or ceilings with firestopping work .

1.2 SHOP DRAWINGS

- .1 Provide shop drawings for cabletray sizes and routing. Include all pertinent physical characteristics. Routing shop drawings is to include the location and size of the cabletray on a plan view and the appropriate sections detailing supporting methods.

2. PRODUCTS

2.1 RACEWAYS, GENERAL

- .1 Provide raceways of types and sizes indicated.
- .2 Where not indicated, select proper types and sizes to fulfill wiring requirements and comply with Canadian Electrical Code.

2.2 CABLE TRAYS

- .1 Cable trays and fittings: to CSA C22.2 No. 126-M91 and EEMAC-F5-1, and as follows:
 - .1 Location: Waste Water Plant
 - .1 Type: ladder.
 - .2 Size: as required to comply with CEC.
 - .3 Material: extruded aluminum.
 - .4 Accessories and fittings: Horizontal elbows, end plates, dropouts, vertical risers and drops, tees, wyes, expansion joints and reducers, manufactured for cable tray supplied.
 - .5 Radii on Fittings: minimum 300 mm.
 - .6 Barriers: As required when separating cables of different signal types and voltages.
 - .7 Minimum loading requirements: 438 kg/m at 3m support distance
 - .8 Ensure that cable tray is supported at miniumum every 2500mm from roof trusses and wall.
 - .9 Side rail depth: 100mm
 - .10 Manufacturer: Thomas and Betts AH3-4 or approved equivalent.

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2.3 WIREWAYS

- .1 Wireways, Auxiliary Gutters and Associated Fittings: to CSA C22.2 No. 26-1952 and as follows:
 - .1 Material: sheet steel.
 - .2 Accessories: elbows, tees, couplings, and hanger fittings manufactured for wireway supplied.

3. EXECUTION

3.1 INSTALLATION OF CABLE TRAYS

- .1 Support cable trays with single side hangers, at all bends and tee fittings as per manufacturer's specifications.
- .2 Install cable tray barriers when separating cables as per section 16121.
- .3 The Contractor is responsible for the exact design, routing and sizing of the cabletray. Sizes indicated on the drawings show the minimum cabletray size acceptable.
- .4 All cable tray, including instrumentation tray is not permitted on or near flooring surfaces. Minimum clearance of 3 meters is required.
- .5 All cable tray installation is not to obstruct day to day operations of the facilities intent, including, but not limited to:
 - .1 Floor Cleaning
 - .2 Walkway Obstruction
 - .3 Equipment Access

END OF SECTION

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1. GENERAL

1.1 COORDINATION

- .1 Coordinate box locations with work specified in:
 - .1 Division 4, for installation of boxes in masonry.
 - .2 Division 9, for installation of boxes in locations where access panels are required.

2. PRODUCTS

2.1 METAL OUTLET BOXES

- .1 Outlet boxes: to CAN/CSA-C22.2 No. 18-92 and as follows:
 - .1 Sheet Steel Boxes: pressed sheet steel, galvanized, blanked for conduit, integral locating lugs.
 - .2 Cast Boxes: corrosion resistant cast aluminum, factory threaded hubs, weatherproof.

2.2 NON-METALLIC OUTLET BOXES

- .1 Outlet boxes: to CAN/CSA-C22.2 No. 85-M89 and as follows:
 - .1 Same as sheet steel boxes, except of rigid PVC material.

2.3 PULL AND JUNCTION BOXES

- .1 Surface mounted pull and junction boxes: to CSA C22.2 No. 40-M1989 and as follows:
 - .1 Type: NEMA 3.
 - .2 Material: 14 gauge steel, continuously welded seams ground smooth.
 - .3 Covers: screw-on, closed cell, oil resistant neoprene gasket, stainless steel screws and clamps on four side of cover to assure water tight seal.
 - .4 Barriers: where indicated and required.
- .2 Recessed pull and junction boxes or surface mounted boxes in areas above 3000 AFF: to CSA C22.2 No. 40-M1989 and as follows:
 - .1 Material: sheet steel
 - .2 Covers: screw-on
 - .3 Barriers: where indicated.

2.4 BUSHINGS, KNOCKOUT CLOSURES, AND LOCKNUTS

- .1 Bushings, Knockout Closures and Locknuts: to CAN/CSA-C22.2 No. 18-92, corrosion resistant.

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2.5 AIR/VAPOUR HATS

- .1 Air/vapour Hats: polyethylene, minimum 0.40 mm thick, with minimum 25 mm wide flanges, designed to be installed over electrical boxes and provide an effective air/vapour seal.

2.6 FIREWALL CONDUIT/CABLE PENETRATIONS

- .1 The following products are considered acceptable for maintaining fire ratings where cable/conduits cross fire rated walls providing the product is used in accordance with manufacturer's installation requirements.
 - .1 Fire barrier Block/Brick (3M or similar)
 - .2 Roxtec cable gland system
 - .3 Approved alternates
 - .4 Spray foam will not be considered and acceptable method

3. EXECUTION

3.1 OUTLET BOX INSTALLATION

- .1 Provide boxes where indicated and as required for:
 - .1 Splices.
 - .2 Taps.
 - .3 Wire pulling.
 - .4 Equipment.
 - .5 Device location.
- .2 Install boxes flush mounted were applicable.
- .3 Except where otherwise indicated, install boxes for vertical mounting of devices.
- .4 Support boxes independent from conduit.
- .5 Use metal outlet boxes, except in following locations where non-metallic outlet boxes shall be used:
 - .1 Where subject to moisture or corrosive material.

3.2 LOCATION OF WALL OUTLET BOXES

- .1 Outlets are indicated on drawings schematically. Consider locations indicated as approximate. Verify locations prior to rough in.
- .2 Confirm size and location of equipment supplied and installed under other Sections, prior to rough in.

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- .3 Do not install boxes back to back. Allow minimum:
 - .1 150 mm separation in conventional walls.
 - .2 600 mm separation in acoustic rated walls.
- .4 Position boxes in masonry walls to suit masonry course lines.
- .5 Except where otherwise indicated, box at the following heights:
 - .1 Local switches: 1200 mm
 - .2 Receptacles:
 - .1 General (finished Areas): 300 mm
 - .2 Industrials Areas (Elec Room, Mech Room, Pump Room Etc.) 450 mm
 - .2 Above counters: 150 mm
 - .3 Above baseboard heaters: 200 mm
 - .3 Telephone or Data outlets:
 - .1 General: 300 mm
 - .2 Beside local Receptacle box
 - .4 Emergency Lighting Battery Receptacle 2500 mm
- .6 Measure mounting height from finished floor to centre line of device.
- .7 Owner's representative reserves the right to change location of outlets prior to installation with no change in Contract Price, provided that distance does not exceed 3 m from originally indicated location.

3.3 PULL AND JUNCTION BOX INSTALLATION

- .1 Locate above accessible ceilings and in unfinished areas.
- .2 Locate so as to minimize need for access doors.
- .3 Support boxes independent from conduit.
- .4 Installation is not permitted in ceiling spaces without prior written permission from Owner's Representative

3.4 AIR/VAPOUR HAT INSTALLATION

- .1 Install air/vapour hats around electrical boxes located in walls and ceilings where air or vapour barriers are present.

END OF SECTION

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1. GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 Basic Electrical Requirements: Section 16005.

1.2 SOURCE OF SUPPLY

- .1 All cabinets and enclosures larger than 300 mm square and 100 mm deep shall be by a single manufacturer.

1.3 COORDINATION

- .1 Coordinate size and depth of cabinets and enclosures with systems specified in other Sections which require enclosures.
- .2 Coordinate installation and identification of cabinets and enclosures with painting of mechanical and electrical work specified in Division 9.

2. PRODUCTS

2.1 CABINETS AND ENCLOSURES

- .1 Cabinets and Enclosures: to CSA C22.2 No. 40-M1989 and as follows:
- .1 Material: sheet steel
 - .2 Finish: pre-painted
 - .3 Covers: hinged
 - .4 Hinges: concealed flush type
 - .5 Latches: flush lock and catch assembly.
- .2 Backboards for Mounting of Cabinets and Enclosures: as specified in Division 6.

3. EXECUTION

3.1 INSTALLATION

- .1 Install surface or flush mounted cabinets at locations and heights indicated on drawings.
- .2 Mount enclosures on flat, even surfaces. Wall mounted enclosures to be plumb.
- .3 Attach enclosures solidly to backboards, structural members or suitable backing. Drywall supports are not acceptable for new construction.

END OF SECTION

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1. GENERAL

1.1 SOURCE OF SUPPLY

- .1 Each of the following shall be by a single manufacturer:

- .1 Switches.
- .2 Receptacles.
- .3 Cover plates.

1.2 COORDINATION

- .1 Coordinate installation of wiring devices and cover plates with site painting and finishing work specified in Division 9.

2. PRODUCTS

2.1 SWITCHES

- .1 Switches to CSA C22.2 No. 111-M1986 and as follows:

- .1 Rating: except where otherwise indicated or specified, 15 A 125/277V, full load rated for fluorescent and 80% for motor load.
- .2 Type: single pole, three-way or four-way as indicated.
- .3 Operation: toggle, quiet action.
- .4 Features:
 - .1 Totally enclosed, 2-piece phenolic case.
 - .2 Large silver cadmium oxide contacts.
 - .3 Rust resistant continuous steel mounting strip.
 - .4 Captive mounting screws.
 - .5 Large head terminal screws.

2.2 RECEPTACLES

- .1 Receptacles, plugs and similar wiring devices to CSA C22.2 No. 42-M1984.

- .2 Heavy Duty Specification Grade General Purpose Receptacles:

- .1 Rating: : 15A, 125V except where otherwise indicated.
- .2 Configuration: : 5-15R, 2 pole, 3 wire grounding.
- .3 Features:
 - .1 Ground terminal and poles connected to continuous mounting yoke.
 - .2 Wiring terminals: 8 back-wired entrances, 4 side screws.
 - .3 Split feed operation.
 - .4 Nylon face.
 - .5 Triple wipe brass power contacts.

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- .4 Isolated Ground Receptacles: same as general purpose receptacles, except for the following features:
 - .1 Isolated ground.
 - .2 Orange face.
- .5 Ground Fault Circuit Interrupter Receptacles: same as general purpose receptacles, except for the following features:
 - .1 Solid state ground fault sensing and signaling.
 - .2 5 milliamperes ground fault trip level.
 - .3 Feed-through type.
 - .4 Red Trip Indicator Light.

2.3 COVER PLATES

- .1 Stainless Steel: 1.0 mm thick, protective release paper, stainless steel screws.
- .2 Weatherproof: Heavy duty die-cast zinc, dual self closing flip lids, resilient rubber or closed cell foam urethane gasket, four mounting screws.
- .3 Exterior and weatherproof In-Use: Heavy duty polycarbonate construction, self closing covers, closed cell foam, neoprene blend gasket, single receptacle plate, to accept 30A locking plugs, molded hinge covers. Install for all exterior receptacles. To be Arlington Weatherproof Box.

2.3 PIN AND SLEEVE RECEPTACLES

- .1 Provide matching pin and sleeve plug and receptacles for equipment connection as noted in the contract documents.
- .2 Provide all accessories necessary required for a complete and operational system.
 - .1 Wall mounted systems to include at minimum: junction box and cover plate.
 - .2 Inline connections to include at minimum: strain relief, cord grip handle, plug caps.
- .3 Coordinate selected cable sizing (outside diameter and conductors sizes) with selected connector.
- .4 Coordinate connected load ratings (voltage, current, horse power etc...) with selected equipment ratings.
- .5 All connectors to be approved for use in Canada (CSA, cUL etc...)
 - .1 Submersible Pumps (Explosion Proof)
 - a. Application: Sewage wet well pumps
 - b. Environmental Ratings: Class 1 Zone 2
 - c. Voltage: See contract drawings
 - d. Amperage: See Contract drawings
 - e. Power connections: 3 (1 per phase)
 - f. Neutral connections: n/a
 - g. Ground connection: 1

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- h. Auxillary contact connections: 3
- i. Receptacle (female):
 - i. Mounting: wall mounted
 - ii. Cover lid: closed lid
- j. Inlet (male):
 - i. Mounting: wall mounted
 - ii. Cover lid: closed lid
- k. Basis of Design: Meltric EX series
- l. Alternates: Alternate manufacturers will be considered providing the product meets all project requirements.

3. EXECUTION

3.1 INSTALLATION, GENERAL

- .1 Install wiring devices as indicated and in accordance with manufacturer's written instructions.
- .2 Install wiring devices only in electrical boxes which are clean.
- .3 Install devices and cover plates flush and level.
- .4 Except as specifically indicated otherwise install weatherproof receptacle and switch covers on the exterior of buildings, vaults and all process areas

3.2 REPLACEMENTS

- .1 Replace all wiring devices and cover plates damaged during construction.

END OF SECTION

1. GENERAL

- .1 Utility service provider for project site is SaskPower.
- .2 Owner's representative has initiated service change request with SaskPower. Owner will pay Utility fees and construction expenses for service upgrade directly to SaskPower.
- .3 Electrical service to conform to all Utility requirements including SaskPower Technical Requirements, and the Canadian Electrical Code.
- .4 Contractor to coordinate work with SaskPower and provide notification for service connection.
- .6 Provide a copy of inspection report from authority having jurisdiction to SaskPower and Owner's representative prior to energizing service.

2. PRODUCTS

2.1 SERVICE

- .1 Underground Service: Provide rigid PVC conduit and wire of size, amperage, voltage and phase indicated on drawings.
- .2 Coordinate with Utility for provision and connection of service.

2.2 METERING

- .1 Metering at service transformer by utility.

2.3 SERVICE EQUIPMENT

- .1 MCC-1 service entrance rated breaker as specified in Section 16422, complete with main breaker in barriered compartment as indicated on drawings.

2.5 SURGE PROTECTIVE DEVICE

- .1 Type: Surge Protective Device (SPD) carrying a UL Listing or recognized status to ANSI/UL 1449 4th edition.
- .2 Feature: Metal Oxide Varistor (MOV) suppression.
- .3 Surge Capacity:
 - .1 Electrical Room: 250kA per phase and 125 kA per mode.
- .4 Location and mounting:
 - .1 Electrical Room in MCC-1 section with line fusing/breakers as required to meet code.

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- .5 Monitoring: status indicator lights on each phase, form 'c' contacts, audible alarm, and transient counter for Sag, Swell, Outage and Surge, Voltage meter.
- .6 Disconnecting means capable of completely isolating unit from supply for safe servicing or replacement of parts, including fuses. Handle for disconnecting means must be accessible without opening doors or covers

2.7 POWER QUALITY MONITORING METER

- .1 Electrical Power Quality Meter shall provide continuous monitoring of a three phase system.
- .2 Location: MCC-1
- .3 Meter to have the following monitoring features:
 - .1 Ia, Ib, Ic, In
 - .2 Va, Vb, Vc, Vab, Vbc, Vca
 - .3 Unbalance: V and I
 - .4 True PF, crest and K factor
 - .5 Hz, W, VAR, VA
 - .6 Wh, VARh, Vah, W cost
 - .7 Demand: A, W, VAR, VA
 - .8 Waveform capture for voltage and current channels
 - .9 Event and Alarm logging
 - .10 Harmonic monitoring
 - .11 Programmable alarm setpoints
- .4 Communications
 - .1 Outputs: 1 programmable dry contact output for common alarm
 - .2 Ethernet Communications
 - .1 Protocols: Ethernet/IP or Modbus TCP
- .5 Acceptable Manufacturers:
 - .1 Allen Bradley
 - .2 GE
 - .3 Eaton
 - .4 Schneider Electric

3. EXECUTION

3.1 SERVICE

- .1 Connect main breaker to meter base with conduit and wire as indicated on drawings.
- .2 Provide main electrical ground connection from neutral bar of service disconnect to ground grid as indicated on drawings.
- .3 Record exact service conductor length and route on record drawings.

3.2 INSTALLATION

- .1 The Contractor to be responsible for the correct installation and assembly of all items of equipment. Manufacturer's instructions to be carefully read and rigidly adhered to in the installation.
- .2 Any damage resulting from failure to observe the installation instruction or as a result of proceeding without sufficient knowledge of proper installations techniques will be the Contractor's responsibility.
- .3 Mounting of Equipment & Accessories
 - .1 Equipment to be installed in accordance with the drawings. Equipment shall be rigidly supported, level and plumb, and in such a manner as to provide accessibility, protection from damage, isolation from heat, shock and vibration, and freedom from interference with other equipment, piping and electrical work.
 - .2 Equipment not to be installed until heavy construction work adjacent to the Equipment has been completed.
 - .3 Equipment devices including accessories to be located where they will be accessible from structural platforms, permanent ladders, or grade. Locally mounted indicating Equipment to face toward, and within reading distance of a normal operating area.
 - .4 Sufficient clearance to be allowed for removal of equipment for maintenance and repair.
 - .5 Field located Equipment to be mounted on building columns and walls or pipe stands and/or other means of support as required in accordance with manufacturer's instructions and the Drawings.

3.3 INSPECTION

- .1 The Contractor shall obtain an electrical permit for each site or service location. The contractor is responsible to pay all fees and costs associated with the electrical permit, including inspection, and re-inspection fees.
- .2 The contractor shall coordinate inspections with the Authority Having Jurisdiction as required.
- .3 The Contractor will forward a copy of each inspection report to the Owner's Representative within 7 days from the date of inspection.
- .4 The Contractor shall, at their own expense, repair any irregularities or discrepancies determined during inspections.

3.4 EQUIPMENT MANUFACTURER'S REPRESENTATIVE

- .1 The equipment manufacturer's technical representative shall be familiar with the equipment supplied and shall come prepared with both knowledge and equipment to

perform and interpret the test, inspections and procedures recommended by the manufacturer for the starting of equipment that has not previously been run. The representative is required to complete all programming and setup of the device prior to testing. Provide Modbus address list in electronic .csv and .pdf format to Owners representative prior

- .2 The equipment manufacturer's technical representative shall, immediately after completion of the inspection, convey to the Engineer in writing, confirmation of the tests and inspections carried out and the result of this examination of the work.
- .3 If the inspection reveals defects in the work, correct as soon as possible and repeat the entire inspection procedure. Repeat until the work passes the inspection.
- .4 Document the results of the inspection by the equipment manufacturer's representative.
- .5 Ensure the installation meets all manufacturer's requirements for durable and trouble-free operation.

3.5 FIELD INSPECTION

- .1 The Owner's representative will request that the equipment be operated to demonstrate that it will perform as specified. The Owner's representative will note deficiencies, and if possible, the deficiency will be corrected immediately by the Contractor. All deficiencies that cannot be corrected at the time of inspection will be noted by the Owner's representative who will advise the Contractor of these deficiencies in writing. Correct the deficiencies as soon as possible and advise the Owner's representative of their correction. Should the deficiencies be of a sufficiently serious nature to require the work to be re-inspected, the cost of the inspection will be borne by the Contractor.

3.6 TRAINING

- .1 The Contractor will include in their price costs a minimum of one hour of training for the waste water treatment plant operating personnel for field Equipment listed in this section by qualified manufacturer personnel. The training shall cover all aspects of operation, maintenance and calibration of the equipment.

3.7 TESTING, ADJUSTING AND COMMISSIONING

- .1 Testing, adjusting and commissioning of all Equipment shall be in accordance with Section 01810.

3.8 PANELBOARDS

- .1 Adjust circuits to optimize phase current balance.

3.9 CONNECTION OF NON-MOTORIZED EQUIPMENT

- .1 Connect all equipment with electrical requirements specified in other Divisions:

END OF SECTION

1. GENERAL

1.1 SYSTEM

- .1 Provide emergency power system for supply of power in the event of failure of normal supply as indicated and in accordance with Canadian Electrical Code Section 46 and local inspection authority.
- .2 System to consist of a complete standby power supply unit, liquid air cooled, diesel engine directly coupled to ac alternator complete with fittings, connections, auxiliaries, control panels, safety devices, meters, etc. as indicated for a complete operating system.
- .3 Provide full automatic operation such that upon power failure, unit is on line taking full required load within 10 seconds. On resumption of normal power after time delay on transfer switch, load shall re-transfer to normal power and after rundown time delay, generator unit shall automatically shut down and return to starting condition ready for another operating cycle.
- .4 This section includes packaged engine generator sets for standby power supply with the following features:
 - .1 Diesel driven engine
 - .2 Unit mounted cooling system
 - .3 Exhaust system
 - .4 Starting system
 - .5 System control and alarm panel
 - .6 Skin tight weather and sound enclosure
- .5 Equipment to be supplied and installed in accordance with the following standards:
 - .1 National Building Code
 - .2 Canadian Electrical Code
 - .3 NFPA 110
 - .4 NFPA 30
 - .5 NFPA 37
 - .6 ISO-8528-1

1.2 RELATED SECTIONS

- .1 Section 15060 – Hangers and Supports
- .2 Section 15081 – Ductwork and Breeching Insulation
- .3 Section 15082 – Piping and Equipment Insulation
- .4 Section 15811 – Ductwork
- .5 Section 15852 – Louvres and Dampers
- .6 Section 16005 – Basic Electrical Requirements
- .7 Section 16061 - Grounding
- .8 Section 16075 - Electrical Identification
- .9 Section 16237 - Automatic Transfer
- .10 Section 16443 - Over Current Protection

- .11 Section 16971 - Electrical Starting and Testing

1.3 SUPPLIER QUALIFICATIONS

- .1 Qualifications: service and parts facilities in close proximity with 24 hour service, experienced in installation and operation of set of comparable size.
- .2 The manufacturer shall supply factory trained service and parts support through a factory authorized dealer/supplier that is regularly doing business in the area of installation. Manufacturer to supply proof to Owner's Representative that the aforementioned service is available.

1.4 SHOP DRAWINGS

- .1 Comply with requirements of Section 16005.
- .2 Submit full technical data and service and parts facilities complete with manufacturer's published h.p. data.
- .3 Provide at minimum the following information:
 - .1 Dimensional and elevation drawings of generator set and other associated equipment specified.
 - .2 Wiring diagrams for power, signal and control wiring.
 - .3 Generator set and associated equipment weights and point loads
 - .4 Installation instructions including required clearances.
 - .5 Heater sizing and voltage requirements
 - .6 Current Transformer ratio and model number and accuracy class
- .4 Alternate generator manufacturer/suppliers as noted in item 2.1, will be responsible for including a detailed load and sizing report specific to the project requirements and stepped loads. Program is to be created by generator manufacturer being submitted, competitor sizing program analysis for submitted design will not be acceptable.

1.5 FACTORY TESTING

- .1 It is the responsibility of the generator set supplier to provide a factory test report to the Owner's representative of the actual generator being installed on site **PRIOR** to shipping the generator. The Owner's representative will provide acknowledgement of the report and provide written consent to ship the generator set to site. The following information is required to be included in the factory test report:
 - .1 Perform torsional analysis test of engine and generator compatibility.
 - .2 Perform a four hour load test using a portable test bank. Perform test for four hours with load applied in 20% steps every 30 minutes until full load is applied. Record following at 30 minute intervals during the entire test:
 - .1 Kilowatts
 - .2 Amperes
 - .3 Voltage
 - .4 Frequency

- .5 Oil Pressure
- .6 Coolant Temperature
- .3 Upon completion of 4 hour test, run generator past 100% and record data as noted above indicating the point where the generator "unload protection" is enabled (anticipated 103-110%).
- .4 Test response of governor (droop or isochronous) applying 20% load and 100% load in one step. Use a Computer (plugged into ECU), storage oscilloscope or strip chart recorder to determine response time, voltage and frequency fluctuations during test.
- .5 Test voltage regulator and compare for conformance to manufacturer's product data.
This measurement
- .6 Submit certified tests results for approval by Owner Representative.

1.6 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: For packaged engine-generator sets to include emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Contract Acceptance Procedures" include the following:
 - 1. List of tools and replacement items recommended to be stored at the project location for ready access. Including part and drawing numbers, current prices, and source of supply.

1.7 MAINTENANCE MANUAL MATERIAL SUBMITTALS

- .1 Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: One for every ten of each type and rating, but no less than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 - 4. Belts: One set of each generator and fan belt.

1.8 WARRANTY

- .1 The supplier of the generator and associated materials is to provide a two (2) year - 400 hour full parts and labor warranty for all equipment and materials supplied under this specification. The warranty time is to start upon date of substantial completion.

1.9 PROJECT CONDITIONS

- .1 Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

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1. Notify Owners representative no fewer than **seven (7) business days** in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Owner's representative written permission.
- .2 Environmental Conditions: Engine driven system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability.
- .1 Minimum outdoor ambient temperature: - 37°C
 - .2 Maximum ambient operating temperature: 30°C
 - .3 Relative humidity: 0 - 95%
 - .4 Elevation: 482 meters
- .3 The following is a listing of special conditions and requirements for the specified generator set and equipment:
- .1 **Clearance from sides and back:** 1200mm minimum from widest/longest point on the generator/frame to adjacent wall or nearest piece of equipment. Maintain 1200mm egress path.

2. PRODUCTS

2.1 MANUFACTURERS

- .1 Basis of design product: Subject to compliance with requirements, provide Cummins C175D6D that conforms to these specifications or a comparable product by one of the following:
 - .1 MTU Onsite Energy
 - .2 Caterpillar Power Systems
 - .3 No other alternates will be accepted
- .2 If the Contractor chooses to use an alternate generator model than the basis of design product, the Contractor will be responsible for all architectural, structural, mechanical and electrical changes and alterations necessary to meet the Owner's requirements. The Contractor will be responsible for paying the Owner's representative for all additional engineering costs associated with the review and re-calculation of altered design variables. The additional review work shall include but not be limited to the following:
 - .1 Concrete floor/pad thickness and/or additional support (columns, pillars, screw piles etc.)
 - .2 Supplementary load voltage, current, cable requirements (heaters, battery charger etc.)

2.2 GENERATOR SET

- .1 Packaged generator set shall be coordinated assembly of compatible components capable of providing:
 - .1 Waste Water Treatment Plant: 170kW, 212.5 kVA, 600 VAC, 3 phase, 60 Hz

UNLESS a larger generator set is required to meet the site rating. Generator to be manufactured to CEMA standards.
- .2 Site Rating: The generator set shall have a minimum site rating of:
 - .1 Waste Water Treatment Plant: 170 kW

based on project conditions. It is the generator set supplier's responsibility to account for site conditions indicated and provide an adequately sized generator set meeting all requirements indicated in this specification. Should the generator set not meet the minimum site rating during on site commissioning the Owners representative reserves the right to:

 - .1 Request manufacturer to modify generator onsite until the site generator meets or exceeds the site rating.
 - .2 Withhold money from the Contractor at a value deemed acceptable by the Owners representative and allow the under rated generator to remain in operation.
 - .3 Request manufacturer to replace the undersized generator with a suitable generator that will meet the minimum site rating.
- .3 Factory assembled and tested engine generator set, provide report as indicated in Item 1.6 of this specification.
- .4 Provide semi-flexible couplings between generator and engine and protective guards over moving parts.
- .5 Provide properly sized generator main circuit breaker **100%** full load rated and enclosure. Breaker to be sized for unit protection and motor starting capacity. See specification 16433 for related requirements. The generator main breaker cannot have a larger rating than the transfer switch and main distribution system it is connected to. Coordinate sizing with the single line diagram in the contract drawing set. Generator main breaker shall be equipped with auxiliary contacts. The breaker auxiliary contacts shall indicate the position of the main breaker to the generator controller.
- .7 Provide fuel shut-off valve to the engine.

- .7 The generator set and all associated equipment specified is to be mounted on a common steel rail base.
- .8 Steel spring vibration isolators shall be provided between rail base and sub-base fuel tank for any generator set installed either partially or completely above a reservoir, or other structure.
- .9 The generator set and all associated equipment specified is to be mounted on a sub base frame complete with lifting attachments and enclosed in an exterior mounted weather proof sound attenuated enclosure. The enclosure is to include the features as noted in item 2.12 of this specification.

2.3 ENGINE

- .1 Capacity: 5% per cent overload for one hour and 25 per cent overload for transient or intermittent loads operating on diesel fuel at the listed elevation in 1.9.2.4 and an ambient temperature of 32°C.
- .2 Governor: speed regulation 3 cycles maximum from "No Load" to "Full Load" with two second maximum recovery to steady state.
- .3 Accessories: provide all replaceable type oil filters, dry type air cleaners, automatic choke, lubricating oils and greases, etc. as indicated in Item 1.7 of this specification.

2.4 COOLING SYSTEM

- .1 Engine - self-contained liquid cooling complete with pusher type fan maintaining safe operating temperature for unit under full load conditions.
- .2 Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 13mm water column restriction. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.

2.5 ENGINE HEATING SYSTEM

- .1 Immersion coolant heater: located in cooling jacket complete with immersion thermostat for 208V operation as required. It is the Contractors responsibility to provide proper conduit, wiring and breakers in local electrical panel to power the heater. Heater isolation valves are to be installed so as to replace the heater element without draining the entire cooling system.
- .2 Oil pan heater: located on the outside or inside of the oil pan with integral thermostat for 120V, operation as required. It is the Contractors responsibility to provide proper wiring and breakers in local electrical panel to power the heater. Heater is to be installed so as to replace the heater element without draining the oil system.
- .3 The coolant heater(s) and engine oil pan heaters as required shall be sized and provided as recommended by the engine manufacturer to warm the engine to a minimum of 104F (40C) in compliance with NFPA110 requirements, and the temperature required for starting and load pickup requirements of this specification in:
 1. Outdoor mounted generator: a -40F (-40C) ambient

2.6 STARTING SYSTEM

- .1 Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
- .2 Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
- .3 Battery: Per manufacturer voltage and amp hour requirements in order to meet 8 hour run time capacity requirements, and starting sequence as per 3.5 without depleting the battery below manufacturer recommended minimum starting voltage.
- .4 Battery Cable: Sized as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

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- .5 Battery Compartment: Plastic acid proof battery box which includes cover mounted on unit. Include accessories required to support and fasten batteries in place.
- .6 Battery Charger: constant potential type with manual and automatic control mounted on wall adjacent to unit, complete with dc ammeter, volt meter, overload protection, ac input switch, pilot switch for ac "On", equalizing charge and high rate charge. Adjustable rate of charge, "floating" on batteries at all times with full charging period of 24 hours maximum. Charger to have charger fault/fail alarm dry contact output relay.

2.7 ALTERNATOR

- .1 Alternator to be PMG excitation and appropriately sized for variable frequency drive (VFD) motor loads. Shunt or EBS regulators will not be accepted. Temperature rise to be no greater than:
 - .1 20kW – 200kW Generator = 130 °C
 - .2 201kW – 800kW Generator = 105 °C
 - .3 801kW+, Hospital or prime rated Generator = 80°C

2.8 FUEL SYSTEM – DIESEL FUEL SYSTEM

- .1 Provide a complete fuel system including duplex filters. Filter elements to be directly replaceable with elements of Canadian manufacturers.
- .2 Bring fuel supply lines and return lines to extreme forward part of base plate with drop ear elbows to be affixed thereto. Connect the other end of each elbow with 1m of flexible neoprene hose.
- .3 All non- metallic fuel hoses shall be of the steel reinforced rubber type with crimped or swaged end fittings.
- .4 Install sub-base dual wall diesel fuel tank, sized for a minimum 8 hour generator operation. Fuel tank to bolt to concrete pad. Fuel tank to c/w emergency vent outside as per NFPA30, 50mm NPT fill and fuel cap and riser located nearest to the door way, 50mm mechanical level gauge, low level alarm sensor, secondary containment break alarm sensor, supply and return ports, 38mm NPT for draining tank c/w isolation ball valve. Tank to conform to the maximum dimensions, as per 1.10.3

2.9 EXHAUST SYSTEM

- .1 Muffler and piping: Provide a complete exhaust system including heavy duty commercial type muffler with condensate drain, plug and flanged couplings. Exhaust system to be steel and completely sealed with corrugated stainless steel expansion joints of suitable length to absorb both vertical and horizontal expansion.

Muffler type: Critical Grade

2.10 ALARMS AND INSTRUMENTATION

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- .1 Engine Control Panel: Solid state controller mounted in Code gauge metal enclosure on frame of unit complete with oil pressure gauge, water temperature gauge, low oil pressure alarm contacts high water temperature alarm contacts low oil pressure shutdown contacts high water temperature shutdown contacts over speed shutdown contacts cranking limiter relay.
- .2 Generator Control Panel: Totally enclosed ventilated Code gauge metal panel mounted on unit constructed of channel or angle iron frame finished in enamel over corrosion-resistant primer, complete with hinged door incorporating output circuit breaker volt meter and volt meter selector switch ammeter and ammeter selector switch complete with current transformers as required frequency meter, voltage adjustment rheostat running time meter.
- .3 Generator Controller: Incorporate large size 320x240 pixel LED-backlit Liquid Crystal Display. Controller to be capable of displaying scrolling alarms, engine and alternator performance characteristics and alarm history. Complete with generator Stop/Start/Auto/Manual/Reset selection, emergency stop button, cranking limiter, trouble horn, and double pole, double throw silencing switch. HMI to include LED indicating lamps: running, remote start, not in auto, shutdown, warning, auto, manual and stop. HMI to be mounted on generator control panel to provide clear and easy access for operating. HMI to be mounted no higher than 1800mm above finished floor to centre of display.
 - .1 Current Transformers: Where Generator Controller utilizes Current Transformers (CT) for measuring alternator current, CT ratio shall not to exceed generator overcurrent device rating.

2.11 REMOTE MONITORING

- .1 Remote Monitoring: In addition to contacts for remote start and damper control, the generator control system shall provide the following 120VAC rated, form C dry contact output relays as to indicate the following generator alarms:
 - .1 Diesel Generator
 - .1 Generator Running
 - .2 Generator Fault
 - .3 Low Fuel Level
 - .4 Tank Leak
 - .3 Battery Charger
 - .1 Charger fail

2.12 WIRING AND CONNECTIONS

- .1 Provide all conduit, wiring and connections required and recommended by unit supplier.
- .2 Install all control and alarm wiring in RPVC conduit unless otherwise noted in the drawings.

- .3 Connect mid-point (neutral) of generator to insulated “Grounded Conductor” back to electrical service common neutral point. **Do not** install system bonding jumper between generator neutral point and generator frame/ground. Refer to Canadian Electrical Code for complete details.

2.13 OUTDOOR GENERATOR-SET ENCLOSURE

- .1 Description Sound Attenuated Steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- .2 Hinged Doors: Lockable. For each door provide either integral lock or padlocking provision and high security padlock. All locks to be keyed alike. Provide 6 keys. Restraint/Hold back hardware to keep doors door open at 110 (minimum) degrees during maintenance. Restraint/Hold back hardware is to allow all doors to be held open or closed without interfering with opening or restraining another door. Rain lips over all doors.
- .3 Exhaust System: Muffler Location: Self-contained within enclosure.
- .4 Hardware: All hardware and hinges shall be stainless steel.
- .5 Wind Rating: Wind rating shall be 195 kph.
- .6 Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
- .7 A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- .8 Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40°C.
- .9 Dampers: For generator sets greater than 200kW provide adjustable intake and exhaust dampers with thermostatically controlled electric damper motors.
- .10 Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer’s standard color or as directed on the drawings.
- .12 Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 75 dBA measured at any location 7 m from the engine generator in a free field environment.
- .13 Site Provisions: Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

- .14 Control Heater: Outdoor generators and enclosures shall be provided with control heaters for anti-condensation protection.
- .15 Integral electrical distribution panel, 120/208VAC, 1 phase, suitable for 60A supply, with breakers and wiring suitable for all required generator heating, control, and battery charging loads.
- .16 Rodent Proof: All penetrations and openings along bottom of enclosure to be sealed with filler plugs.
- .17 Enclosure to come complete with D.C. task lighting on each side of the generator enclosure.
- .18 Provide motorized intake and exhaust dampers to minimize air flow through the enclosure when generator set is not operating. Dampers shall include provisions to prevent accumulation of ice or snow that might prevent operation. Intake and exhaust dampers shall be powered closed and spring open to ensure fail safe operation and controlled by manufacturer provided temperature controller.

3. EXECUTION

3.1 COORDINATION WITH OTHER SECTIONS OF WORK

- .1 Coordinate to ensure proper execution of work covering ventilation, field supply and products-of-combustion exhaust, to form an efficient and well-coordinated layout.

3.2 INSTALLATION OF GENERATOR SET

- .1 Provide terminal box for generator and exciter leads.
- .2 Install unit complete and make operational.
- .3 Coordinate installation of all in-slab conduits with manufacturer drawings prior to pouring concrete.

3.4 OPERATION OF STARTING SYSTEM

- .1 Stop/start sequence: in automatic position, auxiliary contacts in transfer switch initiates starting cycle of unit. The control system provided shall include a cranking system, which shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between periods. After which if engine fails to start, trouble circuit contacts close illuminating appropriate trouble annunciator window and locking out starting cycle until manually reset. On starting of engine, starting circuits automatically reset. On resumption of normal power after time delay in transfer switch, load to retransfer to normal supply and following rundown period engine shall shutdown and return to starting condition.

3.5 CONTROL PANEL TROUBLE INDICATION

- .1 Incorporate contacts so that when shutdown occurs from one set of shutdown contacts, subsequent operation of all shutdown contacts are locked off from operating annunciators.
- .2 Operation of silencing switch shall silence trouble alarm but pilot light shall remain illuminated.
- .3 On return to normal and resetting off annunciators, trouble horn shall sound again until switch is returned to normal position.

3.6 STANDBY POWER GENERATION SYSTEM TESTING

- .1 Prior to energizing power generation units on site:
 - .1 Ensure generating system is disconnected from normal power supply.
 - .2 Ensure all auxiliary support devices are operational, including ventilation and exhaust systems.
 - .3 Ensure that engine has proper lubricant levels, coolant levels and fuel supply.
 - .4 Ensure all testing on emergency distribution equipment and transfer switch as specified has been completed.
- .2 Site Testing:
 - .1 Perform torsional analysis test of engine and generator compatibility.
 - .2 Perform a four hour load test using a portable test bank. Perform test for four hours with load applied in 20% steps every 30 minutes until full load is applied and one hour at maximum power or 110%; whichever is less. Record following at 5 minute intervals for the first 30 minutes and 30 minute intervals for the remainder of the test. All recordings to be done with computer or digital chart recorder, handheld meter and handwriting on paper are not acceptable:
 - .1 Kilowatts
 - .2 Amperes
 - .3 Voltage

- .4 Frequency
- .5 Oil Pressure
- .6 Coolant Temperature
- .3 Test response of governor (droop or isochronous) applying 20% load and 100% load in one step. Use a Computer or storage oscilloscope or strip chart recorder to determine response time, voltage and frequency fluctuations during test. Record readings at minimum 0.01 second intervals for a duration of 15 seconds.
- .4 Test voltage regulator and compare for conformance to manufacturer's product data.
- .5 Record noise level measurements in dBA at various locations around unit and area surrounding exhaust port.
- .6 Submit certified tests results for approval by owner representative.
- .7 Conduct Site Testing in conjunction with manufacturer and in presence of the owner representative.
- .8 Test maximum power up to 110% of rated generator set. This does not mean oversize the generator, the intent is to measure and record absolute maximum output before the generator shuts off.
- .9 Simulate power failure including operation of:
 - .1 Transfer switch.
 - .2 Automatic starting cycle.
 - .3 Automatic shutdown and return to normal.
 - .4 Loss of single phase by utility and return to normal
- .10 Test all alarm and shutdown circuits by simulating conditions. Closing or opening of appropriate sensor contacts mechanically is not acceptable. The following should be tested at a minimum:
 - .1 Low oil pressure alarm.
 - .2 High water temperature alarm.
 - .3 Low oil pressure shutdown.
 - .4 High water temperature shutdown.
 - .5 Over speed shutdown.
 - .6 Over cranking shutdown.
 - .7 Low Fuel alarm
 - .8 Fuel cell leak alarm
 - .9 Low coolant temp alarm
 - .10 Low coolant level shutdown
 - .11 Not in Auto
 - .12 Breaker Open
- .11 Test building load and automatic transfer switch settings, coordinate testing with section 16237 Automatic Transfer.

- .12 Contractor is responsible for filling the diesel tank prior to testing. After Site testing has been completed to the satisfaction of the owners representative the Contractor is responsible to refill the diesel fuel tank with “winter diesel” to the full level.
- .14 Generator Manufacturer to provide test results to Contractor and Owner's representative within 10 business days of completion of test. Result to be submitted as an electronic document. Excel (.xls or .xlsx) and Portable Document Format (.pdf) are acceptable. Owner’s representative reserves the right to withhold up to \$2,500 if the test results are not received.

END OF SECTION

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1. GENERAL

1.1 SYSTEM

- .1 Provide complete factory assembled power transfer equipment with electronic microprocessor-based controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of the normal source and one phase of the emergency source, positive mechanical and electrical interlocking, and mechanically held contacts for both.
- .2 The transfer system shall consist of a delayed neutral position (open) transition transfer switch. All control modules shall be the product of the same manufacturer.
- .3 The transfer switch shall transfer the load in delayed transition: break – delay position (no connection) - make mode. Transfer is accomplished with a user-defined interruption period in both directions adjustable from 1 second to 5 minutes in a maximum of 15 second increments. Unit is to be designed for fully automatic operation upon power failure.

1.2 ACCEPTABLE MANUFACTURERS

- .1 The automatic transfer switch shall be provided by:
 - .1 Onan
 - .2 ASCO
 - .3 No alternates.

2. PRODUCTS

2.1 COMPONENTS

- .1 Automatic transfer switch: fully automatic electrically operated, mechanically held, for all load classes with normal and emergency supply as defined below. Switch to be complete with auxiliary engine starting contacts, full phase relay protection to operate on normal power voltage drop to 70 per cent on any phase. Detects when all three phases are present, have the correct sequence and detects if voltage or phase angle asymmetry is below set value. Transfer switch to be a contactor based switch, not a breaker style type. The switch is to have the following ratings:
 - .1 Voltage (VAC): 347/600
 - .2 Phase: 3
 - .3 Wire: 4
 - .4 Pole: 3
 - .5 Amperage (Amp): 400

- .2 The electrical operator shall be a solenoid mechanism, momentarily energized. The transfer switch unit shall include both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at the same time. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- .3 Provide time delay relays, adjustable from 10 seconds to 5 minutes to delay transfer from normal to standby until standby power source has obtained 90 per cent of rated voltage.
- .4 Provide time delay relays, adjustable from 1 to 5 minutes, to delay transfer from standby to normal source.
- .5 Provide time delay relays, adjustable from 0 seconds to 5 minutes , to adjust time in neutral "off" position.
- .6 Provide time delay relays, adjustable from 0seconds to 5 mintures , to delay engine start contact.
- .7 Provide time delay relays, adjustable from 10 seconds to 30 minutes for engine cool down.
- .8 Fault level to match level of specified equipment fed from transfer switch.
- .9 In cover of transfer switch provide red pilot light indicating emergency position of transfer switch complete with test switch to simulate a power failure.
- .10 Provide two sets of normally open contacts, one on normal supply and the other on standby supply.
- .11 Provide a set of normally open contacts for transfer switch controller alarm contacts.
- .12 Provide time delay relays adjustable for 0-2 minutes, to delay transfer from load to neutral to load.
- .13 Source status screens shall be provided for both normal and emergency to provide digital readout of voltage on all three phases and frequency. System status screens shall display a clear description of the active operating sequence and switch position.
- .14 Inspections of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- .15 The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The controller shall include a user selectable algorithm to prevent repeated transfer cycling to a source on an installation which experiences primary side, single phase failures on a Grounded Wye – Grounded Wye

transformer which regenerates voltage when unloaded. The algorithm shall also inhibit retransfer to the normal (utility) source upon detection of a single phasing condition until a dedicated timer expires, the alternate source fails, or the normal source fails completely and is restored during this time delay period. The time delays associated with this feature shall be adjustable by the user through the controller keypad and LCD.

- .16 A 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port.
- .17 All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port. The time delay value displayed on the LCD or remote device shall be the remaining time until the next event occurs.
- .18 The automatic Transfer Switch control system shall provide as a minimum, two programmable 120V dry contact output relays as to indicate the following generator alarms:
 - .1 Automatic Transfer Switch fail to transfer or fault
 - .2 Automatic Transfer Switch normal source available
- .19 Provide routine to exercise generator engine automatically based on a programmable schedule. The following routine parameters shall be adjustable by the user via the user interface:
 - .1 Enable or disable the routine;
 - .2 Enable or disable transfer of the load during the routine;
 - .3 Start time of the routine (time of day, day of week, week of month, or equivalent); and
 - .4 Duration of routine.
- .20 The Automatic Transfer Switch contactor mechanism shall include a means to manually operate the mechanism to transfer between Utility and Emergency sources with out the need to using control power. Provide manual operation tool (Switching Bar) safely secured inside Automatic Transfer Switch enclosure.

3. EXECUTION

3.1 OPERATION

- .1 Automatic start-up upon normal power failure.
- .2 Transfer when standby unit reaches 90% of rated voltage.
- .3 Retransfer to neutral position then to normal supply after time delays, when normal power is resumed.
- .4 Engine rundown period at "No "Load".
- .5 Engine shutdown.

- .6 Operating sequence automatically reset.
- .7 Connect emergency circuit to emergency contacts in transfer switch for connection to damper controls associated with cooling system.

3.2 COMMISSIONING

- .1 To be performed in conjunction with sections 16971 and 01810.
- .2 Provide and pay for the manufacturer representative to commission the transfer switch.
- .3 Notify the Owner 1 week prior to the day in which the transfer switch is to be commissioned.
- .4 Set and adjust all Transfer Switch parameters as per the Owners requirements.
- .5 Commission the transfer switch in the presence of the Owner or Owners representative via a live load test as follows:
 - .1 Turn off the main breaker to the transfer switch.
 - .2 Verify the power transfer from normal to emergency power.
 - .3 Turn on the main breaker to the transfer switch.
 - .4 Verify the power transfer from emergency to normal power.
 - .5 Coordinate Utility to turn off a single phase at a time for the primary of the transformer. Ensure all building loads are turned off or disconnected.
 - .6 Verify "Ghost" phasing does not occur in the disconnected phase by verifying that the transfer switch does not transfer back to utility (normal power) when not under load.
 - .7 Demonstrate all input and output signals from Automatic Transfer Switch
- .6 Record all data and parameter settings on a type written sheet and provide copies to be inserted into the Operation and Maintenance Manuals.

END OF SECTION

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1. GENERAL

1.1 PRODUCT DATA

- .1 All performance and test data to meet with the Owners Representative approval, CEMA and IEEE Standards.

2. PRODUCTS

2.1 DRY CORE - LESS THAN 500KVA

- .1 Grounded star, air cooled type, natural circulation in ventilated metal case to CSA and CEMA standards, Class B insulation with temperature rise not exceeding 80°C for rise above 40°C.
- .2 Provide four 2.5 per cent full capacity taps, two above and two below normal voltage.
- .3 Certification: High Efficiency NEMA Standard TP-1 (Energy Star sucesor), CSA C802.2.
- .4 Windings to be copper.
- .5 On transformers 175 kVA and larger, provide temperature gauge, reading core and coil temperature, mounted in a fixed cover section, complete with auxiliary alarm contacts.
- .6 All transformer to have flexible connection to primary and sencondary feeder conduits.
- .7 Mounting configuration of transformers is to be coordinated contract drawings and as follows:
 - .1 Integral to MCC / Switch gear: Coordinate physical dimensions with MCC enclosure
 - .2 Floor Mounted: On concrete housekeeping base complete with vibration isolation dampers.
 - .3 Wall mount: Provide manufacture mounting brackets. Equipment to be specifically rated for wall mounting.
 - .4 Clearances as required by CEC.
- .8 Specified Equipemnt:
 - .1 Tag: T-101
 - .1 Primary : Secondary Voltage: 600:120/208VAC, 3PH
 - .2 Winding Configuration: Delta / Wye
 - .3 kVA: 75
 - .4 Mounting: Wall Mount in electrical room

3. EXECUTION

3.1 NAMETAGS

- .1 Provide name tags indicating full electrical data, connection diagrams, etc.

END OF SECTION

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1. GENERAL

1.1 SOURCE OF SUPPLY

- .1 All disconnects shall be by a single manufacturer.

1.2 COORDINATION

- .1 Coordinate installation of disconnects for equipment specified in other Divisions with installation of such equipment.

2. PRODUCTS

2.1 UNFUSED DISCONNECTS

- .1 Unfused Disconnects: to CAN/CSA-C22.2 No. 4 - M89 and as follows:
 - .1 Poles, Voltage, Amperage, kW Rating and Enclosure: as indicated on drawings or schedules; if not indicated, select disconnect to suit application.
 - .2 Type: general duty.
 - .3 Operation: lever handle, capable of being locked in "On" or "Off" position.

2.2 FUSED DISCONNECTS

- .1 Fused Disconnects: to CSA C22.2 No. 39-M1987 and as follows:
 - .1 Same as unfused disconnects except complete with fuse holders.
 - .2 Fuse holders shall be compatible with fuses as specified in Section 16443.
 - .3 Provide complete loose set of spare fuses for **ALL** fused disconnects.

3. EXECUTION

3.1 INSTALLATION

- .1 Disconnects shall be located by all motors and mechanical units as required by the Canadian Electrical Code.
- .2 Coordinate installation of disconnects for equipment specified in other Divisions and installed by this Division.

END OF SECTION

01. GENERAL

1.1 REFERENCE STANDARDS

- .1 Provide motor protection switches of the CEMA size listed. Maximum rating of units not using CEMA rating to be equivalent to CEMA size indicated.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01330 - Submittals.
- .2 Submit full technical data, service and parts facilities complete with manufacturer's publish data.
- .3 Full shop drawings to be submitted for starter equipment, submit as a minimum:
 - .1 Specification and Data Sheets.
 - .2 Manufacturer's published warranty documents.
 - .3 Shop drawings showing plan and elevation views with certified overall and interconnection point dimensions.
 - .4 Interconnection wiring diagrams showing all external connections required; with all field wiring terminals marked in a consistent manner.
 - .5 Manufacturer's installation instructions.
 - .6 Complete programming instructions (Soft Start).
 - .7 Manufacturer's recommended spare parts.
 - .8 Complete parts list.
 - .9 Manufacturer to provide indication of overcurrent device sizing for line side of the Soft Start.
- .4 Submit shop drawings in conjunction with MCC shop drawings. Shop drawing package to clearly indicate with dimensioned drawings, how the starters will integrate into the MCC line up.

2. PRODUCTS

2.1 SINGLE PHASE MOTOR STARTERS

- .1 For motors 1/8 h.p and above, quick-make, quick-break with 120VAC operating coil, motor rated contacts sized for the h.p. rating of the motor controlled.

2.2 THREE PHASE MOTOR PROTECTION SWITCHES

- .1 Across-the-line magnetic motor protection switches with three overload relays, complete with 120 V operating coil, 600/120 V control transformer of sufficient VA to handle the starter coil, controls, and integral pilot lights.

2.3 COMBINATION STARTERS

- .1 Molded case air circuit breaker style complete with rotary type switch with operating handle and lock-off facility. Opening starter enclosure restricted by the use of a defeater screw, unless switch is in the "Off" position.
- .2 Each combination magnetic motor protection switch installed in unit motor control centre or field installed is to house the following facilities:
 1. Moulded case automatic air circuit breaker.
 2. Contactor with three overload relays.
 3. 120 V holding coil.
 4. Pilot light in cover (LED type).
 5. Elapsed time meter in cover.
 6. Reset button, HOA switch in cover, field convertible to Off/Auto or Start/Stop push button as indicated.
 7. Two sets of normally open auxiliary contacts in addition to the standard auxiliary holding contacts supplied with each contactor. One set of auxiliary contacts convertible to normally closed.
 8. Control transformer primary and secondary fusing - primary fusing to be HRC type.
 9. Control transformer 600/120 V of sufficient VA to operating coil and associated controls.
 10. Pilot lights, switches push buttons are to be Allen Bradley 800T, Furnace 52 or EATON 30mm.

3. EXECUTION

3.1 INSTALLATION

- .1 In finished area, provide flush mounted motor protection switches complete with stainless steel cover plates.
- .2 Coordinate motor starter relay sizes of all motors. Starter relay heaters as furnished with starters to be checked in field and if not correctly installed by the manufacturer, they shall be changed and sized according to manufacturer's recommendations for the motor nameplate full load current.
- .3 Furnish disconnection means for motors as required by the Canadian Electrical Code.
- .4 Where motor starters are shown mounted in motor control centers, provide suitably sized moulded case breaker or fused switch ahead of starter in accordance with Canadian Electrical Code requirements. Select heaters to suit full load current of motors.

3.2 STARTUP AND COMMISSIONING

- .1 Retain the services of the manufacturers representative for commissioning of the equipment after installation. Testing to be in accordance with the specifications and shall include but not be limited to:
 - .1 All equipment shall be function tested, calibrated and load tested.
 - .2 Prior to performing any tests or applying power to the starters, verify all cable and wiring connections as well as equipment setup and mounting arrangement (i.e. Foundation, cable entry, operation of the HMI etc.)
 - .3 Verify the interface with the facility's PLC system.
 - .4 Provide type written report of the commissioning test including all parameter settings.

END OF SECTION

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1. GENERAL

1.1 PRODUCT DATA

- .1 Comply with requirements of Section 16005.

1.2 COORDINATION

- .1 Coordinate installation with:
 - .1 Section 13313 - Instrumentation - Control Panels
 - .2 Section 16211 - Service and Distribution
 - .3 Section 16237 - Automatic Transfer
 - .4 Section 16270 - Transformers
 - .5 Section 16411 - Disconnects
 - .6 Section 16421 - Motor Starters
 - .7 Section 16690 - Variable Frequency Drives
 - .8 Section 16692 - Active Harmonic Filters
- .2 Mechanical Equipment Controls to provide an complete integrated functional system.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01330 - Submittals.
- .2 Submit full technical data, service and parts facilities complete with manufacturer's publish data.
- .3 Full shop drawings to be submitted for VFD equipment, submit as a minimum:
 - .1 Specification and Data Sheets.
 - .2 Manufacturer's published warranty documents.
 - .3 Shop drawings showing plan and elevation views with certified overall and interconnection point dimensions.
 - .4 Interconnection wiring diagrams showing all external connections required; with all field wiring terminals marked in a consistent manner.
 - .5 Manufacturer's installation instructions.
 - .6 Manufacturer's recommended spare parts.
 - .7 Complete parts list.
- .4 Submit VFD shop drawings in conjunction with MCC shop drawings. Shop drawing package to clearly indicate with dimensioned drawings how the VFD's will integrate into the MCC line up.

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2. PRODUCTS

2.1 MODULAR MOTOR CONTROL CENTRES

.1 Motor control centres to CSA C22.2 No. 14-95 and as follows:

.1 Bus Characteristics:

- .1 Capacity: MCC-1 400 Amperes,
- .2 Construction: rectangular section copper, tin plated joints.
- .3 Minimum Bracing: 16,000Amperes symmetrical.
- .4 Neutral: No.
- .5 Ground bus: Copper.

.2 General Construction:

- .1 To EEMAC standards for construction of Class I motor control centre with type B wiring.
- .2 Dead front, multi-unit, modular type with assembly of vertical stacks containing cubicles sized to house equipment required.
- .3 Minimum height per module: 305 mm. Each module shall house combination starter, disconnect breaker, relays, and control transformer as per schedule.
- .4 Horizontal bussing across top or centre and vertical bussing down each stack.
- .5 Wiring gutter across top and bottom and vertically down each stack. Wiring gutter shall be barriered from busway compartments.
- .6 Each combination starter or disconnect switch assembly shall be mounted in tub or rack assembly of removable plug-in type with necessary bus connection stabs.
- .7 Blank combination starter spaces shall have hinged cover section provided with full bussing to receive future rack assemblies.
- .8 Refer to documentation for the following equipment Integral equipment located within the motor control center. The motor control center shall be able to contain but not be limited to:
 - .1 Motor Starters.
 - .2 Variable Frequency Drives.
 - .3 Transformers.
 - .4 Distribution Panels.
 - .5 Disconnects.
 - .6 Automatic Transfers Switch.
 - .7 Phase Line Monitor.
 - .8 Transient Voltage Surge Suppressor.
 - .9 Harmonic Filters
 - .10 Load reactors

2.2 ACCEPTABLE MANUFACTURES

.1 Basis of design: Schneider Electric Square D Model 6 MCC

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- .2 The following manufacturers will be accepted providing they can meet the space and specification requirements.

- .1 Benshaw
- .2 Siemens
- .3 ABB (General Electric)
- .4 Schneider Electric
- .5 Eaton
- .6 Rockwell Automation
- .7 No alternates

3. EXECUTION

3.1 INSTALLATION

- .1 Set and secure modular motor control centre in place concrete housekeeping pad.
- .2 Make field power and control connections as indicated.
- .3 Provide overload devices to suit motors installed.
- .4 Provide breakers to suit motors installed.
- .5 Tighten bus connections and mechanical fasteners to manufacturer's recommended torque values to assure permanent and effective connection.
- .6 Adjust operating mechanisms for free mechanical movement.
- .7 Touch-up scratched or marred surfaces to match original finish.

3.2 PROTECTION OF COMPLETED WORK

- .1 Protect motor control centres to prevent entry of duct, paint and other foreign matter.

3.3 TESTING

- .1 Comply with requirements of Section 16971.

END OF SECTION

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1. GENERAL

1.1 PRODUCT DATA

- .1 Comply with requirements of Section 16005.
- .2 Provide manufacturer's product data for all devices.
- .3 Provide following information:
 - .1 Time current characteristic curves on full size (280 mm x 432 mm) log-log time/current graph paper.
 - .2 Fault interrupting capability of each device in symmetrical amperes at applied voltage.
 - .3 Time current curves for all circuit breaker overload, overcurrent and ground current tripping devices.
 - .4 Relay current transformer ratios, accuracy class and current sensor tap ranges.
 - .5 Motor control overcurrent protective device characteristics and curves.
 - .6 Current limiting let-through information for HRC fuses in graph form.
 - .7 Minimum melting and maximum clearing time/current curves for HRC fuses.

1.2 SOURCE OF SUPPLY

- .1 Supply all overcurrent protective devices in each of the following categories by a single manufacturer:
 - .1 Moulded case circuit breakers.
 - .2 Fuses.

2. PRODUCTS

2.1 MOULDED CASE CIRCUIT BREAKERS - GENERAL

- .1 Moulded Case Circuit Breakers: to CAN/CSA-C22.2 No. 5.1-M91.

2.2 BRANCH MOULDED CASE CIRCUIT BREAKERS

- .1 Trip Type: thermal/magnetic.
- .2 Voltage: as indicated in schedules.
- .3 Poles: as indicated in schedules.
- .4 Interrupting Capacity: 10,000 symmetrical.
- .5 Mounting: bolt-in any position.
- .6 Normal operation: in 40°C ambient.

- .7 Features:
 - .1 Thermal and instantaneous magnetic trip.
 - .2 Trip free, toggle type operation.
 - .3 Quick-make, quick-break action.
 - .4 Positive handle trip indication.
 - .5 Trip rating visible with panel trim installed.

2.3 FEEDER MOULDED CASE CIRCUIT BREAKERS

- .1 Trip Type: thermal/magnetic.
- .2 Voltage: as indicated in schedules.
- .3 Poles: as indicated in schedules.
- .4 Interrupting Capacity: 16,000.
- .5 Mounting: bolt-in any position.
- .6 Normal operation: in 40°C ambient.
- .7 Features:
 - .1 Thermal and instantaneous magnetic trip.
 - .2 Trip free, toggle type operation.
 - .3 Quick-make, quick-break action.
 - .4 Positive handle trip indication.
 - .5 Trip rating visible with panel trim installed.
 - .6 Fixed pad lockable hasp to lockout breaker in the on and off position.
 - .7 Electronic Long, Short, Instantaneous dial adjustable protection.

2.4 FUSES

- .1 Plug and Cartridge Standard (STD) Fuses: to CSA-C22.2 No. 59.1-M1987 and as follows:
 - .1 Standard fuse interrupting ratings: 10 kA symmetrical.
 - .2 HRC fuses: to CAN/CSA-C22.2 No. 106-M92 and as follows:
 - .1 HRC fuse interrupting ratings: 200 kA symmetrical.
 - .2 HRC fuse types:
 - .1 HRCI-J non-time delay.
 - .2 HRCI-J time delay.
 - .3 HRCI-R non-time delay.
 - .4 HRCI-R time delay.
 - .5 HRCII-C (motor protection only).
 - .6 HRC-L non-time delay.
 - .7 HRC-L time delay.

- .3 Voltage: as indicated on drawings.
- .4 Ampacity: as indicated in drawings and schedules.
- .5 Fuse Types: as indicated on drawings.

3. EXECUTION

3.1 INSTALLATION

- .1 Install overcurrent protective devices as indicated, in accordance with manufacturer's written instructions.
- .2 Fasten overcurrent protective devices without causing mechanical stresses, twisting or misalignment of equipment in final position.
- .3 Set field-adjustable trip settings as indicated subsequent to installation.
- .4 Overcurrent protective device sizes and identification as specified in respective equipment schedules.

3.2 TESTING AND ADJUSTING

- .1 Comply with requirements of Section 16971.

END OF SECTION

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1. GENERAL

1.1 SHOP DRAWINGS

- .1 Provide shop drawings for luminaires. Include all pertinent physical characteristics. Manufacturer's standard catalogue literature, clearly marked, may be used where applicable. Provide photometric data for each fixture and lamp combination.

2. PRODUCTS

2.1 LUMINAIRES

- .1 As indicated in Luminaire Schedule in drawings.

2.2 LAMPS

- .1 Provide all luminaires complete with integral LEDs.

2.3 BALLASTS

- .1 LED drivers to be easily replaceable in the field without the need to remove entire light fixture.

2.4 LIGHTING CONTROLS

- .1 Controls: Provide switches, photoelectric controls, timers and relays for lighting circuits and luminaires as indicated on drawings.

2.5 APPROVED ALTERNATES

- .1 Contract lighting design is based on the light figures and controls specified in the drawings, specifications, and luminaire schedule. Alternate make and models of light fixtures and lighting control equipment will be considered during shop drawing submissions (not during Tender) providing the Contractor:
 - .1 Provides product specification sheet for each fixture clearly indicating comparable features to the specified equipment.
 - .2 Carries an allowance of \$200 per alternate type, payable to the Owners Representative. Payment shall be made for additional work required by the Owner's Representative to review alternate equipment compliance with NECB and AHJ requirements.

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3. EXECUTION

3.1 INSTALLATION

- .1 Provide adequate supports for luminaires. Use chain or rods for suspended luminaires. Do not support luminaires over 5 kg in weight from outlet boxes.
- .2 Coordinate luminaire installation with architectural details, reflected ceiling plans and mechanical equipment. Install accurately in line and level, to present a neat appearance and avoid conflicts.
- .3 Do the following prior to Interim Acceptance of the Work:
 - .1 Clean all luminaires to remove construction dust and debris.
 - .2 Re-lamp with new lamps, all luminaires which have been used for more than two months as temporary lighting during construction.

END OF SECTION

1. GENERAL

1.1 RELATED SECTIONS

- .1 Start-up and commissioning

1.2 CODES AND STANDARDS

- .1 Design and construct the VFD in accordance with the applicable sections of the following standards or as modified in the specification:
 - .1 ANSI C84.1982 Voltage Ratings for Electric Power Systems and Equipment.
 - .2 CAN/CSA-C22.2 Industrial Control Equipment No. 14-M91
 - .3 ANSI C37-90.1-1989 Guide for Surge Withstand Capability Tests.
 - .4 Equipment shall have CSA approval.
 - .5 Equipment shall comply with the electrical bylaws of the local electrical authority.
 - .6 Equipment shall be designed and manufactured in compliance with ISO-9001 quality standards.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01330 - Submittals.
- .2 Submit full technical data, service and parts facilities complete with manufacturer's published data.
- .3 Full shop drawings to be submitted for VFD equipment, submit as a minimum:
 - .1 Specification and Data Sheets. Clearly indicate complete part number and associated tag.
 - .2 Manufacturer's published warranty documents.
 - .3 Shop drawings showing plan and elevation views with certified overall and interconnection point dimensions.
 - .4 Interconnection wiring diagrams showing all external connections required; with all field wiring terminals marked in a consistent manner.
 - .5 Manufacturer's installation instructions.
 - .6 Complete programming instructions.
 - .7 Manufacturer's recommended spare parts.
 - .8 Complete parts list.
 - .9 Line harmonic distortion calculations for the drive and the motor the drive is controlling.
 - .10 Manufacturer to provide documentation with selection guide for sizing drives for single to three phase operation. Contractor to ensure all single to three phase drives are sized accordingly to manufacturer's recommendation.
 - .11 VFD Manufacturer to provide indication of overcurrent device sizing for line side of the VFD

- .4 Submit VFD shop drawings in conjunction with MCC shop drawings. Shop drawing package to clearly indicate with dimensioned drawings, how the VFD's will integrate into the MCC line up.

1.4 COORDINATION

- .1 It shall be the responsibility of the Variable Frequency Drive manufacturer to obtain all operating data and operating characteristics of the electric motors and the pump/motor combinations as may be required to ensure that the VFD's will safely and efficiently drive the intended equipment over the full range of intended operating conditions for the expected service life of 25 years.

2. PRODUCTS

2.1 GENERAL

- .1 The Contractor shall ensure full and complete coordination of the drive and motor characteristics which shall include, but not be limited to, the following:
 - .1 A guarantee that the drive and motor meet the load demands and acceleration requirements of the driven equipment throughout the speed range when the input voltage varies over a range of 10%; and,
 - .2 Ensuring complete compatibility of the drive's current limit protection with the motor thermal withstand capability.
- .2 The drive shall be 97% efficient at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
- .3 Controlled acceleration and deceleration times, separately adjustable, shall be provided. When requested on the Data Sheet, the vendor shall provide adjustable damping for the response to speed change.
- .4 Separately adjustable minimum and maximum frequency limits shall be provided.
- .5 The drive shall be capable of regulating the frequency to a $\pm 1\%$ of the setpoint over the full input voltage and ambient temperature operating range.
- .6 The vendor data shall indicate the efficiency, power factor, kW output, heat rejection and harmonic distortion of the drive 25%, 50%, 75% and 100% operating points.
- .7 Audible noise levels produced by the drive shall be limited 80 dBA sound pressure at one meter, at any point throughout the operating range of the drive.
- .8 The drive input shall be protected to withstand surges as defined in ANSI Std. (C37.90.1 - 1989, Guide for Surge Withstand Capability (SWC) Tests.

2.2 FRONT PANEL CONSTRUCTION REQUIREMENTS

- .1 Provide the following features as a minimum on the drive enclosure door:
 - .1 HOA selector switch
 - .2 Elapsed time meter
 - .3 Two (2) Pilot lights (Run-Green, Fault-Red)
 - .4 Digital VFD Display
 - .5 Potentiometer to manually adjust the speed of the respective VFD when the Hand-Off-Auto selector switch is in the Hand position.
 - .6 Equipment lamaroid name plate indicating:
Line 1: Equipment tag (ie...VFD PWP-402)
Line 2: xxx AMP / xxx HP
 - .7 Removable air intake filters (where required)
 - .8 Exhaust fan(s) (where required)
- .2 All the pilot devices indicated are to be Allen Bradley 800T or Furnas 52
- .3 All front panel control and pilot devices to be clearly marked as to operation with 3mm thick, black face, white core, mechanically attached lamaroid nameplates with 8mm high letters.

2.3 CONSTRUCTION REQUIREMENTS

- .1 The drive shall be enclosed in:
 - .1 A motor control center unless otherwise specified on the Drawings.
- .2 The drive shall be complete with cable compartments for connection of incoming and outgoing cables.
- .3 When auxiliary cooling is required, the drive shall have fans and the required thermostatic controls for proper operation.
- .4 Terminal blocks for control, alarms, metering and diagnostics shall each be readily accessible, grouped and shall be segregated from power devices, for personnel safety.
- .5 Each terminal block, fuse, control switch, circuit breaker, auxiliary switch, relay, instrument transformer and other auxiliary component shall be permanently labeled to correspond with the schematics and wiring diagrams.
- .6 The shop drawing shall state what corrosion protection is provided.
- .7 Line Filtering 5% Line reactors or 3% line reactors and DC link choke to be provided and installed on the line side of each VFD as a minimum and Load filters to be provided and installed as indicated on the contract drawings.
 - .1 Line reactors and load filters to be installed integral to the same enclosure or MCC section as the applicable VFD and be clearly marked as to operation.

- .8 Drive enclosure shall have overcurrent protection as per contract drawings and shall have a local disconnecting means as a minimum. Disconnect or circuit breaker handle shall be accessible from the exterior of the enclosure when the door is closed and be capable of being locked in the off position. Opening the VFD enclosure shall be restricted by the use of a defeater screw, unless switch is in the "Off" position.

2.4 CONTROL FEATURES

- .1 Front panel interface module with LCD display and entry keypad to provide the following functions as a minimum:
 - .1 Drive setup parameters
 - .2 Diagnostic information
 - .3 Drive operating values
- .2 The drive shall have, as a minimum discrete/dry contact input connections and circuits within the drive for connection of remote signals as follows:
 - .1 Drive "enable" permissive signal, normally open contact, operable drive is in remote or local control mode.
 - .2 Run signal, closed to run, open to stop in remote mode.
 - .3 Emergency Stop Device (ESD) which will stop the drive in both manual and automatic modes.
 - .4 Preset Speed: bypasses run/analog signal and runs at user programmed speed in automatic mode.
- .3 The drive shall provide the following relay outputs (form C, rated 2 amp at 120 VAC) as minimum:
 - .1 Run Status
 - .2 In Auto
 - .3 Fault
- .4 The drive shall provide the following isolated analogue outputs (4-20 mA) as minimum:
 - .1 One (1) programmable to - frequency, speed, current, torque, power.
- .5 The drive shall provide the following isolated analogue inputs as a minimum:
 - .1 4-20mA programmable input for speed set point from the facility control system.
 - .2 Manual speed adjust device (typ. 0-10VDC).
- .6 The diagnostic system shall monitor each alarm and shutdown function and shall display the status of each point on the enclosure front panel.
- .7 Each VFD requiring Ethernet Communication shall be equipped with Ethernet modules capable of communicating via Ethernet/IP communication protocol. The VFD shall be capable of being fully controlled with ethernet controls. All digital inputs shall be

available via ethernet communication. All drive status' including current running status, speed feedback and faults will be accessible through via ethernet communications, as well as the capability to set drive speed and on or off state.

2.5 PROTECTION SYSTEMS

- .1 All power connections, cables and buswork shall be braced to withstand the available asymmetric short circuit current.
- .2 The drive shall be equipped with a minimum of 15 ms power loss ride-through capability.
- .3 The loss of AC input power longer than 15 ms shall cause the drive to shutdown in an orderly fashion, without causing pulsations in the drive or motor systems.
- .4 The drive shall have the capability of being restarted with a remote signal from the PLC control system.
- .5 The drive shall not be affected by radio frequencies emitted by portable radios/transmitters.
- .6 The drive shall protect itself against the following as a minimum:
 - .1 Under/over voltage
 - .2 Overcurrent
 - .3 Overtemperature
 - .4 Output short circuit
 - .5 Output ground fault
 - .6 Stall

2.6 OPERATING PARAMETERS

- .1 Equipment Ratings:
 - .1 Tag: VFD xxx-xxxx refer to drawings
 - .1 Voltage: refer to drawings
 - .2 Current: refer to drawings
 - .3 Horse Power: refer to drawings
 - .4 Short circuit: refer to drawings
- .2 The VFD shall be connected and programmed to provide the following control operation as a minimum:
 - .1 When the HOA selector switch is in the Hand position:
 - .1 The drive shall receive a "run" signal and accept the speed signal from the potentiometer located on the door of the VFD control cabinet.
 - .2 The drive shall not accept start/stop signals or speed control signals from the remote controlling device.

- .2 When the HOA selector switch is in the Off position:
 - .1 The drive shall if running decelerate and come to a stop and while in the Off position and not accept start/stop signals or speed control signals from either speed control device
- .3 When the HOA selector switch is in the Auto position:
 - .1 The drive shall not accept start/stop signals or speed control signals as described above when controlled in the Hand position.
 - .2 While in Auto position, the drive shall be controlled by a remote controlling device, which is typically, but not necessarily a Programmable Logic Controller. The drive shall accept start/stop signals and speed control signals from the remote controlling device.
 - .3 While in the Auto position the drive shall be programmed and wired to allow the remote controlling device start/stop signals and speed control signals to be bypassed or overridden by forcing the drive to a preset speed. This preset speed value to be determined on site during commissioning.
- .3 Questions about the wiring of or operation and control of the VFD's to be addressed to the owners representative prior to commissioning.
- .4 Switching the control of the VFD between Hand and Auto operations to be seamless without the requirement of entering extra parameters or operation menus from the keypad of the VFD:
- .5 Fault Input: permissive signal from remote device, normally closed or open contact. Drive shuts down and provides fault status upon change of state.

2.7 ACCEPTABLE SUPPLIERS

- .1 Qualifications: service and parts facilities in the Province of Alberta with 24 hour service, experienced in installation and operation of VFD's.
- .2 Acceptable VFD Manufacturers:
 - .1 Yaskawa
 - .2 Mitsubishi
 - .3 Toshiba
 - .4 MGI
 - .5 Eaton
 - .6 Schneider
 - .7 Allen Bradley
 - .8 No Alternates
- .3 To maintain uniformity of structures and equipment, the VFD's are to be provided by a single manufacture.

3. EXECUTION

3.1 INSTALLATION

- .1 Install variable speed drives with the assistance of factory-trained engineers in accordance with the manufacturer's specifications.
- .2 Protect against dust and damage during entire construction period.
- .3 After connections have been made, vacuum-clean interior. Hand-clean exterior and touch-up damaged paint.

3.2 STARTUP AND COMMISSIONING

- .1 Retain the services of the manufacturers representative for commissioning of the equipment after installation. Testing to be in accordance with the specifications and shall include but not be limited to:
 - .1 All equipment shall be function tested, calibrated and load tested.
 - .2 Prior to performing any tests or applying power to the drives, verify all cable and wiring connections as well as equipment setup and mounting arrangement (i.e. Foundation, cable entry, operation of the HMI etc.)
 - .3 Verify the interface with the facility's PLC system.
 - .4 Provide written report of the commissioning test including all parameter settings.

3.3 WARRANTY

- .1 Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment.
- .2 The warranty shall include all parts, labor, travel time and expenses.

END OF SECTION

1. GENERAL

1.1 CODES AND STANDARDS

- .1 The harmonic mitigation equipment and all of its components shall be manufactured and tested in accordance with the latest applicable standards of CUL, CSA and NEMA.
- .2 Harmonic mitigation equipment shall be warranted to be free of defects in materials and workmanship for a period of 12 months from the date of startup or 18 months from the date of shipment.
- .3 Factory Performance Testing: Manufacturer must be capable of factory testing for harmonic mitigating performance and energy efficiency under actual variable frequency drive loads. A detailed description of the program and a sample test report must be provided at time of quotation.
- .4 The filter shall be of a fully proven design which is in production currently as a standard product or that is based on an active filter generation that has been in production for more than five years.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01330 - Submittals.
- .2 Submit full technical data, service and parts facilities complete with manufacturers publish data.
- .3 Full shop drawings to be submitted for Filtering equipment, submit as a minimum:
 - .1 Specification and Data Sheets.
 - .2 Manufacturer's published warranty documents.
 - .3 Shop drawings showing plan and elevation views with certified overall and interconnection point dimensions.
 - .4 Interconnection wiring diagrams showing all external connections required; with all field wiring terminals marked in a consistent manner.
 - .5 Breaker ratings
 - .6 CT: quantity, rating, class
 - .7 Manufacturer's installation instructions.
 - .8 Complete programming instructions.
 - .9 Manufacturer's recommended spare parts.
 - .10 Complete parts list.
- .4 Submit for approval before shipment certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

1.3 COORDINATION

- .1 It shall be the responsibility of the Harmonic Filter manufacturer to obtain all operating data and operating characteristics of the electric motors, VFD's and the pump/motor combinations as may be required to ensure that the Filter will safely and efficiently filter the harmonics and prevent resonance of the intended equipment over the full range of intended operating conditions for the expected service life of 25 years.

2. PRODUCTS

2.1 GENERAL

- .1 The active filter shall be of the shunt configuration and of 3-wire type to filter harmonics in the phases.
- .2 The active filter shall be connected at the LV level in an installation allowing for the reduction of harmonic stress and to reduce harmonic emissions to the feeding network.
- .3 The active filter shall be able to work on utility fed networks as well as on local backup generators.
- .4 The active filter shall measure the network currents at the supply side of the unit allowing for closed loop control. Standard current transformers of class 1 accuracy shall be sufficient for proper filter operation.
- .5 The active filter power inverter shall be based on IGBT technology. It shall employ a PWM modulation technology using a fixed switching frequency.
- .6 The active filter shall have an automatic restart function which will ensure that the filter will restart automatically after a power outage when it was on at the moment that the power outage occurred.
- .7 The active filter shall be capable of operating in parallel operation with at minimum 4 other identical filter modules.

2.2 MODE OF OPERATION

- .1 The active filter shall monitor all three phases of the low voltage line current in real time and process the measured harmonics by means of a Digital Signal Processor (DSP) based system.
- .2 The output of the DSP based system shall be a pulse width modulated (PWM) signal to control power modules based on IGBT (Insulated Gate Bipolar Transistor) technology that shall be controlled as a current source.
- .3 The control of the power modules and associated reactors shall be such that harmonic currents of exactly the opposite phase of those to be filtered are injected into the source of

supply to the filter so that the harmonic currents flowing in the line are reduced to levels that can be individually programmed by the user.

- .4 The system shall be operated under closed loop control. The control system shall be such that the active filter cannot be overloaded.
- .5 The active filter shall be able to co-exist with tuned and detuned capacitor banks in some way.

2.3 FILTER RATINGS AND CHARACTERISTICS

- .1 Voltage: The active filter shall be 3 phase 3-wire unit suitable for operation on a network characterized by system line voltages in the following ranges:
 - .1 600VAC, 3 Phase, 3 Wire System: 480-600VAC
- .2 Current: The RMS current rating of each active filter module shall not be less than 40 Amps per phase.
- .3 The active filter shall be able to filter simultaneously at least 20 individual harmonic components individually programmable in a frequency range from the 2nd to the 49th harmonic.
- .4 In order to be able to comply with power quality standards, the degree of filtering shall be programmable, for each harmonic, in Amps which defines the value of the current that may be injected into the network for each harmonic component.
- .5 The active filter shall allow for different filter modes to be set expressing the priority to be given to the filtering of harmonics and the generation of reactive power and load balancing.
- .6 Filtering efficiency shall be typically not less than 95% related to the filter rating.
- .7 The active filter shall be able to perform reactive power compensation and aim to compensate for a target displacement power factor ensuring correct operation in the presence of harmonics. The user must be able to choose this target power factor in a range from 0.6 inductive to unity and in a range from 0.6 capacitive to unity.
- .8 The active filter shall be able to do load balancing between phases with the same priority level as doing reactive power compensation.
- .9 The active filter shall have the possibility to set up two different types of compensation settings that are selectable by triggering an external contact.
- .10 The active filter shall have intelligent control technology that minimizes the filter switching losses for each operating point
- .11 The active filter shall incorporate its own protection devices that ensure protection against at least overcurrent, short-circuit, thermal overload, IGBT bridge abnormal

operation, network voltage phase loss, network synchronization loss and DC capacitor over- and undervoltage.

- .12 The over temperature protection shall allow for the filter to de-rate smoothly to a certain extent while triggering a temperature alarm contact. When the temperature problem is solved, the filter when running in de-rated mode shall automatically assume its normal rating again.
- .13 The active filter shall have the capacity to filter at least an ampacity of 40 amps on 600V 3 phase system.

2.4 OPERATOR INTERFACE

- .1 The active filter shall be provided with an operator interface suitable for programming and monitoring the performance of the unit. The operator interface must at least be a dedicated programming and monitoring unit mounted permanently on the front of each active filter.
- .2 The operator interface shall incorporate access levels to ensure that non-authorized people cannot alter system settings. At least three access levels shall be provided as per the following:
 - .1 Monitoring network and filter parameters
 - .2 Programming the filtering, reactive power and balancing requirements.
 - .3 Setting up the hardware configuration parameters
- .3 The operator interface shall allow for the logging of the time during which selected network parameters have been higher than a preset value and also for the storing of the maximum value recorded during a logging session.
- .4 The operator interface shall allow for the setting up of programmable warnings and alarms that may be associated with a selection of network parameters.
- .5 The operator interface shall allow for the setting up of the digital inputs and the digital outputs of the active filter.
- .6 The operator interface shall allow for the printing of the setup parameters and selected measurements on a serial printer
- .7 The operator interface shall incorporate displays covering the following subjects:
 - .1 Network Parameters:
 - .1 Vrms of all phase to phase voltages,
 - .2 Vfundamental of all phase to phase voltages
 - .3 THDV of all phase to phase voltages,
 - .4 Irms of all line currents,
 - .5 Ifundamental of all the line currents
 - .6 THDI of all line currents

- .7 Active, reactive and apparent power
- .8 Power factor and displacement power factor
- .9 Voltage imbalance
- .10 Network frequency
- .2 Filter Parameters:
 - .1 Percentage of filter capacity used,
 - .2 IGBT and control board temperatures
 - .3 Voltage present on the DC bus
 - .4 Operating hours of the filter fan
 - .5 Operating hours of the filter system
- .3 Spectrum displays in graphical format for all line voltages, line currents and filter currents.
- .4 Waveform displays in graphical format for all line voltages, line currents and filter currents.
- .5 Event and faults that have occurred in a event log display with real time stamp.
- .6 The operator interface is to be installed on the front door of the enclosure. Should the filter be installed in a separate MCC enclosure the display is to be remote mounted on the front cover of the outer door.

2.5 ALARM INPUTS AND OUTPUTS

- .1 The active filter shall be capable of switching on and off by remote control.
- .2 The active filter shall provide at least one alarm contacts (Dry form 'c') that allows to monitor the active filter alarm status.
- .3 The active filter shall have at least one multi-purpose digital input contacts
- .4 The active filter shall have at least one multi-purpose digital output contacts. It must at least be possible to use these contacts to monitor basic filter operation or to output specific alarm conditions selectable out of a predefined list.

2.6 CONSTRUCTION REQUIREMENTS

- .1 The active filter shall be suitable for indoor operation in cooled room with the following environmental factors:
 - .1 Maximum temperature: + 40°C (50°C with derating)
 - .2 Minimum temperature: + 5°C
 - .3 Maximum average temperature: + 35°C over 24 hours
 - .4 Relative humidity: maximum 95% non-condensing
 - .5 Altitude: maximum 1000m without derating

- .2 Enclosure:
 - .1 Standalone Free Standing Enclosure: The AHF shall be installed in an AHF manufacturer provided NEMA 1 enclosure. The MCC (section 16422) manufacturer shall provide overcurrent devices, CTs and CT shorting blocks as required by AHF manufacturer.
- .3 The active filter shall have both bottom and top cable entry possibilities.
- .4 The active filter shall be available in cubicle and plate versions.
- .5 Additional auto transformers will not be acceptable for connecting a harmonic filter of a different nominal voltage to the main system bus. The Active filter is to be capable of directly connecting to the main buss.

2.7 ACCEPTABLE MANUFACTURER'S

- .1 The following manufacturers will be considered acceptable providing they meet all technical requirements of these specifications and the space constraints within the intended location of installation.
 - .1 600VAC Systems
 - .1 Comsys (Power Survey)
 - .2 ABB
 - .3 Schneider Electric
 - .4 Approved alternates will be considered during shop drawing reviews. Products will not be reviewed during tender period. It is the Contractor and Suppliers responsibility to ensure and provide documentation that the alternate products will be capable of meeting the specifications.

3. EXECUTION

3.1 INSTALLATION

- .1 The harmonic mitigation equipment shall be handled, stored and installed in accordance with the manufacturers recommended installation practices as found in the installation, operation, and maintenance manual. Installation shall comply with all applicable codes.

3.2 STARTUP AND COMMISSIONING

- .1 Retain the services of the manufacturers representative for commissioning of the equipment on-site after installation. Testing to be in accordance with the specifications and shall include but not be limited to:
 - .1 All equipment shall be function tested, calibrated and load tested.

- .2 Prior to performing any tests or applying power to the drives, verify all cable and wiring connections as well as equipment setup and mounting arrangement (i.e. Foundation, cable entry, etc.).
 - .3 Harmonic compliance shall be verified with onsite field measurements of both the voltage and current harmonic distortion at the input terminals of the harmonic mitigating equipment with and without the equipment operating. A recording type Fluke 43B or equivalent harmonics analyzer displaying individual and total harmonic currents and voltages must be utilized.
- .2 The Contractor is responsible for testing and measuring Power Quality of main service and each VFD during commissioning. Contractor to ensure:
- .1 Power quality analyzer (Fluke 43B, Fluke 435 or approved equivalent) is used to monitor, trend and export report including:
 - .1 THD,
 - .2 Individual harmonics for Voltage, Current, and Frequency
 - .3 Power factor, KVA, KW, KVAR
 - .4 Inrush current: 1s, 5s, 10s, 50s
 - .2 Provide type written report with exported data from the Power Quality Analyzer. Report to show graphs of data being measured. Indicate loads being powered at each measurement and measured values as noted in above (items 3.2.2.1).
 - .3 Perform the following tests with the harmonic filter in both the ON and OFF positions.
 - .1 Baseline no load: shut off as many building loads as possible (no pumps running, lights off etc...).
 - .2 Baseline standard building load: Power equipment that will normally be in operation (ie lighting, control panel, heater etc...).
 - .3 One VFD running: Power standard building load and smallest VFD in normal operation
 - .4 Additional VFD/Starter combinations: Power standard building load with additional motor staging configurations available in the facility. Account for up to 10 additional measurements at Owner representative's discretion
3. The Contractor shall coordinate a separate on-site Manufacturer demonstration seminar for the Owner for the AHF system:
- .1 Allow for up to a 1-hour demonstration and instruction seminar. The seminars will be geared towards general operation of the system, operation and maintenance of the equipment, and all specific system programming and shutdowns.

END OF SECTION

1. GENERAL**1.1 RELATED SECTIONS**

- | | | |
|----|----------------------------------|----------------|
| .1 | Instrumentation – Control Panels | Section 13313. |
| .2 | Basic Electrical Requirements: | Section 16005. |
| .3 | Voice and Data Cabling Testing: | Section 16712. |
| .4 | Wire and Cable | Section 16121. |

1.2 ABBREVIATIONS

- | | | |
|-----|----------|---|
| .1 | ETL | Electronic Testing Laboratories |
| .2 | IDC | Insulation Displacement Connectors |
| .3 | UTP | Unshielded Twisted Pair |
| .4 | NEXT | Near End Crosstalk |
| .5 | ELFEXT | Equal Level Far End Crosstalk |
| .6 | PSNEXT | Power Sum Near End Crosstalk |
| .7 | PSELFEXT | Power Sum Equal Level Far End Crosstalk |
| .8 | DGM | Data-Grade Media |
| .9 | STP | Shielded Twisted Pair |
| .10 | VGM | Voice-Grade Media |

1.3 INSTALLER QUALIFICATIONS

- .1 Personnel installing communications cabling shall be trained and conversant with communications cabling practices required for this project.

1.4 SCOPE

- .1 System to be complete with all data and voice outlets, patch panels, patch cords, wire and cable required to from a complete system.
- .2 Install cable in raceway in exposed locations or where concealed in inaccessible walls and ceilings. Elsewhere cable may be installed without raceway.

1.5 STANDARDS

- .1 Comply with the following standards:
- | | |
|----|---------------------------------|
| .1 | TIA/EIA 568-B1, B2 and B3 |
| .2 | TIA/EIA TSB-67, 72 and 75 |
| .3 | ANSI/TIA/EIA 568a-1, 2, 3, 4, 5 |
| .4 | TIA/EIA/IS 729 |
| .5 | BICSI |

2. PRODUCTS

2.1 HORIZONTAL CABLING TO WORKSTATION

- .1 UTP: to CAN/CSA T529-M95 and TIA/EIA 568 - B1, B2, B3, Category 6.
- .2 Fiber Optic Cable: to CSA T529-95.

2.2 COMMUNICATIONS OUTLET ASSEMBLIES

.1 Communications Outlet - Boxes:

- .1 1 gang recessed box, 63 mm minimum depth with 19 mm deep two device adapter ring, 1.6 mm 16 AWG thickness.

.2 Communications Outlet - Housings:

- .1 Formed Outlet Plate.
 - .1 Maximum dimensions: 150 mm x 150 mm x 38 mm deep.
 - .2 Rear and side entry of cable. Strain relief provisions for side entry of cable.
 - .4 Flat plate: minimum thickness 3.9 mm.
- .2 Accepts minimum of two snap-in or slide-in outlet inserts.
- .3 Mounts to standard one or two device opening or mounting ring.
- .4 Constructed of high-impact fire-retardant thermoplastic.

.3 Communication Outlet - Jacks:

- .1 Copper-Based Inserts: to TIA/EIA 568-B1, B2, B3, Category 5 enhanced standards, worst pair:
 - .1 Termination via fixed or removable IDC, AT&T 110, Krone LSA-Plus, or NT BIX IDC's with hinged or separate stuffer cap.
 - .2 If removable IDC type is used, they must meet the following physical specifications:
 - .1 Connection of removable IDC's via 8-position edge connectors plated with minimum 40 microns of nickel. Capable of minimum 250 insertion and withdrawal cycles.
 - .2 Connection of removable IDC's via 8-pin header connector. Maximum 8.9 N engagement force and minimum 2.25 N disengagement force. Pins minimum 1.4 mm square.
- .2 Modular Outlet - UTP:
 - .1 8-position unkeyed jack for voice and data compatible with 4-pair 100 ohm unshielded twisted pair.
 - .2 Capable of minimum of 200 insertion and withdrawal cycles.
 - .3 Copper-based contacts with 50 to 100 microns of nickel overlay uniformly coated with minimum 50 microns of gold overlay.
 - .4 Minimum contact force 1.1 N per contact. Minimum plug retention force 76 N.
 - .5 Conductors separated and aligned internally by comb structure.

- .6 Electrical Specification:
 - .1 Contacts:
 - .1 Dielectric strength: 1000 V rms @ 60 Hz.
 - .2 Insulation resistance: 10 megohms, minimum.
 - .3 Contact resistance: 0.02 ohms, maximum.
 - .4 Current rating: 1.5 amps, maximum.
 - .2 Insulation Displacement Connectors:
 - .1 Voltage Rating: 250 VAC.
 - .2 Current Rating: 5 amps.
 - .3 Resistance: 0.02 ohms maximum.
 - .4 Dielectric Withstanding: 2000 VAC for 60 sec.
 - .5 Insulation Resistance: 500 megohms minimum.
- .7 Rated for data transmission up to 100 MHz.
- .8 Wire configuration to T568A pair assignment

2.3 PATCH CABLES

- .1 UTP Type:
 - .1 Patch Cables to match installed cable's transmission and electrical specifications.
 - .2 Fire Rating: plenum rated overall jacket, CSA FT-4 compliant.
 - .3 Modular Connectors:
 - .1 Matching types and minimum specifications as for outlet components.
 - .2 Long body type.
 - .3 Suitable for solid or stranded conductor and wire gauge used.
 - .4 Tool-stuffed or plier-stuffed with IDC contacts and plier-latched cap.
 - .5 Factory manufactured
- .4 Quantity: Provide one 1 m and one 3 m UTP patch cord for each new cable outlet.

2.4 IDENTIFICATION MATERIALS

- .1 Lamicoid Nameplates: 3 mm thick plastic engraving sheet, black face, white core, mechanically attached, sizes as follows:
 - .1 Size 1: 12 mm high with 5 mm high letters.
- .2 Wire Identification Materials: Use one of the following:
 - .1 Machine-printed heat shrink sleeves.
- .3 Device Identification Materials: Machine-printed black lettering on clear adhesive tape, sizes as follows:

2.5 PATCH PANELS

- .1 Copper Cable Patch Panels
 - .1 Terminate all network cable runs to patch panel. Patch panel to include the following features
 - .1 Punch down blocks on back side of panel for cable run installation
 - .2 RJ45 female jack on front side of panel.
 - .3 24 cables per panel.
 - .4 Standard 19" 1RU rack mount

3. EXECUTION

3.1 INSTALLATION

- .1 Cable Installation:
 - .1 Generally install FT6 rated data cable and voice cable using raceway except where noted otherwise on drawings or as follows.
 - .2 Install data and voice cable in conduit where:
 - .1 concealed in inaccessible walls or ceilings
 - .2 exposed to mechanical damage
 - .3 cable runs require fire rating (for example in riser shafts)
 - .3 Support cable runs independently of ceiling suspension system.
 - .4 Swab raceway system before installing wiring.
 - .5 Do not exceed manufacturer's maximum pulling force.
 - .6 Maintain not less than minimum bending radius for fiber and copper conductors.
 - .7 Install cable along or at right angles to building lines unless impractical to do so. Verify specific cases of deviation in advance.
 - .8 Maintain open copper-conductor cable at maximum practical distance from fluorescent ballasts and other EMF - or discharge-generating equipment.
 - .9 Ensure that cable is not flattened, squeezed, or crimped at any point along entire run. No splices or intermediate terminations in cable runs except by special permission in advance, with documentation detailing locations and nature of splices.
 - .10 Install cables in PVC raceway in telecom room and fan individual cables to applicable patch panels in neat, logical fashion.
 - .11 Tie wrap cables neatly into logical bundles.
 - .12 Minimum 3 m of slack cable per run.
- .2 Connectors:
 - .1 Use tooling specific to connector types in use.
 - .2 Use connectors suitable for nature of conductor in cable, eg. stranded vs solid copper.
 - .3 Ensure that connectors' strain relief provisions are used. Strip jackets only amount required.
 - .4 Maintain pair twists within 13 mm of termination.

- .5 UTP Connection Configuration in accordance with EIA/TIA 568A-1991 or CAN/CSA-T529-M95.

Pair	Colour	RJ-45 Pins
1	Blue	4
	White/Blue	5
2	White/Orange	3
	Orange	6
3	White/Green	1
	Green	2
4	White/Brown	7
	Brown	8

- .3 Outlets, Boxes and Fittings:

- .1 Ensure in advance that outlet box/data outlet installation methods yield vertically-mounted data outlets.
.2 Install all outlets flush with finished surfaces unless indicated otherwise on the drawings.

- .4 Cabinets, Enclosures, Racks, Backboards:

- .1 Install at locations and heights indicated on drawings.
.2 Use green insulated 6 AWG ground conductors for grounding racks. Use grounding bushing, solderless lug, clamp, or cup washer and screw.
.3 Protect ground conductors from mechanical injury.
.4 Install ground conductors such that neither ground conductors nor data cables interfere with one another in regards to future servicing of patch panel rear connections.

- .5 Patch Panels

- .1 Mount patch panels in order shown on drawings.
.2 Ground as required by system.
.3 Attach horizontal wiring in an ordered fashion according to the numbers as indicated on the drawings.
.4 Mount panels to racks with as many screws as there are mounting holes or slots in panels.
.5 Provide and install necessary strain reliefs and cable support brackets, plus trays for cable loop behind panel and install cables utilizing such devices.

3.4 COMMUNICATIONS CABLE AND EQUIPMENT LABELING

- .1 Label communication outlets, panels and ports with size 1 Device Identification Materials.
.2 Label each of cables with other end's address using Wire Identification Materials.
.3 Label outlets with labels vertically aligned in each row.
.4 Position panel labels in the same position on each panel.

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- .5 Use the following naming convention as indicated on the drawings when labeling communications cabling components.

3.2 LOOSE CABLE SCHEDULE

- .1 Supply the following cables in loose form for the use by the Owner. Category 6 UTP loose cables to be factory assembled and tested.

Quantity	Cable Type	Length	Ends
15	UTP	1000mm	RJ-45 both ends

END OF SECTION

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1. GENERAL

1.1 RELATED SECTIONS

- .1 Data and Voice Cabling: Section 16711.

2. PRODUCTS

Not Used

3. EXECUTION

3.1 TESTING

- .1 Test all runs upon completion of permanent terminations, using instrumentation acceptable to Owner. Before commencing testing, submit sample test data sheets and information with respect to test instrumentation to be used.
- .2 Copper Media:
 - .1 Test for the following:
 - .1 Continuity.
 - .2 Pair placement and polarity.
 - .3 DC resistance.
 - .4 Characteristics at Highest contemplated frequency for data and voice cables:
 - .1 Attenuation.
 - .2 Mutual Capacitance.
 - .3 NEXT, PS NEXT, ELFEXT and PS ELFEXT
 - .5 Run length.
 - .2 Before recording results, compare readings to predicted values based on cable specification and run length, using connector and patch cord losses as part of predicted value. Retest runs with:
 - .1 Resistance and capacitance readings more than 10% above or below predicted values.
 - .2 NEXT, PS NEXT, ELFEXT or PS ELFEXT values 3dB higher than predicted values.
 - .3 Attenuation values 2dB higher than predicted values.
 - .3 Reconnect or re-install and retest as necessary to correct excessive variations.

3.2 REPORT

- .1 Record results in tabular form.
- .2 Segregate horizontal runs, inter-room runs, and risers by category or run and by type of cable.

- .3 Present horizontals' results in ascending order, following grid numbering.
- .4 Report Submission:
 - .1 Submit three reports printed on 215 mm x 280 mm white paper. Leave copies unbound for insertion into O&M manuals.
 - .2 Submit report prepared in electronic form using Microsoft Excel.

END OF SECTION

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1. GENERAL

1.1 SYSTEM DESCRIPTION

- .1 This section includes the supply and installation and connection of all conduit, wire, outlet boxes, components, etc. required for a door access and security control panels, door contacts, card readers, motion detectors, electric and pneumatic strikes and request to exit devices.
- .2 The security control panel shall provide door monitoring, control and alarm functionality. The door access control panel shall also be connected to the Local area network and be configured for alarm notifications.

2. PRODUCTS

2.1 DOOR ACCESS CONTROL PANEL

- .1 Manufacturer: CDVI or as approved by engineer
- .2 Model: Atrium A22 Hybrid 2-door Controller, quantity as required to suite number of doors
- .3 Electrical
 - .1 Power Input: 24VDC
 - .2 12AH 12VDC battery backup
 - .3 Door strike power: 12VDC
 - .4 External Lock Power: 12-24VDC
 - .5 Lock Door Input
 - .6 Unlock Door Input
 - .7 Dry Contact Alarm Output
- .4 System to be capable of monitoring and controlling 5 single doors and provide 2 door contact inputs for 2 overhead doors. System to be self contained and operate in standalone mode.
- .5 Management of users, cards, door lock, door unlock, system events and controller information shall be available on an embedded web server and accessible from a standard web browser. Controller shall be assigned an IP address at time of commissioning by owners representative.
- .6 Readers
 - .1 Reader types: Wiegand Readers with Multiple Protocol Support (Wiegand 26-bit, 30-bit & 44-bit), Magnetic Stripe ABA Track 2
 - .2 No. of Readers Supported: 2 per controller
- .7 Communication: Ethernet 10/100Base-T via RJ45 connector
- .8 Accessories:
 - .1 Accessories as required to provide a complete system.

- .9 Installation Location: Laboratory.

2.2 REQUEST TO EXIT DEVICES

- .1 Location: Secure Side of Building and as per contract drawings.
 - .1 RTE Device Type: Motion
 - .2 Manufacturer: Kantech or equal
 - .3 Model: T.Rex-XL or equal
 - .3 Features:
 - .1 Detector Type: Passive infrared
 - .2 filter Technology: Disgital Signal Processor (DSP)
 - .3 Piezo Buzzersnip: 5-28VDC
 - .4 Relay contacts: Form C, 1 amp time adjustable 0-60sec
 - .5 Operating Voltage: 12-24VDC
 - .4 Accessories: backplate for mounting on single gang box
- .2 Location: Headworks
 - .1 RTE Device Type: Push to Exit
 - .2 Manufacturer: Assa Abloy or equal
 - .3 Model: EXP-1 or equal
 - .3 Features:
 - .1 Zone 2 (Class I Div 2 Groups B, C, D, E, F and G) Rated
 - .2 50mm Push Button
 - .3 Black Epoxy Ink Reading "PUSH TO EXIT"
 - .4 Accessories: as required for a complete installation

2.3 ELECTRIC STRIKES

- .1 Electric strikes to be coordinated to fit in door frames of controlled doors and the door latch type being provided, coordinate with specification 08111 Hollow Metal Frames.
- .2 Location: As per contract drawings.
- .3 Features:
 - .1 Pneumatic Actuation
 - .2 Holding Force: Minimum 634kg (1400lbs)
 - .3 Fail mode: Fail secure (energize to open)
 - .4 Fire Rated: 2 hour minimum
 - .5 Zone 2 Rated (Class I Div 2)

2.3 PNEUMATIC STRIKES

- .1 Pneumatic strikes to be coordinated to fit in door frames of controlled doors and the door latch type being provided, coordinate with specification 08111 Hollow Metal Frames.
- .2 Location: Headworks
- .3 Features:
 - .1 Operating Voltage: 12VDC
 - .2 Holding Force: Minimum 634kg (1400lbs)
 - .3 Fail mode: Fail secure (energize to open)
 - .4 Fire Rated: 2 hour minimum

2.4 PROXIMITY READERS

- .1 Location: on the public side of each secured door as noted in the contract drawings.
- .2 Coordinate to fit in door frames of controlled doors, coordinate with specification 08111 Hollow Metal Frames.
- .3 Compatible card formats: Wiegand 26-bit, 30-bit or 44-bit.
- .4 Manufacturer: CDVI or equal
- .5 Model: DGLI WLC26 or DGLI F WLC26
- .6 Features:
 - .1 LED indicator
 - .2 Piezo Buzzer: Integrated
 - .3 Operating temp range -30C to 60C
 - .4 Stainless Steel Housing

2.5 PROXIMITY CARDS

- .1 Provide proximity cards/fobs.
- .2 Quantity: 15 pre programmed for use with the system

2.4 DOOR CONTACTS

- .1 Door contacts to be mounted on each hinged door that is being controlled. All double doors to receive two contacts (one per side)
- .2 Coordinate to fit in door frames of controlled doors, coordinate with specification 08111 Hollow Metal Frames.
- .3 Specified Equipment (Man doors):
 - .1 Make: GE or equal
 - .2 Model: 1076W or equal
 - .3 Features:
 - .1 Type: Magnetic reed contact switch.

- .2 Mounting: Recessed in door and frame
 - .3 Features: 25mm diameter with “lock-in” mounting caps, standard gap 32mm, zip cord lead, rare earth magnet.
- .4 Specified Equipment (Overhead doors):
 - .1 Type: Magnetic Contact switch.
 - .2 Mounting: Surface
 - .3 Features: Standard gap 61mm, Form C contact, armoured cable lead, Adjustable magnet with L bracket, epoxy sealed for protection from moisture and impact, shock absorber design.
- .5 Specified Equipment (Headworks):
 - .1 Type: Magnetic Contact switch.
 - .2 Mounting: Surface
 - .3 Features: Zone 2 (Class I Div 2) rated, Standard gap 32mm, Form C contact, armoured cable lead.
- .6 Operation: Normally closed Contact opens on opening of door.

3. EXECUTION

3.1 INSTALLATION

- .1 Install cables from each of the devices (i.e. door contacts and overhead door contacts) Leave sufficient slack in cables and identify at both ends. Install all cabling in conduit.
- .2 Identify panel with lamacoid nameplate to read “Door Access Control Panel”.
- .3 Install door contacts where identified. Install as per manufacturers instructions. Locate door contact toward, and as close as possible to latch side of door. Connect one pair of control wires to switch contact.
- .4 Test operation of door contact. Contact must change state prior to latch passing the door frame.

3.2 SYSTEM OPERATION

- .1 The door access controller is to monitor and control all secured doors indicated in the project drawings. Each door is to include at minimum:
 - .1 Door contact (ie door position switch)
 - .2 Electric or pneumatic strike
 - .3 Card reader
 - .4 Request to exit motion detector or push button
- .2 Each controlled door electric strike is to remain secure until an acceptable card reader or keypad acknowledge signal is sent to the door controller. Once the strike is opened the door contact will not cause an alarm if access was permitted by the card reader or keypad.
- .3 When occupants pass from the secure to public (non secure) side the request to exit motion sensor or push button will acknowledge the presence of the individual and disregard the door contact change of state when the panic hardware on the door is pressed to open the door. The electric strike is to remain closed.
- .4 Should the door open in the event when neither a motion sensor or card reader signal is acknowledge at the panel, the buzzer at the door is to alarm and an alert message is to be sent via email to the facility operators.
- .5 Each individual door is to be programmed with time and date schedule based on Owner supplied times.

3.3 PROGRAMMING AND COMMISSIONING

- .1 Contractor is responsible for retaining the services of a qualified technician for controller setup and programming.
- .2 Contractor is to document and record all parameter settings used for the programming of the panel and include them in a typewritten report on the Operations and Maintenance Manual. This documentation is to be submitted to the Owners representative for approval prior to integration into the manual.
- .3 The Owner reserves the right to withhold \$1000 should the documentation not be submitted.

3.4 TESTING AND COMMISSIONING

- .1 Prior to final acceptance of the system, contractor to fully test the system. Tests shall include:
 - .1 Verify each device and functionality
 - .2 Verify system operation
 - .3 Verify call outs
 - .4 Verify integration with SCADA system.

- .2 Call out test shall be conducted after system is connected to the network to ensure that remote signals are properly received.
- .3 Tests shall be carried out in the presence of the Owner Representative.
- .4 Refer to specification 01810 for additional commissioning requirements.
- .5 Upon completion of system testing described above, the system installer shall conduct a training program for designated maintenance and operating personnel. Operating personnel shall be trained to accomplish and understand all aspects of system operation. Maintenance personnel shall be trained to perform maintenance of the system. Training period schedule to be set by the Owner. Training periods shall be of duration required to serve all personnel and shall be carried out after the system is totally completed.

3.5 MANUALS

- .1 Provide three (3) full operating and maintenance manuals for the system. Each manual to contain descriptive literature on each system component, full system wiring diagrams, operation and maintenance procedures, parts list, etc.

END OF SECTION

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1. GENERAL

- .1 Coordinate all startup and testing with specification 01810 Startup and Commissioning.

2. PRODUCTS

- .1 Not applicable.

3. EXECUTION

3.1 BASIC ELECTRICAL START-UP AND TESTING

- .1 Energizing Main Electrical System:
 - .1 Prior to energizing main electrical system:
 - .1 Verify supply authority voltage and phase rotation.
 - .2 Testing of Wiring and Wiring Devices:
 - .1 Test conductors at distribution centres and panelboards for insulation resistance to ground (megger test).
 - .2 Test service grounding conductors for ground resistance.
 - .3 Test all wiring devices for correct operation and circuitry.
 - .3 Ground Resistance Testing:
 - .1 Measure ground resistance of ground grids with earth test megger to verify compliance with CSA C22.2 No. 0.4-M1982 and Canadian Electrical Code.
 - .2 Provide recorded data to Owners representative and insert a copy in the Operation and maintenance manual.
 - .4 Starting Motors:
 - .1 Prior to starting motors:
 - .1 Confirm motor nameplate data with motor starter heater overloads, setting of MCP's and sizing of fuses.
 - .2 Verify rotation.
 - .3 Ensure disconnects are installed.
 - .4 Confirm labeling of motors, disconnects and starters.
 - .5 Confirm operation of connected I/O
 - .6 Confirm protection relay settings and operation

.5 Power Quality

- .1 The Contractor is responsible for testing and measuring Power Quality of main service and each VFD during commissioning. Contractor to ensure:
 - .1 Power quality analyzer (Fluke 43B, Fluke 435 or approved equivalent) is used to monitor and trend and export .xls report for:
 - .1 THD,
 - .2 Individual harmonics for Voltage, Current, and Frequency
 - .3 Power factor, KVA, KW, KVAR
 - .4 Inrush current: 1s, 5s, 10s, 50s
 - .2 Provide type written report with exported data from the Power Quality Analyzer. Report to show graphs of data being measured. Indicate loads being powered at each measurement and measured values as noted in above (items 3.1.5.1.1). Complete the following measurements with the harmonic filter(s) off and then again when the filter(s) is on.
 - .1 Baseline no load: shut off as many building loads as possible (no pumps running, lights off etc...).
 - .2 Baseline standard building load: Power equipment that will normally be in operation (ie lighting, control panel, heater etc...).
 - .3 One VFD running: Power standard building load and smallest VFD in normal operation
 - .4 Additional VFD/Starter combinations: Power standard building load with additional motor staging configurations available in the facility. Account for up to 10 additional measurements

3.2 MOTOR CONTROL CENTRES

- .1 Ensure all starters are properly labeled prior to testing.

3.3 STANDBY POWER GENERATION SYSTEM

- .1 Factory Testing: Refer to section 16228 item 1.5 Factory Testing
- .2 Site Testing: Refer to section 16228 item 3.7 Standby Power Generation System Testing
 - .1 After Site testing has been completed to the satisfaction of the owner's representative the Contractor is responsible to refill the diesel fuel tank to the full level.

3.4 SMOKE AND HEAT DETECTOR TESTING

- .1 Provide the following equipment:
 - .1 Artificial Smoke
 - .2 Rate of Rise Heat Detector Tester

7603-002-00

- .2 Do not proceed with the testing unless the following parties are present at all times during the testing procedure:
 - .1 Electrical Contractor
 - .2 Owner's testing representative
- .3 Perform a smoke/heat test to each device in the facility. Ensure that the device properly responds to the test (alarms) through the PLC system.
- .4 Disassemble and reassemble system components as required.
- .5 Disconnect and reconnect wiring as required.
- .5 Perform required field adjustments.
- .6 Repair defective work and replace defective components
- .7 Perform all other work on system required by the testing procedure to ensure a complete working fire detection system.

END OF SECTION

APPENDIX A

WWTP Geotechnical Evaluation



Final Report for:

ENGLISH RIVER PROPERTY MANAGEMENT GRASSWOOD WASTEWATER TREATMENT PLANT GEOTECHNICAL EVALUATION

Prepared By:

Chris McRae, B.Sc., P.Eng.
Geotechnical Engineer

MPE Engineering Ltd.
122, 103 Marquis Court
Saskatoon Saskatchewan
P: (360) 668-1966
Email: cmcrae@mpe.ca

Date: September 2, 2020

Project #: 7603-002-00

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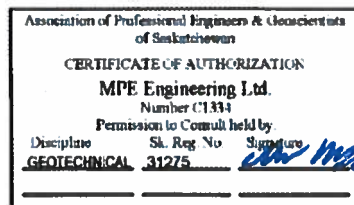
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CORPORATE AUTHORIZATION

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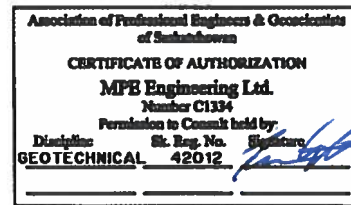
Respectfully submitted,

MPE ENGINEERING LTD.



Prepared by:

Chris McRae, B.Sc., P.Eng.
Geotechnical Engineer
Tel: 306-668-1966
Email: cmcrae@mpe.ca



Reviewed by:

Trevor Curtis, P.Eng.
Geotechnical Manager
Tel: 403-317-3638
Email: tcurtis@mpe.ca

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

This report presents the results of the geotechnical evaluation conducted by MPE Engineering Ltd. (MPE), for the proposed Wastewater Treatment Plant (WWTP) located north of Grasswood Rd and west of Hwy 11, on the English River First Nation land, south of the City of Saskatoon. The general site location is presented on Figure 1 (Appendix A). The objective of the work was to observe the general subsurface conditions and prepare geotechnical recommendations related to design and construction of the project.

1.2 PROJECT DETAILS

The overall scope of this project is the design and construction of a proposed WWTP that will meet the capacity and disposal needs for the proposed industrial and commercial development within the Grasswood Development. The proposed main building footprint is approximately 497 m² in plan. In addition to the main structure, a below grade holding tank and generator pad are to be constructed. Currently occupying the location of the main structure is a large clay fill stockpile.

The below grade components are expected to be constructed at multiple depths with the deepest up to approximately 6 m below the existing grade. Two options are being considered for the foundation of the main WWTP structure:

- Option 1 – Construct the building at grade with no below grade components. The foundation would be a structurally supported slab supported by a deep foundation.
- Option 2 – Construct the building with a below grade component that is 5.5 m below final ground surface. The foundation would be a structural raft foundation supported on partially pre-consolidated high plastic clay.

1.3 SCOPE OF WORK

The scope of work for this evaluation included three components: A field program comprised of three (3) boreholes, testing of recovered soil samples in MPE's laboratory, and engineering analysis/reporting. This report presents the results of the field and laboratory work and provides recommendations for the design and construction of the proposed development.

2.0 FIELD INVESTIGATION

On March 19th and 20th, 2020, the project field program was carried out using a truck mounted drill rig contracted from Mobile Augers and Research, from Saskatoon. The drill rig was equipped with solid stem continuous-flight augers. Soil samples were retrieved at intervals of approximately 0.6 m. The soil was classified and logged by MPE's field representative, Mr. Brett Tataryn, Geotechnical Technologist. Standard Penetration Testing was generally performed at regular intervals of 1.5 m, unless otherwise noted on the logs. Upon completion of the geotechnical drilling, Mr. Tataryn completed a visual site reconnaissance of the development area to assess geotechnical aspects of the site. Water levels were measured in each of the boreholes 1 week following completion of the drilling.

The site is illustrated in Figure 1, with borehole locations shown. The borehole locations were selected by MPE based on the conceptual site plan. Borehole locations were obtained from handheld GPS with an accuracy of ± 4 m.

Laboratory testing was conducted on the soil samples to aid in the determination of engineering properties. Testing included natural moisture content, Atterberg Limits, standard proctor, and water-soluble sulphate content. The test results are summarized in the borehole logs (Appendix B) and are attached in Appendix C.

3.0 SITE CONDITIONS

3.1 SITE DESCRIPTION

The following is a summary of the surface conditions observed during the site reconnaissance. The area within the proposed WWTP building footprint is currently occupied by a clay fill stockpile up to approximately 6 m thick. The area directly south and east of the proposed structure is comprised of native grasses, shrubs, and deciduous trees. To the west and north is a natural drainage slough. The drainage in the structure footprint area is generally flat to sloping slightly northwest, towards the slough.

3.2 LOCAL GEOLOGY

MPE reviewed surface geology mapping published by the Saskatchewan Geological Survey (SGS). According to the Surficial Geology Map of Saskatchewan, the site's surficial geology is classified as Eolian (hummocky) deposits, bordered to the north by Glaciolacustrine Plain deposits. SGS defines these deposits as follows:

Eolian (hummocky) Deposits: "Fine- and medium-grained sand and silt reworked by wind to form undulating and rolling topography."

Glaciolacustrine Plain Deposits: "Sand, silt, and clay accumulations deposited in glacial lakes."

3.3 SOIL STRATIGRAPHY

The soil conditions at the site were generally comprised of stockpiled clay fill, underlain silt, clay, and clay till. Clay fill was observed in each of the boreholes to depths ranging from 1.2 m to 6.5 m, as the boreholes were situated on a large clay fill stockpile. Beneath the clay fill stockpile, there was the native clay layer that extended to the clay till. The clay till, which was observed in boreholes 20BH002 and 20BH003, extended to borehole termination. A summary of the soil layers encountered is provided below.

It should be noted that layers of sand and topsoil were located 0.0 m to 1.5m above native soil in the stockpile. Pockets of sand and topsoil should be expected to be encountered in some of the site excavations near the surface during this project.

For consistency and brevity, it should be understood that all depths are below existing ground surface and all elevations are metres above mean sea level, unless otherwise stated. For a more detailed view of the soil conditions, refer to the borehole logs attached in Appendix B. A description of the terms and symbols used in the borehole logs is also included in Appendix B.

3.3.1 Stockpile Clay Fill

Clay fill was encountered above the native soil in all boreholes in stockpile formation. The clay fill was generally silty, sandy with trace gravel, moist, low to medium plastic, very stiff, and dark brown. Organic material, sand seams, and topsoil were observed in the bottom 1.5 m of the clay fill stockpile.

Moisture contents taken from clay fill samples ranged between 11% and 18%. The average of two Standard Penetration Tests within the clay fill indicated an 'N' value of 27 per 300 mm of penetration, indicative of very stiff consistency. Atterberg Limits testing one clay fill sample indicated a Liquid Limit of 26% and a Plastic Limit of 14%, indicative of low plasticity.

3.3.2 Silt

Silt was encountered beneath the fill in all boreholes and extended to depths of 8.5 m and 8.0 m in boreholes 20BH001 and 20BH002, respectively, and to a depth of 2.5 m in borehole 20BH003. The silt was generally clayey, sandy, very moist, firm, low plastic, light brown to orange, and contained trace oxide staining.

Moisture contents taken from silt samples ranged between 24% and 31%. Standard Penetration Testing within the silt till indicated 'N' values between 6 to 11 blows per 300 mm of penetration, indicative of firm to stiff consistency. Atterberg Limits testing of one silt sample indicated a Liquid Limit of 29% and a Plastic Limit of 24%, indicative of low plasticity.

3.3.3 High Plastic Clay

Clay was encountered beneath the fill in all boreholes and extended to a depth of 21.8 m and 16.5 m in boreholes 20BH002 and 20BH003, respectively, and to the end of borehole in 20BH001. The clay was generally silty, sandy, laminated, moist to very moist, low becoming high plastic, firm to stiff, brown, and contained trace sulphate crystals 5 mm – 25 mm in size.

Moisture contents taken from clay samples ranged between 30% and 40%. Standard Penetration Testing within the clay till indicated 'N' values between 5 to 12 blows per 300 mm of penetration, indicative of firm to stiff consistency.

3.3.4 Clay Till

Clay till was encountered beneath the clay in boreholes 20BH002 and 20BH003 and extended to borehole termination depth. The clay till was generally silty, sandy, trace gravel, moist, hard, medium plastic, and grey.

Moisture contents taken from clay till samples ranged between 12% and 15%. Standard Penetration Testing within the clay till indicated 'N' values of 21 and 33 blows per 300 mm of penetration, indicative of very stiff to hard consistency.

3.4 GROUNDWATER CONDITIONS

At the time of drilling, borehole closure was encountered in 20BH001 and 20BH002, caused by saturated high plastic material. Seepage occurred in 20BH003 at a depth of approximately 11.3 m. Groundwater readings taken on March 27th, 2020, are summarized in Table A.

Table A – Groundwater Elevation – Measured March 27, 2020

Borehole Locations	Depth of Standpipe (m)	Seepage (m)	Sloughing (m)	Elevation of Borehole (m)	Groundwater Elevation (m)	
					March 27, 2020	May 15, 2020
20BH001	17.2	none	10.0	513.10	506.30	506.80
20BH002 ¹	-	-	-	513.07	-	-
20BH003	17.2	none	7.6	508.77	506.15	-
BH112 ²	3.8	0.5	1.0	508.30	506.39	-

¹No piezometer installed in 20BH002.

²BH112 installed by Clifton Associates in May 2016.

Groundwater levels are expected to fluctuate seasonally and in response to climatic conditions. The water level in the pond to the northwest of the site is expected to affect groundwater levels. The elevation of the pond water level is within centimetres of the groundwater level in the boreholes suggesting that they are hydraulically connected. If groundwater conditions encountered during construction are observed to be drastically different from this report, MPE should be notified so that the implications of the changes can be reviewed.

It should be noted that the standpipes installed for this project were left in place for further readings to be taken prior to construction. These standpipes should be suitably decommissioned by the contractor during construction.

4.0 RECOMMENDATIONS

The site is generally suitable for the proposed WWTP; however, the following will need to be considered:

- The clay fill stockpile occupying the area will either need to be moved prior to construction or a new site will need to be selected.
- Water soluble sulphate present in the soil will dictate the use of an S1 exposure class for concrete in contact with soil.
- Low strength clay extending to a considerable depth will increase the overall foundation costs.
- Buried topsoil and silt soils within frost depth make surfacing the site costly. A gravel surfacing structure is recommended.
- A layer of silt, potentially hydraulically connected to the adjacent pond, will likely increase the care of water for any below grade excavations.

Detailed recommendations are provided in the following subsections. It should be noted that recommendations provided in this report are based on assumed stratigraphy between and surrounding the three discrete borehole locations. An adequate field review should be completed during construction to confirm these assumptions. Recommendations and design parameters presented herein are provided on the assumption that MPE will be retained to provide engineering design review and construction supervision. MPE takes no liability for work performed where MPE is not retained to provide adequate construction supervision services. Construction supervision should include:

- Inspection of bearing surfaces for shallow foundations.
- Full-time monitoring of pile foundation construction.

- Full-time monitoring and compaction testing for earthworks.
- Strength testing for concrete.

4.1 FOUNDATION DESIGN

Shallow foundations are recommended as the preferred foundation for the building, given the depth of firm soils at the site and equipment loading within the building. The shallow foundations can be founded on the partially pre-consolidated high plastic clay layer; however, careful planning and design will be required to be successful. Alternatively, a structural slab supported by a deep foundation system could be used to support the structure. Recommendations for CFA have been provided as the recommended deep foundation for Option 1, optional recommendations have been provided for helical piles.

4.1.1 Limit States Design

Under the Limit States Design methodology, foundation design must consider both the Ultimate Limit State (ULS) as well as the Serviceability Limit State (SLS). All foundations must be designed in accordance with the National Building Code (NBC). For ULS design, soil resistance factors should be applied to the ultimate soil capacity in order to obtain the factored soil capacity. Soil resistance factors, as provided in the NBC and in the Canadian Foundation Engineering Manual 2006 (CFEM), are summarized in Table B.

Table B – Soil Resistance Factors

Ultimate Limit State		Soil Resistance Factor
Shallow Foundations	Bearing Resistance	0.5
	Passive Resistance	0.5
	Sliding Resistance	0.8
Deep Foundations Axial Compressive Capacity	From Semi-Empirical Analysis	0.4
	From Dynamic Monitoring	0.5
	From Static Load Test Results	0.6
Deep Foundations Axial Uplift Capacity	From Semi-Empirical Analysis	0.3
	From Static Load Test Results	0.4
Deep Foundations Lateral Capacity	From Semi-Empirical Analysis	0.5

For SLS design, the load-settlement behaviour of the foundation must be analyzed. Comments on foundation settlement for SLS design are provided in Section 4.1.4. **For this project, the SLS limit states for shallow foundations will govern.**

4.1.2 Shallow Foundations

Shallow foundations are presented as the preferred foundation type for the structure, forming the basis of Option 2. However, this will require careful planning to be successful. Shallow foundations must be placed on natural, firm high plastic clay only, at an approximate elevation of 454.0 ± 0.5 m in the area of the building expansion. A key component of this option is that the foundation is placed within the footprint of the existing site stockpile. The surcharge provided by the preload of the stockpile allows for an increased SLS below the building. It should be noted that the pile has been assumed to be in place for

at least 5 years with the approximate shape and depth in the area of the structure. Satellite imagery does suggest that the pile has been at this location for that time period. If the building location is moved, additional borehole exploration may be required.

Any fill, deleterious matter, or soft natural soil that does not meet the design bearing capacity must be completely removed at the time of excavation and replaced with lean mix concrete. As an alternative to replacing with lean mix concrete, the bearing surface may be lowered to more suitable natural soil. The final excavation of the bearing surface should be completed using a smooth trimming bucket and all loose material should be removed from the surface prior to the inspection. The bearing surface should not be allowed to freeze, become desiccated, or saturated at any point during construction. It is considered vital that a perimeter dewatering system be in place, prior to the final excavation of the bearing surface. Water should not be allowed to sit on the bearing surface for any length of time. If any high plastic clay is allowed to become saturated, the surface shall be remediated to the satisfaction of the Geotechnical Engineer.

MPE should be retained to inspect the exposed bearing surface at the time of excavation. Upon positive inspection, a 50 mm thick concrete mudslab should be placed immediately. The intent of the mudslab is to protect the bearing surface from disturbance/deterioration when subjected to construction activity (rebar, forms, and concrete placement). The mudslab will also help seal off small amounts of groundwater seepage. **The mudslab is considered essential and must be placed immediately after excavation. Excavation to final bearing elevation should not proceed until concrete, support equipment/crew, and MPE inspector are on site.** The Contractor may complete the bearing surface excavation in up to three sections, as long as each section meets the above requirements. **Delays in mudslab placement may be grounds for rejection of the bearing surface** if it becomes weathered or disturbed. Rejection will be at the discretion of the Geotechnical Engineer. A protective temporary layer of native soil of at least 300 mm should be left over the bearing surface until final bearing surface excavation.

The net static bearing capacity of the native soil at an elevation of 504.0 ± 0.5 m may be taken as 510 kPa (ultimate). Factoring is required, as discussed in Section 4.1.1. The bearing capacity is based primarily on SPT correlations and laboratory test results. This assumes a slab dimension of approximately 10 m by 20 m. The above estimated ultimate capacity is intended to provide an estimate for planning and will vary depending on the size, stiffness and orientation of the shallow foundation structure. An updated bearing capacity can be prepared once the preferred foundation structure is determined. The use of a SLS bearing capacity of less than 110 kPa should limit total settlement of the structure to less than 25 mm, see Section 4.1.5. Hydrostatic uplift of at least 30 kPa should be considered when designing the slab. For frost protection, the minimum depth of the bearing surface is 3.1 m and must be measured from bottom of footing to finished ground level. However, shallow foundations are anticipated to be founded well below the frost line. See Section 4.6 on frost protection.

4.1.2.1 THICKENED EDGE RAFT (MAT) FOUNDATIONS

Raft foundations are considered flexible, shallow foundations and have additional requirements over strip or spread footings. The modulus of subgrade reaction is a relationship between soil pressure and deflection used in structural analysis of flexible foundations. The following equation can provide an estimate for the modulus of subgrade reaction:

$$k_s = 40 (q_{ult})$$

For this project, a k_s of 4000 kN/m³ should be used.

The formula assumes that the settlement at the ultimate soil pressure is 25 mm and that the structural member stiffness is 10 or more times greater than the soil stiffness (Bowles 1997). K_s is a parameter of soil structure interaction and is not a unique fundamental soil property. As such, it is recommended that sensitivity analysis be completed for the estimated K_s over a wide range of values.

4.1.3 Deep Foundations

Continuous flight auger CFA piles are presented as the preferred deep foundation type for Option 1. Bored cast-in-place piles are presented as a potential foundation type for the proposed development, however; a risk of seepage and sloughing exists and therefore may require casing. Helical pile parameters are not provided and are not recommended as the preferred deep foundation option for this development. The strength of helical piles decreases with depth, and the bearing surface bears high plastic clay. Recommendations for individual deep foundation types are provided in the following section.

4.1.3.1 BORED CONTINUOUS-FLIGHT-AUGER PILES

If a structural slab is selected for the WWTP building, bored CFA piles are the preferred deep foundation type. Bored CFA concrete piles may be designed on the basis of shaft friction and end bearing. Due to the specialized nature of CFA piles, the pile design is to be completed by the piling contractor and MPE will review the proposed design prior to construction. Preliminary geotechnical design parameters are provided for bored CFA concrete piles in Table C below.

Table C – Preliminary CFA Pile Parameters

Depth Interval (MASL)	Ultimate Shaft Friction (kPa)	Ultimate Bearing Capacity (kPa)
Clay Fill & Overburden (above 504.5)	0	0
High Plastic Clay (505.0 – 491.5)	40	350
Clay Till (below 491.5)	70	1300

Design and construction of bored CFA concrete piles should adhere to the following general recommendations:

- The minimum pile length is 9.0 m; however, pile uplift due to frost should be considered when calculating minimum pile lengths. The minimum pile diameter is 0.4 m.
- Friction should be neglected for any portion of the shaft placed within existing or planned fill materials.

- Piles should be spaced no closer than 2.5 times the base diameter, measured center to center. Where piles are spaced closer than this, overlapping stresses must be considered.
- Full time pressure monitoring and reporting of concrete injection pressure and auger torque is required.
- If CFA piles are selected to support a structural slab of the WWTP building, a minimum of two full scale pile PDA load tests are to be supplied by the piling contractor. The contractor will be responsible for proposing the test pile locations, installing the piles, obtaining third party PDA testing, and providing the PDA test report as well as the updated design. MPE will review and approve the testing plan, as well as the updated design. MPE will accept a GRF of 0.5, for the final design on the basis that the testing program provided by the contractor is successful; however, the contractor should not assume this efficiency. Any designs that have skin friction or bearing values greater than those provided above or with a GRF of greater than 0.4 are at the contractor's risk.

4.1.3.2 BORED CAST IN PLACE PILES

Bored CIP piles are an alternative deep foundation for supporting the generator pad for Option 2. Bored CIP concrete piles may be designed on the basis of shaft friction or end bearing. End bearing should only be included if means are available to clean the pile base of any loose soil prior to placing concrete. Geotechnical design parameters are provided for bored CIP concrete piles in Table D below.

Table D – Bored Cast in Place Pile Parameters

Depth Interval (m)	Ultimate Shaft Friction (kPa)	Ultimate Bearing Capacity (kPa)
Clay Fill & Overburden (above 504.5)	0	0
High Plastic Clay (505.0 – 491.5)	25	260
Clay Till (below 491.5)	60	1200

Design and construction of bored CIP concrete piles should adhere to the following general recommendations:

- The minimum pile length is 9.0 m, however, pile uplift due to frost should be considered when calculating minimum pile lengths.
- The minimum pile diameter is 0.4 m for straight shaft friction piles, and 0.76 m for end bearing piles.
- Friction should be neglected for any portion of the shaft placed within fill materials.
- End bearing should only be considered in design if facilities are available for cleaning the pile base.
- Piles should be spaced no closer than 2.5 times the base diameter, measured center to center. Where piles are spaced closer than this, overlapping stresses must be considered.
- The minimum ratio of depth of cover versus the base diameter (D/B) is 2.5.
- Full length reinforcing is required for piles subject to uplift loading.
- Seepage and sloughing conditions should be expected between elevations of 503.00 m and 505.00 m. The Contractor should make their own estimation of casing requirements, but casing should be on hand before construction begins. The use of casing within weak clay layers is

expected to be difficult.

The piles shall be constructed to dimensions indicated on the pile drawings. The pile tips shall be free of loose material, and water greater than 50mm in depth. If loose material or water is present in the pile base, the piling contractor is to remove it to the satisfaction of the Geotechnical Engineer. The piling contractor may tremie concrete into friction piles if the pile base can be confirmed to be free of loose material. If any pile is not constructed to the satisfaction of the Engineer, the pile may be rejected.

4.1.4 Foundation Settlement – Serviceability Limit State

Foundations designed and constructed according to the recommendations in this report are expected to undergo settlement within typical limits. An estimate for shallow foundation settlement is anticipated to be within 25 mm total settlement and 15 mm differential. Using a SLS bearing capacity for the WWTP structure of less than 110 kPa, would see settlements less than 25 mm. However, this estimate, like the bearing capacity, is dependent on the elevation and location of the foundation as well as loading conditions. If a serviceability bearing capacity of greater than 110 kPa is required, additional detailed analysis or sampling can be completed to refine the consolidation relationship of the deep firm high plastic clay.

Deep foundations designed on the basis of shaft resistance only should experience 5 mm to 10 mm of settlement. Deep foundations designed on the basis of end bearing or a combination of end bearing and shaft resistance should be within 10 mm to 15 mm of settlement.

MPE can provide a detailed settlement analysis during the design stage once loads and foundation type have been determined.

4.2 STRUCTURALLY SUPPORTED SLABS

Structurally supported slabs are recommended for the generator pad and may be used for the WWTP structure. The following are recommendations for preparation of the structural slab:

- Subgrade prep and leveling graded to prevent ponding.
- Installation of a 150 mm thick void form on the subgrade for temporary support of the floor slab. Installation of the void form should be according to the manufacturer's specifications. Care should be taken to select a void form with adequate temporary strength to support the fresh concrete and slab while curing.
- A continuous sheet of 6 mil thick (minimum) polyethylene vapor barrier should be placed between the void form and the bottom of the slab.
- Penetrations through the structurally supported slabs should be separated from the slab to allow for independent movement of utilities as the ground moves below the floor system.

4.3 EXTERIOR SLABS-ON-GRADE

Exterior grade supported concrete slabs are not recommended for this development. If used, they will require careful subgrade preparation to reduce the risks of excessive differential movement.

Grade supported floor slabs are not intended to be used as foundations for heavy equipment or machinery. Heavy equipment or machinery should be supported by independent foundations on structurally supported floors or raft foundations. The recommendations provided in this section are

intended to reduce floor movement to within acceptable limits; however, the amount of differential movement due to changes in the moisture profile or frost movements are difficult to quantify. The final performance of the floor slab is primarily a function of subgrade materials, good construction, and proper care of water during and after construction.

The near surface native soils are considered poor subgrade material. If slabs on grade are to be constructed, quality low to medium plastic cohesive or granular backfill below the subgrade to a depth of at least 1.0 m below the slab-on-grade is recommended. Uniformity of lift thickness, moisture, and compaction is essential. A minimum 300 mm thick base layer of crushed granular structural fill is recommended directly beneath all slabs-on-grade.

4.4 EARTHWORKS

4.4.1 Site preparation

Any vegetation, topsoil, concrete, granular layers, and deleterious matter should be removed prior to earth excavation or site preparation. The contractor should complete site stripping and removal of waste in such a way as to limit mixing into existing site soils.

4.4.2 Fill Materials and Compaction

The stockpiled clay fill currently occupying the proposed structure location is considered suitable for use as general engineered fill. It should be noted that the bottom 2 m of the stockpile in contact with the native soil contains variable contents of topsoil, sand, and low plastic silt. This material should be stripped and replaced with more consistent stockpiled clay fill. General engineered fill should be moisture conditioned to -1% of Optimum Moisture Content (OMC) to 2% above OMC and compacted to 98% of Standard Proctor Maximum Dry Density (SPMDD), unless otherwise stipulated in this report. A Sample of the stockpiled clay fill was tested and the SPMDD was found to be 1880 kg/m³ at 13.0% moisture and the testing report can be found in Appendix C.

Existing site clay fill, mixed with organic material that is greater than approximately 5% by mass, should be stockpiled separately from general engineered fill and only used for landscape fill. The native clay below the clay fill and silt has some natural moisture contents in excess of 40%. Moisture conditioning of this material will likely be required and may be difficult without exceptional drying conditions.

Loose fill should be placed in uniform lifts no thicker than 200 mm and 150 mm for general engineered fill and granular base course, respectively. Moisture conditioning should be expected; however, the Contractor must make their own estimation of moisture conditioning requirements. Granular fill and imported cohesive backfill, should be tested for suitability by MPE prior to arriving on site.

4.4.3 Subgrade Preparation

Subgrade preparation should be completed for all grade supported structures including slabs-on-grade, gravel pavements, aprons, etc. MPE recommends that, following stripping and any excavation, the original ground subgrade should be assessed by means of a proof roll to determine the best course of action for subgrade work. As a minimum, the required depth of subgrade preparation is 300 mm in all areas, unless otherwise stated in this report.

Subgrade preparation should consist of scarification of the original ground surface using appropriate equipment in such a way as to achieve thorough mixing of surface materials. After scarification is

completed the mixed material should be moisture conditioned to the general engineered fill specification in Section 4.4.2. After acceptance of the original ground subgrade, general engineered fill should be placed to bring the subgrade to the design elevation.

The design subgrade surface below slabs-on-grade or surfaced areas should be proof rolled using a single axle truck loaded to give 8,200 kg on the rear axle in order to identify any soft areas that require additional work. Soft areas may need to be subcut and replaced with better quality material or reinforced with geosynthetics. This should be a field determination at the time of construction. Care must be taken during construction to protect the design subgrade surface from weathering or disturbance. If the prepared surface becomes wetted, desiccated, or disturbed from construction traffic, the upper 150 mm at a minimum should be scarified, moisture conditioned, and compacted to the required standard.

A uniformly smooth design subgrade surface should be prepared for the gravel pavement areas containing no ruts, potholes, sheep foot dimples, loose soils, or any imperfections that can retain water on the surface. The design subgrade should be sloped at a minimum of 2% to facilitate drainage of the granular surfacing material.

4.4.4 Site Grading and Drainage

The site should be graded to avoid any ponding of water next to buildings, foundations, and grade supported structures such as sidewalks or pavement. Landscaped areas around the perimeter of buildings should have a minimum 5% slope away from the building. Hard surfaced perimeter aprons and/or sidewalks should have a minimum 2% slope away from the building. Gravel surfaced areas should have grades of no less than 2% to minimize ponding and should be directed to ditches or natural drainage away from the development. Roof drains should have a discharge located a minimum of 2 m away from the building.

4.4.5 Excavation and Backfill

The following recommendations notwithstanding, excavations should be carried out in accordance with Saskatchewan Occupational Health and Safety Regulations. The responsibility of all excavation cutslopes resides with the Contractor, who should take into consideration site-specific conditions regarding soil stratigraphy, groundwater, and precipitation events. All excavations should be reviewed by the Contractor prior to personnel working within the excavation.

Excavation for this project is assumed to be up to 6 m in depth. Excavated side slopes completed in firm clay, clay fill, or saturated silt should be cut back to at least 3H:1V (TYPE 4); however, flatter sideslopes may be required based on encountered conditions such as saturated sand pockets. Some sections where the clay is described as stiff may allow for steeper excavations up to 1H:1V (TYPE 3). However, this decision should be made by an experienced Contractor representative prior to worker entry.

Excavation depths for this development are expected to be below the groundwater table and seepage should be anticipated. The Contractor should have dewatering equipment on site prior to making any excavation and should be prepared to dewater. A ~2 m thick partially saturated silt layer overlies the high plastic clay. The Contractor should expect that **this layer will require special attention and planning by the Contractor for Care of Water and Excavation**. The contractor should consider both seepage and potential soil loss from the bank. A temporary granular filter may be required to prevent soil loss. This unit is expected to be hydraulically connected to the waterbody to the northwest. Seepage should be

directed to sumps for removal from the excavation if open dewatering is selected by the contractor. It may be prudent to consult a specialized dewatering/care of water contractor to plan this work. In general, it is the responsibility of the Contractor to consider drainage of the construction excavation to prevent saturation subgrades or bearing surface and to control water entering the excavation.

Temporary spill piles and mobile equipment should be kept at least 3.0 m away from excavations. Backfill of excavations should be placed in uniform lifts not exceeding 200 mm of compacted thickness. Thinner lifts may be required to achieve compaction. Excavation backfill may consist of general engineered fill or lean concrete. Uniform excavation side slopes are important to avoid an abrupt transition from backfill to native soil, which may cause differential settlement at ground surface.

Backfill is not recommended in below freezing temperatures. If backfilling does occur in freezing temperatures, the contractor is to ensure that backfill is not compacted on frozen subgrades and the no frozen material is incorporated into the fill.

4.5 LATERAL EARTH PRESSURES

Lateral earth pressures for below grade structures may be calculated on the assumption of a triangular pressure distribution. For design of below grade walls where the top of the wall will be braced, the at-rest pressure may be assumed. For unbraced walls, the active condition could be considered. Drainage may be installed on the exterior of the wall to prevent buildup of hydrostatic pressure. The following formula may be used to calculate the lateral earth pressure for the at-rest condition:

$$P_o = K_o(\gamma H + q) + \gamma_w H_w$$

Where:

- K_o = Coefficient of at-rest earth pressure = 0.6 for high plastic clay
- γ = Bulk unit weight of backfill soil = 17.5 kN/m³ for high plastic clay
- H = Height of the soil acting on the wall in meters.
- q = Surcharge pressure at ground level in kPa.
- γ_w = 9.81 kN/m³ (unit weight of water)
- H_w = water head adjacent to wall

As expressed above, the formula includes hydrostatic pressure applied to the below grade structure. In order to eliminate the hydrostatic pressure, the soil adjacent to the below grade structure must be fully drained. Fully drained soil can be achieved through the installation of clean granular backfill adjacent to the exterior underground walls leading to a weeping tile system at the bottom of the foundation. The weeping tile drainage system around the perimeter of all shallow foundations would also have the added benefit of maintaining a relatively consistent moisture profile of the bearing soils and reduce risk of excessive foundation movements. Drainage systems other than granular backfill may also be suitable, such as a drain board waterproofing system. To limit water infiltration from the surface, the upper 600 mm of fill adjacent to the structure should consist of cohesive general engineered fill.

4.6 FROST PROTECTION

The maximum seasonal frost penetration depth was calculated for the near-surface soils using the procedure described in the Canadian Foundation Engineering Manual (CFEM). A mean freezing index of 1,900°C days was used for the site. The maximum seasonal frost penetration depth is estimated to be

approximately 2.8 m below final ground surface. The estimated frost penetration depth assumes a uniform soil type with asphalt surfacing or bare ground and without snow cover. The minimum depth for shallow foundations in heated buildings is 1.8 m, for unheated buildings a minimum depth of 2.8 m would be required.

Frost protection of bearing surfaces and piles should be considered during winter construction. If areas such as interior slabs on grade, footings, and piles are exposed to freezing conditions during construction, frost heave or jacking may be encountered. Frost protection of all bearing surfaces and piles is required by the Contractor until backfill has been completed and the building supported by the foundation is heated. Insulated tarps and hording may be required; however, the Contractor must make their own estimation of heating and hording requirements.

Cast-in-place piles exposed to frost action should be checked against frost jacking caused by adhesion forces. For concrete cast-in-place piles, adfreeze bond stress of 65 kPa should be applied to the depth of pile exposed to frost action.

Rigid insulation may be used to provide frost protection equivalent to the required soil cover. Insulation used for frost protection should be placed at a minimum depth of 0.6 m below the finished ground surface. The top 0.6 m of backfill (i.e. above the insulation) should be ignored for equivalent frost penetration calculation purposes. The insulation should be sloped away from the structure to facilitate drainage and continue vertically up the exterior of the structure.

Pipes that are susceptible to freezing conditions should be installed at a depth of 2.8 m below final ground surface or greater. Insulation would be required to provide equivalent frost protection for shallower pipes. Insulation should be designed and installed according to the manufacturer's recommendations. Buoyancy may need to be considered for insulation below the groundwater surface.

4.7 CONCRETE TYPE

Based on a soluble sulphate content test result of 3.31% obtained from soil samples in the building footprint and visible sulphate minerals within the samples, concrete elements in contact with soil and/or groundwater should have an S-1 exposure classification, as defined by CSA A23.1-14 Table 3, for very severe sulphate exposure. Cement type for this exposure classification includes HS, HSb, HSIb, and HSe. In accordance with CSA A23.1-14 Table 2, concrete with an S-1 exposure classification should have a maximum water/cementitious materials ratio of 0.40 and a minimum compressive strength of 35 MPa at 56 days. The air content should be based on the appropriate air content category for the corresponding nominal maximum aggregate size, as per CSA A23.1-14 Table 4.

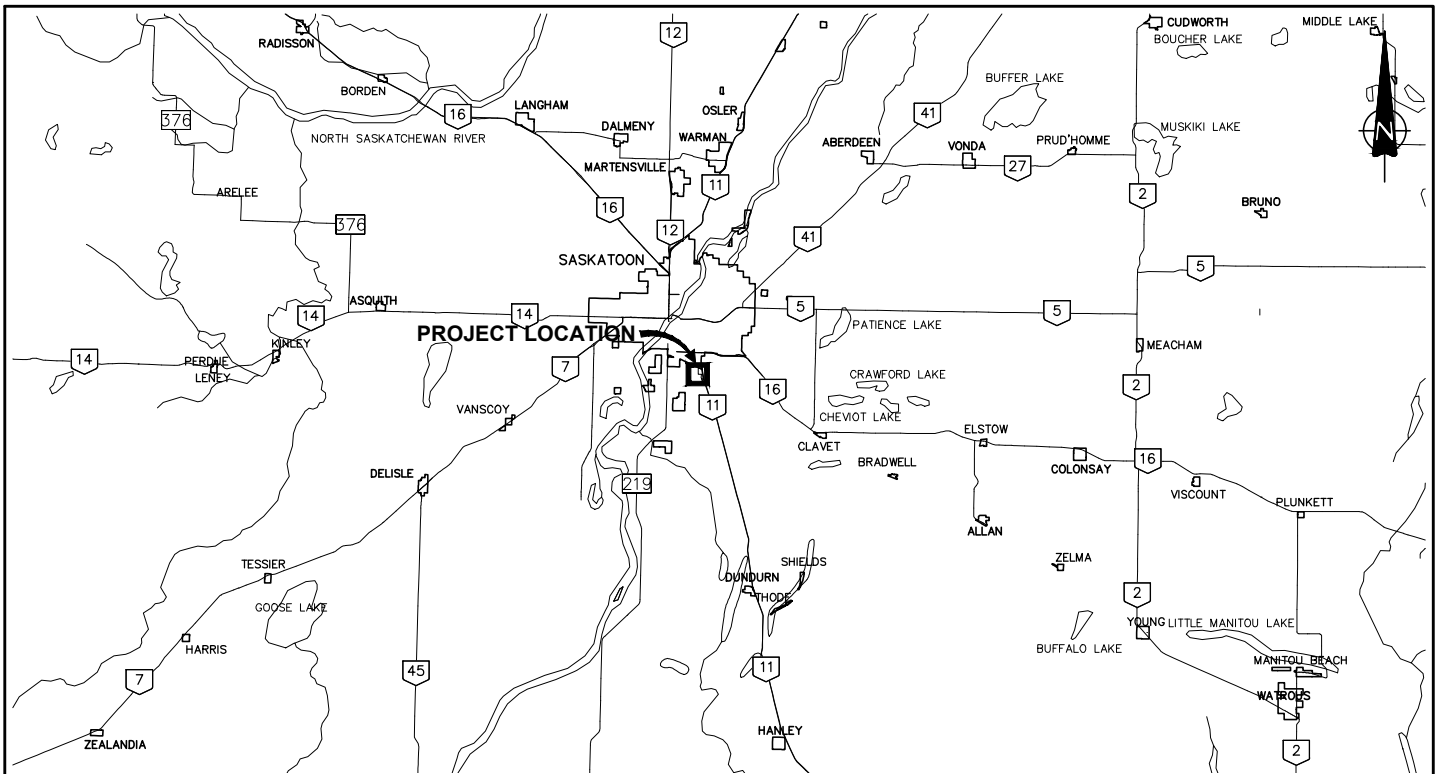
Additional factors such as structural loading or other exposure conditions should be considered when selecting concrete mix and strength requirements. Further recommendations regarding concrete materials can be found in CSA A23.1-14. The Soluble sulphate laboratory test result is included in Appendix C.

4.8 SEISMIC SITE CLASSIFICATION

The Seismic Site Response, according to Table 4.8.1.4.A of the National Building Code (2014), is Classification E, Soft Soil. The classification is based on average soil properties in the upper 30 m of soil.

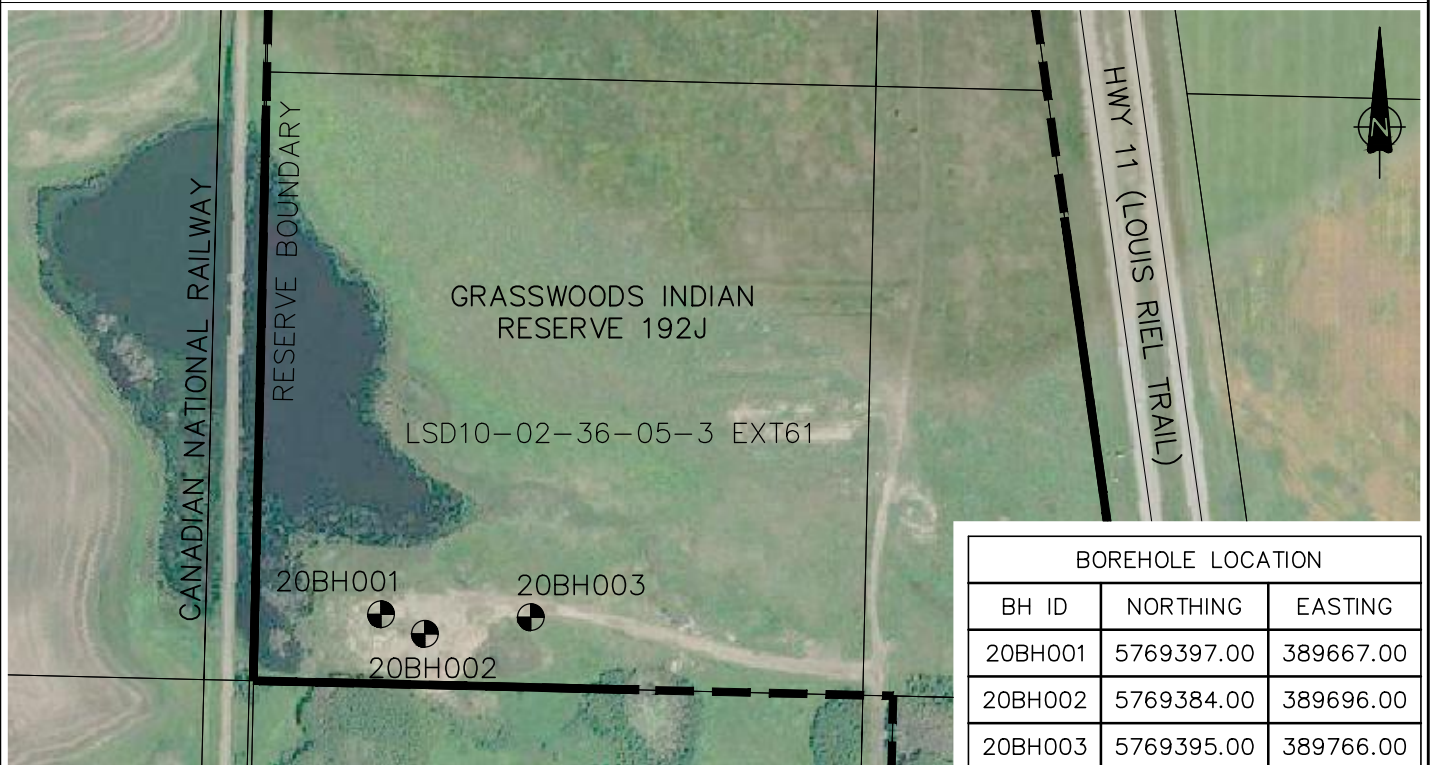
APPENDIX A:

FIGURES



LOCATION PLAN

1:1000000



SITE PLAN

1:10000

BOREHOLE LOCATION		
BH ID	NORTHING	EASTING
20BH001	5769397.00	389667.00
20BH002	5769384.00	389696.00
20BH003	5769395.00	389766.00



ENGLISH RIVER PROPERTY MANAGEMENT

WASTEWATER TREATMENT PLANT
BOREHOLE LOCATION PLAN

SCALE: AS SHOWN

DATE: MAY 2020

JOB: 7603-002-00

FIGURE 1.1

APPENDIX B:

BOREHOLE LOGS

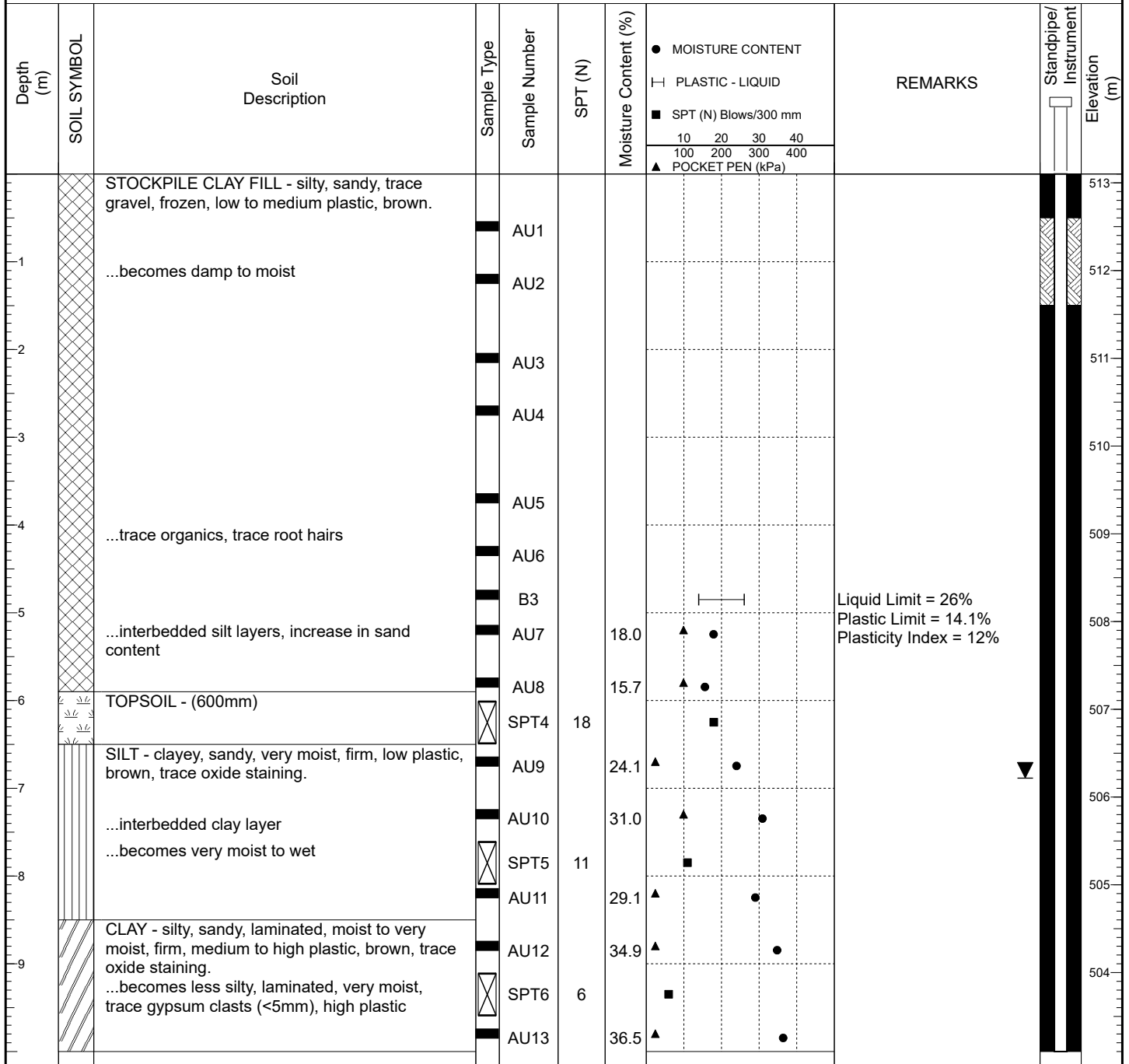


Engineering Ltd.

BOREHOLE No : **20BH001**

PAGE 1 OF 3

CLIENT	English River Property Management	PROJECT NAME	Wastewater Treatment Plant
PROJECT NUMBER	7603-002-00	PROJECT LOCATION	English River First Nation
DATE STARTED	03/19/2020	COMPLETED	03/19/2020
GROUND ELEVATION	513.10m	N	5769397.000 E 389666.700
DRILLING CONTRACTOR	Mobile Augers and Research Ltd.	GROUND WATER LEVEL:	506.30 m
DRILLING METHOD	6" SSA		



Notes:

Sloughing observed at 10.0 m. No seepage observed. Borehole located on a large clay fill stockpile approximately 6.5 m above native soil elevation.

Logged By: Brett Tataryn

Reviewed By: Chris McRae



Engineering Ltd.

BOREHOLE No : 20BH001

PAGE 2 OF 3

CLIENT	English River Property Management	PROJECT NAME	Wastewater Treatment Plant
PROJECT NUMBER	7603-002-00	PROJECT LOCATION	English River First Nation
DATE STARTED	03/19/2020	COMPLETED	03/19/2020
DRILLING CONTRACTOR	Mobile Augers and Research Ltd.	GROUND ELEVATION	513.10m N 5769397.000 E 389666.700
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	506.30 m

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT ▬ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm 10 20 30 40 100 200 300 400 ▲ POCKET PEN (kPa)			
11		...becomes unoxidized, trace oxide staining, occasional gypsum clasts (<10mm)	⊗	AU14	7	36.9			503
		...interbedded silt pockets	⊗	SPT7					
		...trace gypsum clasts (<10mm)	⊗	AU15		34.9			502
12			⊗	AU16	5	37.7			501
			⊗	SPT8					
13			⊗	AU17		38.6			500
			⊗	AU18	7	36.8			499
14			⊗	SPT9					
			⊗	AU19		36.0			498
15			⊗	AU20	8	39.6			497
			⊗	SPT10					
16			⊗	AU21	5	36.9			496
			⊗	AU22		36.0			495
17			⊗	SPT11					
			⊗	AU23	10	37.8			494
18			⊗	AU24		37.2			
			⊗	SPT12					
19			⊗	AU25		36.0			
		...trace gravel (<5mm)	⊗	AU26		38.3			

Notes:

Sloughing observed at 10.0 m. No seepage observed. Borehole located on a large clay fill stockpile approximately 6.5 m above native soil elevation.

Logged By: Brett Tataryn

Reviewed By: Chris McRae



Engineering Ltd.

BOREHOLE No : **20BH001**

PAGE 3 OF 3

CLIENT English River Property Management PROJECT NAME Wastewater Treatment Plant
PROJECT NUMBER 7603-002-00 PROJECT LOCATION English River First Nation
DATE STARTED 03/19/2020 COMPLETED 03/19/2020 GROUND ELEVATION 513.10m N 5769397.000 E 389666.700
DRILLING CONTRACTOR Mobile Augers and Research Ltd. GROUND WATER LEVEL: 506.30 m
DRILLING METHOD 6" SSA

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%) ● MOISTURE CONTENT ┌─ PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)	REMARKS	Standpipe/ Instrument	Elevation (m)
						10 20 30 40 100 200 300 400			
21									493
22									492
23									491
24									490
25									489
26									488
27									487
28									486
29									485
									484

Notes:

Sloughing observed at 10.0 m. No seepage observed. Borehole located on a large clay fill stockpile approximately 6.5 m above native soil elevation.

Logged By: Brett Tataryn

Reviewed By: Chris McRae

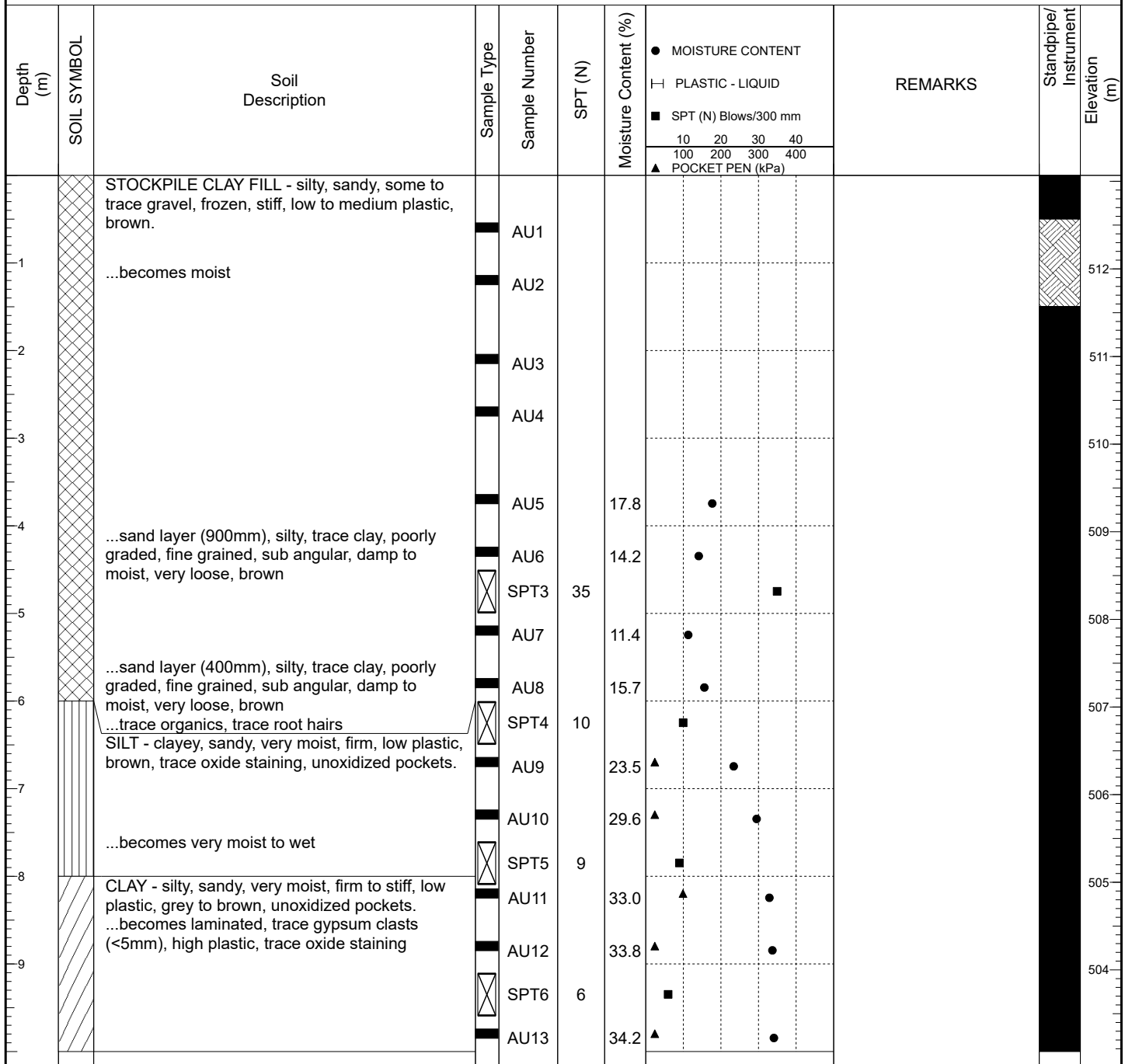


Engineering Ltd.

BOREHOLE No : 20BH002

PAGE 1 OF 3

CLIENT	English River Property Management	PROJECT NAME	Wastewater Treatment Plant
PROJECT NUMBER	7603-002-00	PROJECT LOCATION	English River First Nation
DATE STARTED	03/19/2020	COMPLETED	03/19/2020
GROUND ELEVATION	513.07m	N	5769383.500 E 389695.900
DRILLING CONTRACTOR	Mobile Augers and Research Ltd.	GROUND WATER LEVEL:	
DRILLING METHOD	6" SSA		



Notes:

Sloughing observed at 7.6 m. No seepage observed. Borehole located on a large clay fill stockpile approximately 6.0 m above native soil elevation.

Logged By: Brett Tataryn

Reviewed By: Chris McRae

CLIENT	English River Property Management	PROJECT NAME	Wastewater Treatment Plant
PROJECT NUMBER	7603-002-00	PROJECT LOCATION	English River First Nation
DATE STARTED	03/19/2020	COMPLETED	03/19/2020
DRILLING CONTRACTOR	Mobile Augers and Research Ltd.	GROUND ELEVATION	513.07m N 5769383.500 E 389695.900
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
						10 20 30 40 100 200 300 400			
11		...becomes unoxidized, trace gypsum clasts (<15mm)		AU14	6	35.8			
			☒	SPT7					
				AU15		34.6			
12				AU16	7	37.1			
			☒	SPT8					
				AU17		34.3			
13				AU18		36.5			
			☒	SPT9	8	33.9			
				AU19		37.0			
14				AU20	10	36.4			
		...becomes stiff	☒	SPT10					
				AU21		37.0			
15				AU22	9	38.3			
			☒	SPT11					
				AU23		35.4			
16				AU24	11	38.9			
			☒	SPT12					
				AU25		38.6			
17				AU26					

Notes:

Sloughing observed at 7.6 m. No seepage observed. Borehole located on a large clay fill stockpile approximately 6.0 m above native soil elevation.

Logged By: Brett Tataryn

Reviewed By: Chris McRae

CLIENT	English River Property Management	PROJECT NAME	Wastewater Treatment Plant
PROJECT NUMBER	7603-002-00	PROJECT LOCATION	English River First Nation
DATE STARTED	03/19/2020	COMPLETED	03/19/2020
DRILLING CONTRACTOR	Mobile Augers and Research Ltd.	GROUND ELEVATION	513.07m N 5769383.500 E 389695.900
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
		...trace gravel (<15mm)	⊗	SPT13	10				
			■	AU27		29.6			
21			■	AU28		35.6			492
			⊗	SPT14	14				
22		CLAY TILL - silty, sandy, trace gravel, moist, hard, medium plastic, grey, unoxidized.	■	AU29		14.8			491
			■	AU30		13.2			
23			⊗	SPT15	33				490
		End of Borehole @23.3 m							
24									489
25									488
26									487
27									486
28									485
29									484

Notes:

Sloughing observed at 7.6 m. No seepage observed. Borehole located on a large clay fill stockpile approximately 6.0 m above native soil elevation.

Logged By: Brett Tataryn

Reviewed By: Chris McRae



Engineering Ltd.

BOREHOLE No : 20BH003

PAGE 1 OF 2

CLIENT	English River Property Management	PROJECT NAME	Wastewater Treatment Plant
PROJECT NUMBER	7603-002-00	PROJECT LOCATION	English River First Nation
DATE STARTED	03/20/2020	COMPLETED	03/20/2020
GROUND ELEVATION	508.77m	N	5769394.970 E 389765.580
DRILLING CONTRACTOR	Mobile Augers and Research Ltd.	GROUND WATER LEVEL:	506.15 m
DRILLING METHOD	6" SSA		

Depth (m)	SOIL SYMBOL	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	REMARKS	Standpipe/Instrument	Elevation (m)
						● MOISTURE CONTENT — PLASTIC - LIQUID ■ SPT (N) Blows/300 mm ▲ POCKET PEN (kPa)			
1		STOCKPILE FILL - silty, sandy, some to trace gravel, frozen, stiff, low to medium plastic, brown.		AU1					508
		...becomes moist		AU2					
2		SILT - clayey, sandy, very moist, firm, low plastic, light brown to orange, trace oxide staining.		SPT1	6	25.8			507
		...becomes very moist to wet		AU3		27.3			
3		CLAY - silty, sandy, moist, firm, low plastic, light brown.		AU4		37.1			506
		...becomes less sandy, high plastic		SPT2	4				
4		...becomes laminated, trace oxide staining, trace gypsum clasts (<5mm)		AU5		37.0			505
				AU6		35.9			
5				SPT3	6				504
		...becomes unoxidized, grey, trace gypsum clasts (<10mm)		AU7		36.4			
6				AU8		38.6			503
				SPT4	5				
7				AU9		38.0			502
				AU10		38.5			
8		...trace gypsum clasts (<25mm)		SPT5	5				501
				AU11		36.4			
9				AU12		36.4			500
				SPT6	7				
				AU13		34.6			499

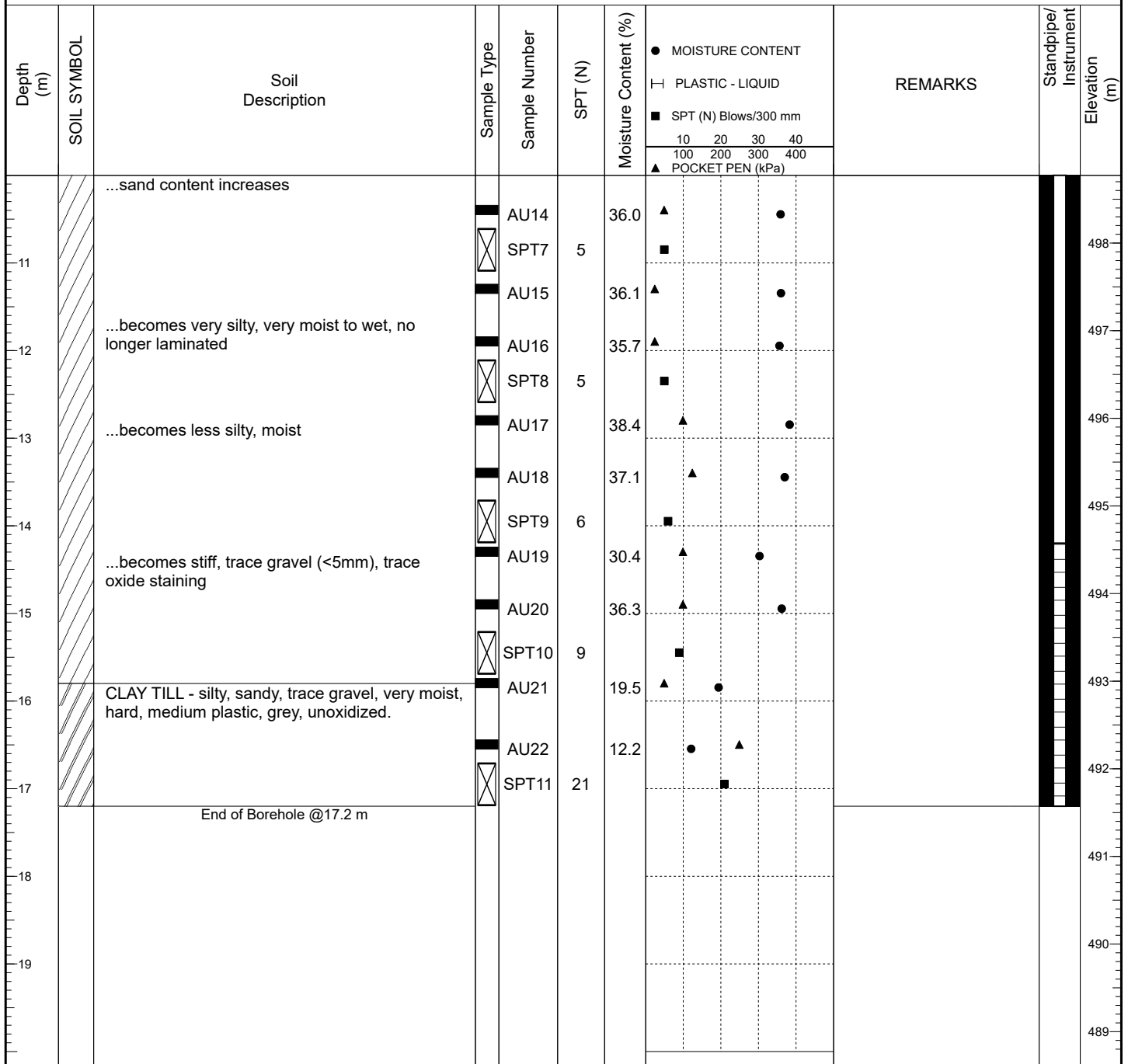
Notes:

No sloughing observed. Seepage observed at 11.3 m. Borehole located on the edge of a large clay fill stockpile approximately 1.2 m above native soil elevation. Water in hole after drilling at 12.2 m.

Logged By: Brett Tataryn

Reviewed By: Chris McRae

CLIENT	English River Property Management	PROJECT NAME	Wastewater Treatment Plant
PROJECT NUMBER	7603-002-00	PROJECT LOCATION	English River First Nation
DATE STARTED	03/20/2020	COMPLETED	03/20/2020
DRILLING CONTRACTOR	Mobile Augers and Research Ltd.	GROUND ELEVATION	508.77m N 5769394.970 E 389765.580
DRILLING METHOD	6" SSA	GROUND WATER LEVEL:	506.15 m



Notes:

No sloughing observed. Seepage observed at 11.3 m. Borehole located on the edge of a large clay fill stockpile approximately 1.2 m above native soil elevation. Water in hole after drilling at 12.2 m.

Logged By: Brett Tataryn

Reviewed By: Chris McRae

APPENDIX C:

LABORATORY TESTING

ATTERBERG LIMITS

Project: Egnlish River First Nation WTP
Project No.: 7603-002-00
Owner: English River Property Management
File No.: AL - 01

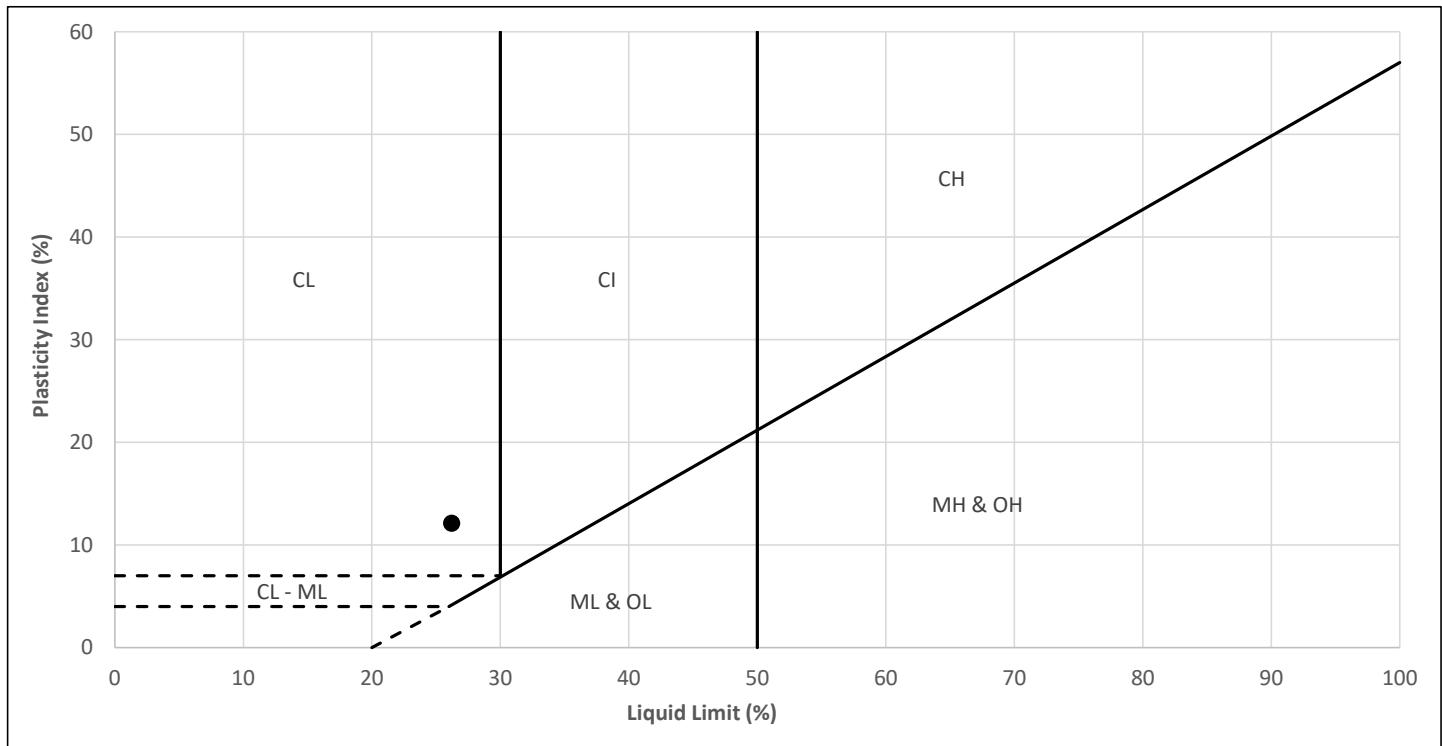
Sample #: 1Bulk3
Source: 20BH001
Sample By: BT
Date Sampled: 19-Mar-20

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils)

Sample Description: Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Liquid Limit (LL)	26.2
Plastic Limit (PL)	14.1
Plasticity Index (PI)	12.1

In Place Moisture	13.5
Soil Plasticity	Low
Soil Classification	CL



Comments:

Reviewed By: _____
 Kasz Leavitt, Engineering Licensee

ATTERBERG LIMITS

Project: Egnlish River First Nation WTP
Project No.: 7603-002-00
Owner: English River Property Management
File No.: AL - 02

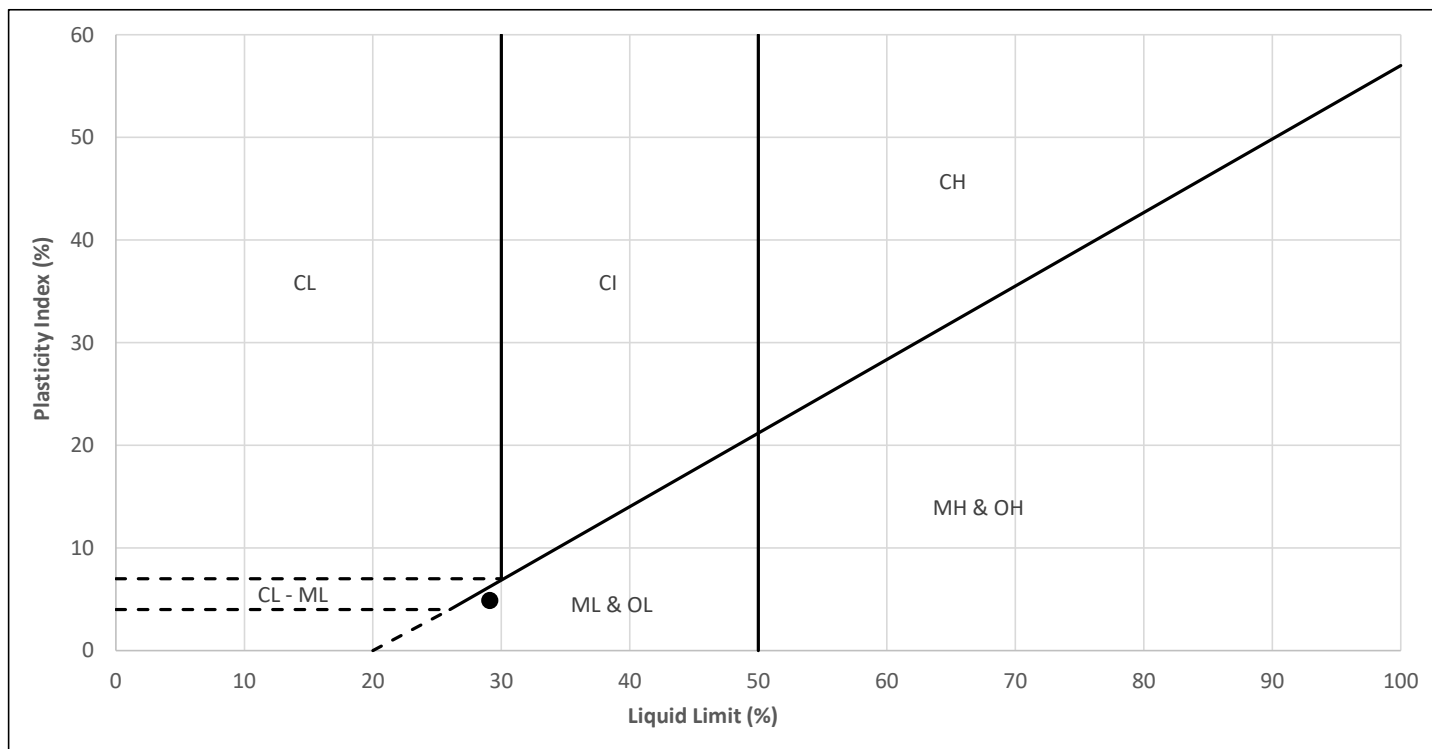
Sample #: 3AU3
Source: 20BH003
Sample By: BT
Date Sampled: 20-Mar-20

Tested in accordance with ASTM D4318 (Liquid Limit, Plastic Limit, and Plasticity of Soils)

Sample Description: Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity

Liquid Limit (LL)	29.1
Plastic Limit (PL)	24.2
Plasticity Index (PI)	4.9

In Place Moisture	27.3
Soil Plasticity	Low
Soil Classification	ML



Comments:

Reviewed By: _____
 Kasz Leavitt, Engineering Licensee

MOISTURE - DENSITY RELATIONSHIP REPORT

Project: English River First Nation Wastewater Treatment Plant **Sample No:** 1
Project No.: 7603-002-00 **Source:** 20BH001
Owner: English River Project Management **Sampled By:** BT
File No.: MDR - 01 **Date Sampled:** March 19, 2020

Tested in accordance with ASTM D698/D1557 and D4718 (Standard /Modified Proctor with rock correction)

Maximum Dry Density (kg/m^3): 1880

Optimum Moisture Content (%): 13.0

Method used: Method A (< 25% retained on 5mm)

Mold size: 101.6mm

Test Date: March 26, 2020

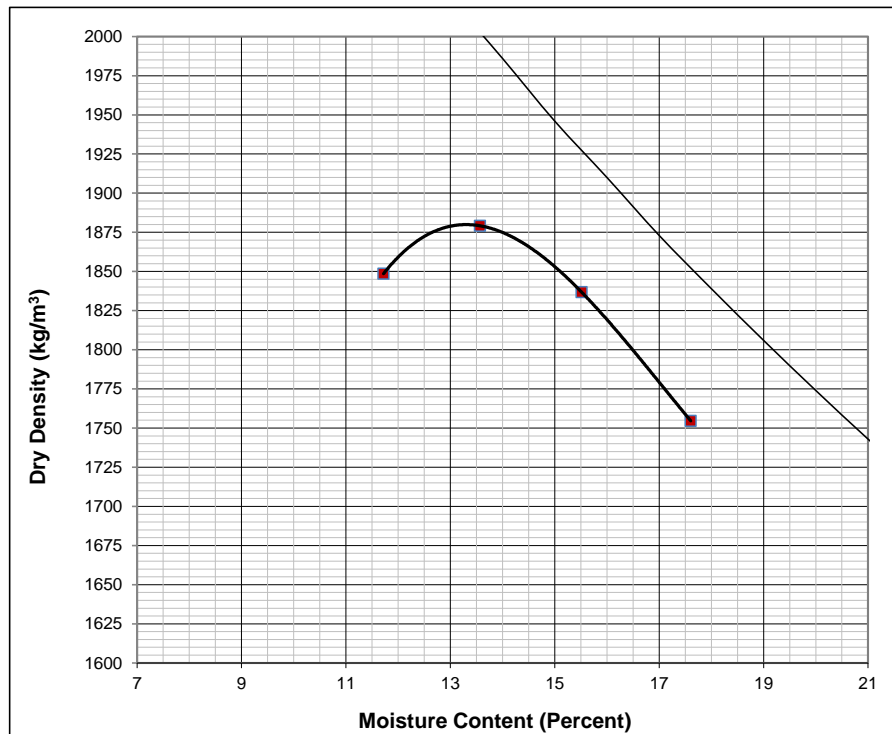
Tested By: BT

Soil Description CL Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays

Oversize rock in sample (%):

Oversize rock density (kg/m^3):

Insitu Moisture Content (%): 13.5



Test Data

Trail No.	Dry Density kg/m^3	Moisture Content (%)
1	1849	11.7
2	1879	13.6
3	1837	15.5
4	1755	17.6

Field oversize correction values:

(where applicable)

Oversize	Corrected Dry Density (kg/m^3)	Adjusted Moisture
5%	1786	13.7%
10%	1692	14.4%
15%	1598	15.3%
20%	1504	16.3%
25%	1410	17.3%
30%	1316	18.6%

Comments:

Checked By: _____

Kasz Leavitt, Engineering Licensee

SRC Group # 2020-3281

Mar 30, 2020

MPE Engineering Ltd.
122, 103 Marquis Court
Saskatoon, SK S7P 0C4
Attn: Brett Tataryn

Date Samples Received: Mar-24-2020

Client P.O.: 7603-002-00

All results have been reviewed and approved by a Qualified Person in accordance with the Saskatchewan Environmental Code, Corrective Action Plan Chapter, for the purposes of certifying a laboratory analysis

Results from Lab Section 2 authorized by Keith Gipman, Supervisor

- * Test methods and data are validated by the laboratory's Quality Assurance Program.
- * Routine methods follow recognized procedures from sources such as
 - * Standard Methods for the Examination of Water and Wastewater APHA AWWA WEF
 - * Environment Canada
 - * US EPA
 - * CANMET
- * The results reported relate only to the test samples as provided by the client.
- * Samples will be kept for 30 days after the final report is sent. Please contact the lab if you have any special requirements.
- * Additional information is available upon request.
- * Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

This is a final report.

SRC Group # 2020-3281

Mar 30, 2020

MPE Engineering Ltd.
 122, 103 Marquis Court
 Saskatoon, SK S7P 0C4
 Attn: Brett Tataryn

Date Samples Received: Mar-24-2020

Client P.O.: 7603-002-00

16928 03/19/2020 3AU7 20BH003 5.2M 19/03/20 *SOIL*

Analyte	Units	16928
---------	-------	-------

Lab Section 2

Sulfate, water soluble	ug/g	33100
------------------------	------	-------

The temperature of the cooler was 18.4 °C upon receipt.

Results are reported on a dry basis.

SRC Group # 2020-3281

Mar 30, 2020

MPE Engineering Ltd.

Analyte Methods

Name	Units	Method
Sulfate, water soluble	ug/g	Chm-620 / Chm-517

APPENDIX B

Novation Agreement

1. The Contractor and Supplier agree to be bound by the terms of the Contract, annexed hereto in Appendix D, with the Contractor assuming all the rights and obligations of the Owner as set out therein.
2. Supplier retains all the rights and obligations set out in the Contract and henceforth accepts the Contractor in place of the Owner.
3. Supplier agrees that henceforth it is a subcontractor to the Contractor in respect of the Construction Contract.

7603-002-00

4. Supplier hereby releases the Owner from all of the Owner's obligations under the Contract and from all claims of every nature whatsoever arising therefrom, excepting only those claims, if any, already notified to the Owner in writing, and acknowledges that it will henceforth look only to the Contractor for the discharge of the Owner's obligations thereunder and that only the Contractor may exercise the rights of the Owner thereunder.
5. Henceforth, the terms and conditions of the Construction Contract insofar as they can apply to a subcontract shall govern the relations between the Contractor and the Supplier; provided nevertheless, that if any term of the Construction Contract is inconsistent with any payment provision or Special Condition or Special Provision in the Contract such payment provision, Special Condition or Special Provision of the Contract shall prevail.
6. The Owner and Supplier agree that the Contract between them has been terminated.
7. It is agreed that as of the date hereof \$_____ is owing to the Supplier under the Contract.

IN WITNESS WHEREOF the parties have hereunto affixed their hands and seals this ____ day of _____, 20__.

ENGLISH RIVER PROPERTY MANAGEMNT

Per: _____

(Title)

Per: _____

(Title)

7603-002-00

CONTRACTOR
FOR INDIVIDUAL OR PARTNERSHIP
SIGNED SEALED AND DELIVERED by:

Contractor (please print)
In the presence of

Signature

Name

Title

Address

City/Province/Postal Code

Seal

FOR LIMITED COMPANY:
The Corporate Seal of

Contractor (please print)
was hereunto affixed in the presence of:

Seal

Authorized Signing Officer Title

Authorized Signing Officer Title

NOTE: If the Contractor is a joint venture, add additional forms of execution for each member of the joint venture in the appropriate form or forms as above.

7603-002-00

SUPPLIER

FOR INDIVIDUAL OR PARTNERSHIP

SIGNED SEALED AND DELIVERED by:

Supplier (please print)

In the presence of

Signature

Name

Title

Address

City/Province/Postal Code

Seal

FOR LIMITED COMPANY:

The Corporate Seal of

Supplier (please print)

was hereunto affixed in the presence of:

Seal

Authorized Signing Officer

Title

Authorized Signing Officer

Title

NOTE: If the Supplier is a joint venture, add additional forms of execution for each member of the joint venture in the appropriate form or forms as above.

END OF SECTION

APPENDIX C

SUEZ Proposal

as-sold proposal for the
**English River Property Management (ERPM)
Wastewater Treatment Facility (WWTF)**
ZeeWeed membrane bioreactor system

submitted to:

MPE Engineering Ltd.
Attention: Ivan Kagoro, P.Eng.
Project Engineer
Tel. (780) 509-4305
Cel. (780) 719-2986
Fax. (780) 486-9090
Email. ikagoro@mpe.ca
www.mpe.ca

October 13th, 2020

project number: 506752 rev 1

submitted by:

Doreen Benson-Regional Sales Manager
Suez Water Technologies & Solutions
905-339-9225
doreen.benson@suez.com

local representation by:

MEQUIPCO LTD
Dan Landry – Managing Partner
204-982-1040
dlandry@mequipco.com

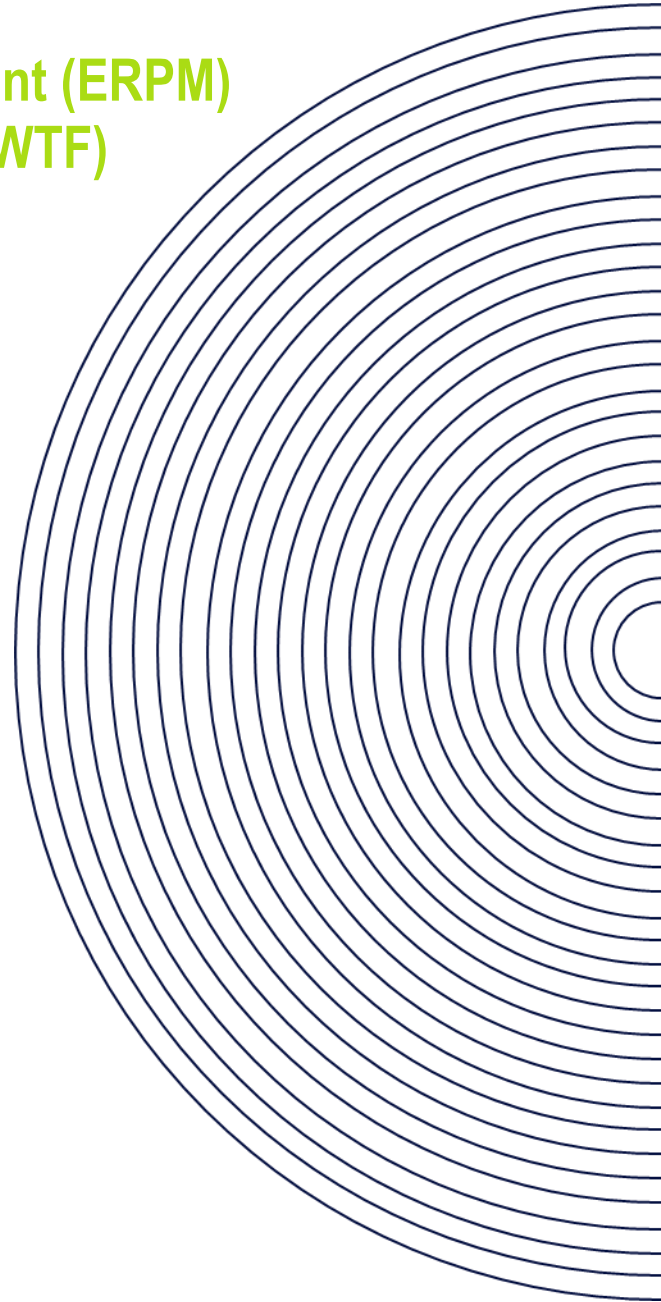


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**SUEZ Water Technologies & Solutions
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1 SUEZ qualifications & experience

1.1 about SUEZ

Since the creation of the Universal Suez Canal Company by Ferdinand de Lesseps in 1858, SUEZ has participated in some of the main social changes of its time: public health in the 19th century, and urban comfort and quality of life in the 20th. Today, recent changes in its governance have put the company in a position to take up one of the greatest challenges of the 21st century: **the resource revolution**.

With 90,000 people on five continents, SUEZ is a world leader in smart and sustainable resource management. We provide water and waste management solutions that enable cities and industries to optimize their resource management and strengthen their environmental and economic performances, in line with regulatory standards. To meet increasing demands to overcome resource quality and scarcity challenges, SUEZ is fully engaged in the resource revolution. With the full potential of digital technologies and innovative solutions, SUEZ recovers 17 million tons of waste a year, produces 3.9 million tons of secondary raw materials and 7 TWh of local renewable energy. It also secures water resources, delivering wastewater treatment services to 58 million people and reusing 882 million m³ (233 billion gallons) of wastewater. SUEZ generated total revenues of 15.8 billion euros in 2017. The complete annual report can be found at: www.suez.com/en/Finance/Financial-information



SUEZ is adding innovation and value to municipal and industrial customers around the world, including:



a **vast geographical footprint** to serve our global customers



one of the **largest portfolios** in the market to contribute to the circular economy – the heart of the resource revolution



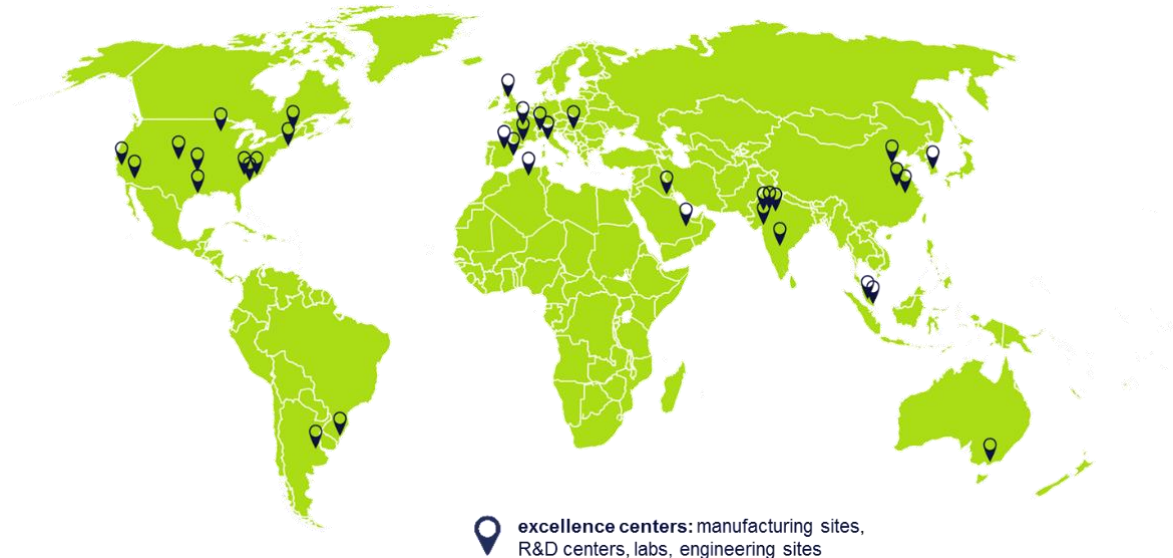
state-of-the art **digital and smart** capabilities to drive process optimization and resource conservation



expert **R&D teams** and strong go-to-market capabilities to bring new solutions to our customers faster

A global footprint: present in 130+ countries

SUEZ is serving customers globally on all five (5) continents.



On this map of the world, we have summarized the number of excellence centers (main manufacturing sites, R&D centers, labs and engineering offices) SUEZ has in each region. The closer we are to our customers, the quicker we can anticipate challenges, and solve issues before they become real problems. Our global footprint speeds up and improves delivery of services, technologies and expertise.

Key North American Locations

SUEZ – Oakville, Ontario

3239 Dundas Street West
Oakville, ON L6M 4B2, Canada
Phone – 905-465-3030

SUEZ – Edmonton, Alberta

9408 – 39th Avenue NW
Edmonton, Alberta, Canada T6E 5T9
Phone - 780 465 5451

To provide maximum support to the **English River Property Management (ERPM) Wastewater Treatment Facility (WWTF)**, the SUEZ offices in Oakville, Ontario and Edmonton, Alberta in conjunction with our representative Mequipco located in Winnipeg, Manitoba will support the execution of this project. Our expert technicians can provide on-site support throughout all stages of the project and continuing during long-term operation. **SUEZ Oakville** is the global UF/MBR Centre of Excellence and North American membrane design headquarters. The Oakville office employs approximately 420 staff, and is focused on developing, designing, and supporting water and wastewater treatment solutions using leading-edge membrane technologies. The **SUEZ Edmonton Service Center** is our local hub for technical support and from which long-term support will be provided. The office has thirty employees dedicated to supporting SUEZ installed equipment in the region.

2 introduction

2.1 company history

From modest beginnings in 1980, ZENON Environmental Inc. grew to become the global leader of low pressure membrane filtration technology. Spurred by the vision that membranes are the world's answer to water shortages, overuse, and pollution, the company has always focused on a single goal—to make superior membrane systems a cost-effective solution for everyone who needs them.



The ZeeWeed ultrafiltration membrane, developed in 1990, was a paradigm shift in membrane technology. At that time, membrane systems were primarily using pressurized cartridges with many components and high energy requirements. ZENON transformed the industry with the introduction of membranes that are immersed directly into process tanks and need only a slight vacuum to filter water.

GE Water & Process Technologies acquired ZENON Environmental Inc. on June 1, 2006, uniting patented ZENON technologies with GE's corporate leadership and financial depth to provide unparalleled performance and the best overall water treatment solutions. GE Water & Process Technologies became a worldwide leading systems and services provider for municipal and industrial customers, supplying state-of-the-art water, wastewater and process system solutions. GE Water & Process Technologies generated ~\$2.1 billion USD in revenues in 2016 with 7,500 highly skilled salesmen and engineers with strong digital capabilities.



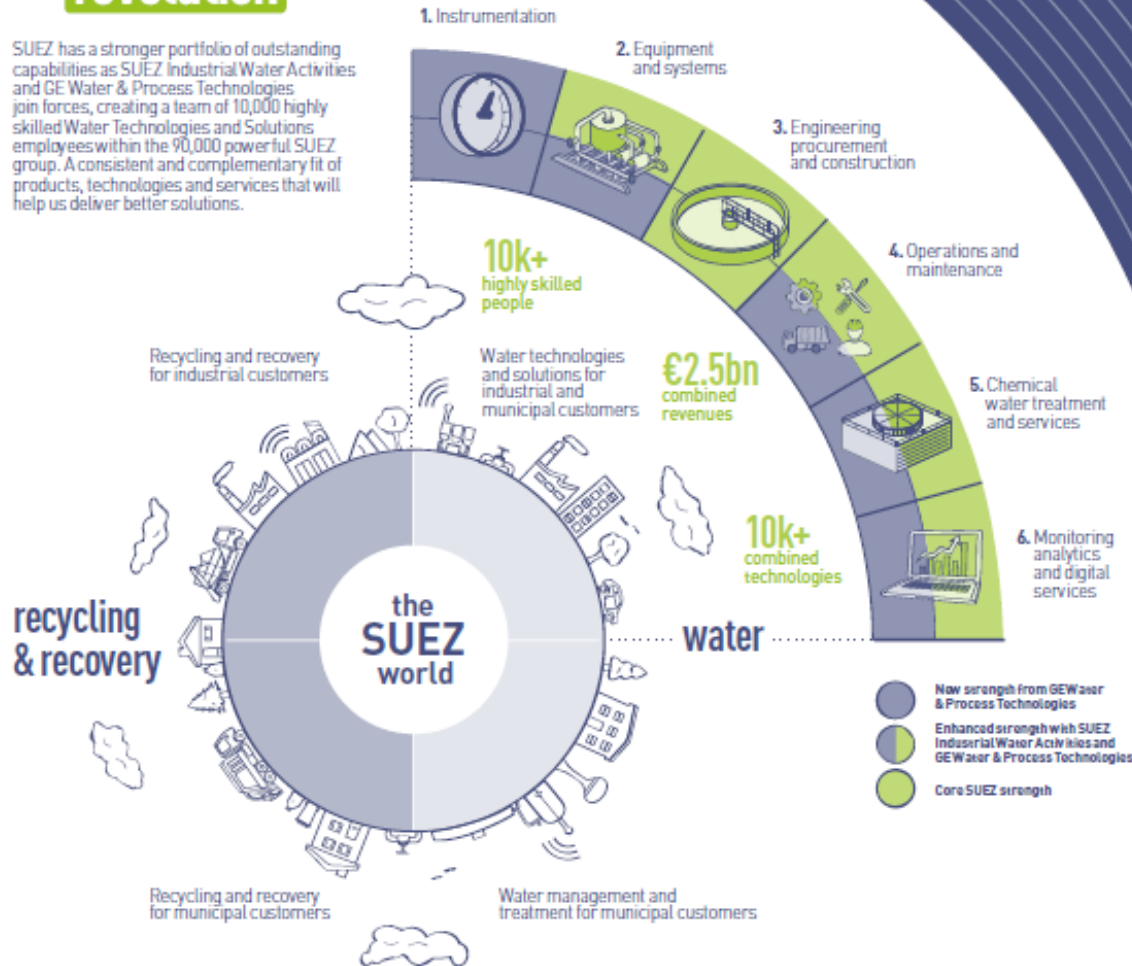
On October 1, 2017, SUEZ purchased GE Water & Process Technologies. GE Water & Process Technologies now joins forces with SUEZ's Industrial Water activities to create the **Water Technologies & Solutions** business unit within the SUEZ Group. With a solid financial position and a wide breadth of portfolios, this business unit aims to be a worldwide leader in water and treatment solutions for the industrial and municipal markets. SUEZ Water Technologies & Solutions now operates with over 10,000



employees and addresses the needs of over 50,000 customers worldwide. Additionally, relying on 650 R&D and expert staff as well as 17 Research & Excellence Centers of SUEZ, the business unit is committed to expanding its water treatment offerings and digital capabilities to deliver best-in-class solutions.

joining forces for the resource revolution

SUEZ has a stronger portfolio of outstanding capabilities as SUEZ Industrial Water Activities and GE Water & Process Technologies join forces, creating a team of 10,000 highly skilled Water Technologies and Solutions employees within the 90,000 powerful SUEZ group. A consistent and complementary fit of products, technologies and services that will help us deliver better solutions.



ready for the resource revolution

In a world where population growth, industrialization and climate change are contributing to increased scarcity, SUEZ, with GE Water & Process Technologies, is getting our customers ready for the resource revolution. Our extended geographic footprint, solutions and enhanced digital capabilities will bring innovation and new value to industrial and municipal customers around the world.

SUEZ new key figures

90k+
employees

€17bn
combined 2016 annual revenues

450k
industrial and business customers worldwide

€120m
combined annual R&D investment

17
research and excellence centers

3,200+
patents

2.2 UF/MBR operations

From its inception 40 years ago, the company had endeavored to listen to customers and anticipate the needs of the market in order to respond with practical solutions for drinking water, wastewater treatment, and water reuse. Today, SUEZ carries on with a complete family of UF/MBR membrane products which provide large-, medium- and small-scale solutions for municipalities, industries, land development and emergency applications.

ZeeWeed ultrafiltration membranes are utilized for drinking water, wastewater, tertiary and water reuse applications, as well as industrial feedwater and reverse osmosis (RO) pretreatment. The advanced technology is operational in thousands of municipal, industrial and commercial applications worldwide:

ZeeWeed 500: immersed membrane designed to handle challenging wastewater, with a greater tolerance of solids and high turbidity. It is the core of our LEAPmbr technology – an advanced, low energy MBR designed for wastewater treatment and reuse.

ZeeWeed 1000: immersed membrane designed for retrofits and larger plants, making it ideal for tertiary, drinking water, brackish, and seawater pretreatment applications.

ZeeWeed 1500: a pressurized membrane ideal for drinking water treatment, tertiary filtration, and pretreatment applications for brackish and seawater desalination in small to medium sized plants.

ZeeWeed 700B: an “inside-out” ultrafiltration membrane ideal for lower solids feedwater like pretreatment for reverse osmosis, high quality industrial processes, high pressure offshore EOR and membrane upgrades. Also appropriate for non-water applications like juice, wine and beer clarification.

SUEZ's global UF/MBR center of excellence in Oakville Ontario, Canada, is the focal point of SUEZ's ultrafiltration (UF) membrane research and development, as well as the design and delivery of UF-based water and wastewater treatment systems. The UF membrane division is 100% focused on developing, manufacturing, and supporting leading-edge, hollow fiber water and wastewater treatment solutions. **All design and engineering for the English River Property Management (ERPM) Wastewater Treatment Facility (WWTF) will be directed out of the Oakville, Ontario UF/MBR center of excellence.**



SUEZ's global UF/MBR center of excellence located in Oakville, Ontario, Canada

2.3 membrane manufacturing

With a world-class manufacturing facility located in Oroszlány, Hungary (the plant where the ZeeWeed 500 membrane modules proposed for the **English River Property Management (ERPM) Wastewater Treatment Facility (WWTF)** project would be produced), SUEZ leads the membrane industry with the world's largest capacity for

membrane manufacturing. By leveraging the capabilities of this manufacturing hub, SUEZ can assure customers of on-time and on-budget product delivery no matter where treatment plants are located.

A dedicated team of individuals monitor incoming project orders that incorporate ZeeWeed membranes, and are responsible for planning the production at the Oroszlány factory to ensure that all projects are delivered on time. As our backlog of orders increases, production capacity is continually reviewed to ensure that it is adequate. Several plant expansions have been implemented to ensure sufficient capacity to meet the demands of all pending and anticipated orders.



**membrane manufacturing plant
located in Oroszlány, Hungary**

Built on a solid foundation of dedication and excellence, the SUEZ membrane manufacturing division is committed to delivering high quality membrane products to global customers. SUEZ owns and operates all of its manufacturing resources to ensure strict controls over the manufacturing process and rigid quality standards for every membrane module that leaves the plants.

SUEZ employs the industry's most advanced manufacturing techniques, which enables the production of top quality membranes with maximum efficiency. The manufacturing process is almost completely automated, which minimizes quality issues and maximizes product consistency. Over the past several years, our manufacturing infrastructure has easily accommodated the rapid increases in demand for SUEZ products – increasing production by more than 500 percent during this period.

While the manufacturing facilities maintain an inventory of products, we constantly monitor bidding activity to confirm that sufficient manufacturing capacity is available to meet customer demand and that adequate product supplies are available to avoid project delays.

Prior to shipping, all of our products undergo a rigorous inspection to verify that all system components meet the quality and performance standards that SUEZ customers have come to expect.

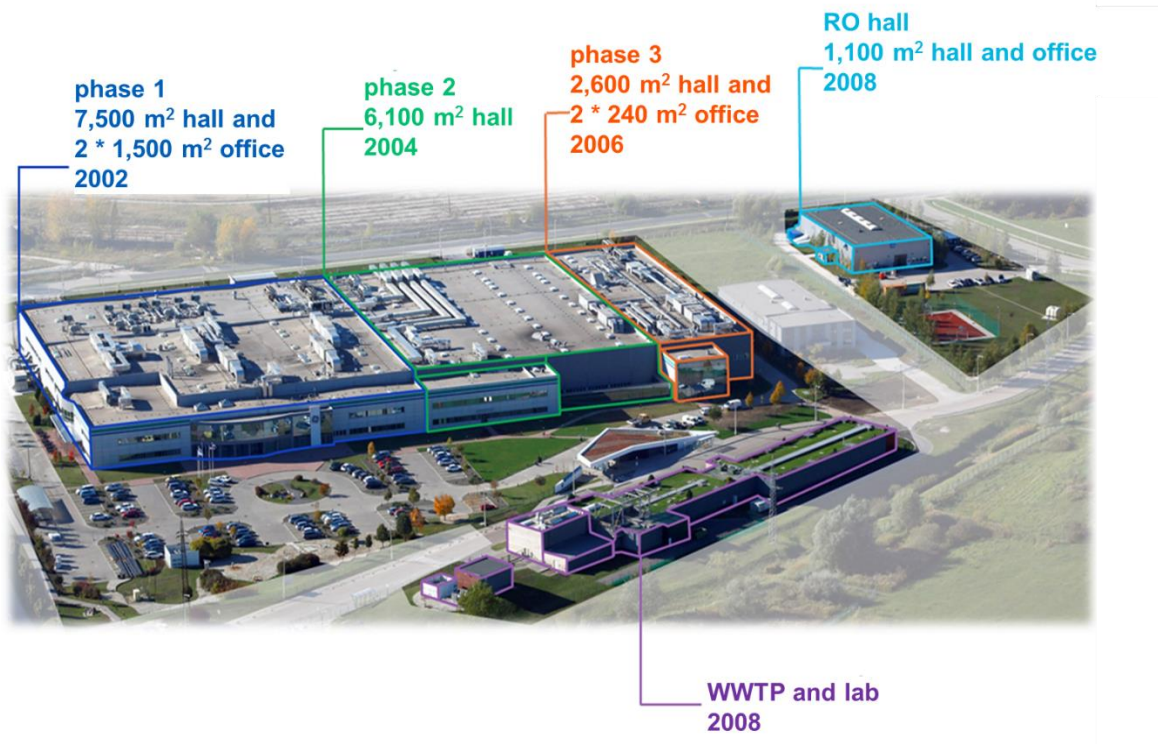
Over the next several years, membranes are expected to comprise more than 20 percent of the global market for water and wastewater treatment equipment. Our proactive manufacturing plan has accounted for this growth, and SUEZ is well positioned to increase manufacturing capacity over this period.

Our production increases, coupled with continued efficiencies in manufacturing, will enable our manufacturing teams to quickly and efficiently deliver high quality membrane products while constantly improving system performance and value. Through these streamlining efforts, SUEZ also strives to improve on a key success metric shared by both the company and its customers—reducing the cost of each gallon of water treated.

Globally, SUEZ currently has over 300,000 square feet of manufacturing and production area at its disposal. Over 660 employees are utilized in the manufacturing of the ZeeWeed membranes and assembling of process equipment.

production expansion

The Oroszlány manufacturing plant has undergone three plant expansions since opening in 2002. Most recently some of our production lines have been expanded for further capacity in 2013.



facts about the Oroszlány facility

physical size

- ☐ total area: 80 000 m²
- ☐ constructed area: 19 300 m²
- ☐ total manufacturing area: 11 700 m²
- ☐ total warehouse area: 5 000 m²

general facts

- ☐ initial building built: 2002
- ☐ activities:
 - UF/MBR manufacturing center of excellence
 - RO manufacturing
 - European distribution center

product mix

- ☐ ZeeWeed 500, 1000, 1500 manufacturing

- ❑ RO element manufacturing

certifications

- ❑ ISO 9001 / ISO14001 / OHSAS 18001
- ❑ NSF 61
- ❑ KTW-TZW (Ger) / DWA (GB) / Gost (Rus)
- ❑ ÁNTSZ (Hun) / PZH (Pol) / KWWA (Kor)
- ❑ MOH (China)

annual transactions

- ❑ number of shipments: 3500
- ❑ number of inbound deliveries: 660

3 MBR experience

3.1 MBR Experience summary

SUEZ Water Technologies & Solutions is the world leader in membrane filtration technology for wastewater treatment, and has been a pioneer in the development of membranes for all water and wastewater treatment applications. Developed in the early 1990's, the patented ZeeWeed membrane is well-proven, with hundreds of ZeeWeed MBR plants in operation around the world, in a variety of wastewater treatment applications.

SUEZ Water Technologies & Solutions has more experience related to the design, delivery, commissioning, operation, and after-sales support of MBR systems than any other supplier in the world. From a small Canadian company started in 1980, to the delivery of the world's largest membrane wastewater treatment plants, SUEZ Water Technologies & Solutions has the knowledge, experience and capabilities to make the English River Property Management (ERPM) Wastewater Treatment Facility (WWTF) project a successful one.

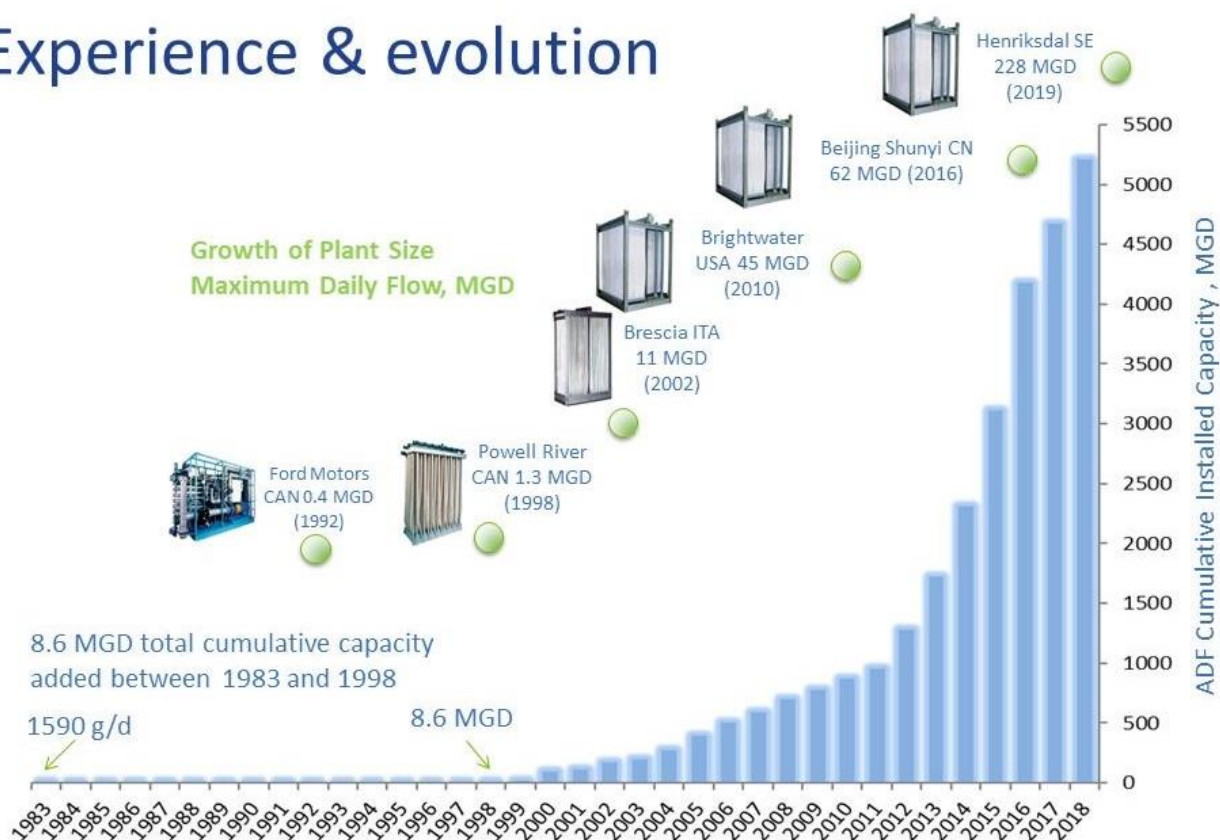
The **English River Property Management (ERPM) Wastewater Treatment Facility (WWTF) project** will benefit from all the experience gained and lessons learned through the completion of hundreds of previous MBR projects. SUEZ Water Technologies & Solutions regional knowledge, combined with our experience in delivering membrane treatment projects of all sizes, means choosing SUEZ as a partner for this project will substantially reduce risk and minimize additional project costs.

Highlights of SUEZ's extensive MBR experiences also include:

- First MBR installations, using Permaflow tubular membranes, in the early 1980's
- Earliest ZeeWeed immersed MBR systems in operation for nearly 20 years
- Largest operating municipal and industrial MBR's worldwide
- 8 of the 10 largest MBR plants awarded worldwide use SUEZ ZeeWeed membranes
- ZeeWeed wastewater treatment installations in 58 countries
- Total MBR online treatment capacity that is more than double that of the next largest membrane supplier

Since the installation of the first ZeeWeed wastewater treatment facility in 1993, total installed capacity has grown at an exponential rate. Over the next few years, global ZeeWeed treatment capacity will double, as plants currently in design and/ or under construction are brought online.

Experience & evolution



Treatment plants currently in operation using ZeeWeed membranes (including both wastewater and water treatment applications) range in size from less than 1,500 gallons per day to over 90 million gallons per day.

Total number of ZeeWeed membrane treatment plants worldwide	> 2,000
Total number of ZeeWeed membrane wastewater treatment plants in North America	558
Total number of ZeeWeed membrane wastewater treatment plants in the USA	488
Total number of ZeeWeed membrane wastewater treatment plants in Canada	70

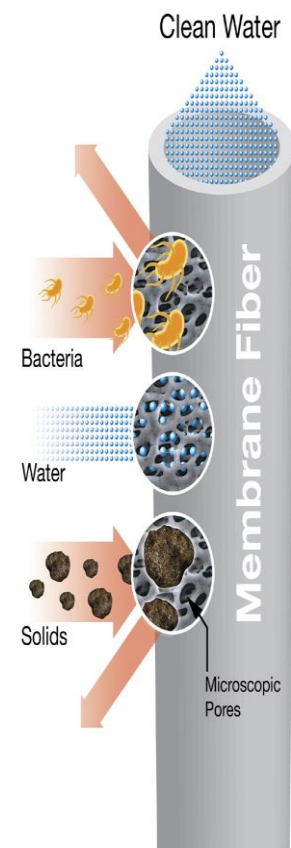
4 benefits of SUEZ system design

ZeeWeed systems are focused on ultrafiltration as the heart of the MBR process, with the ability to add biological or other additional components into the system as required.

Each system has been engineered with a multitude of design options, features and benefits to enable engineers, clients and operators to design and configure the MBR system that best fits each individual application.

ZeeWeed systems are designed with 3 key attributes in mind:

- ❑ lowest lifecycle cost MBR – lowest cost of ownership for the Owner;
- ❑ simple operations – simple & automated operations coupled with SUEZ support for the operating team;
- ❑ robust design – prove design parameters with scope and configuration options for a wide variety of conditions.



ZeeWeed UF membranes operate under a low-pressure vacuum, drawing clean water to the inside of the fiber (outside-in flow path), while leaving impurities in the process tank.

4.1 low lifecycle cost MBR

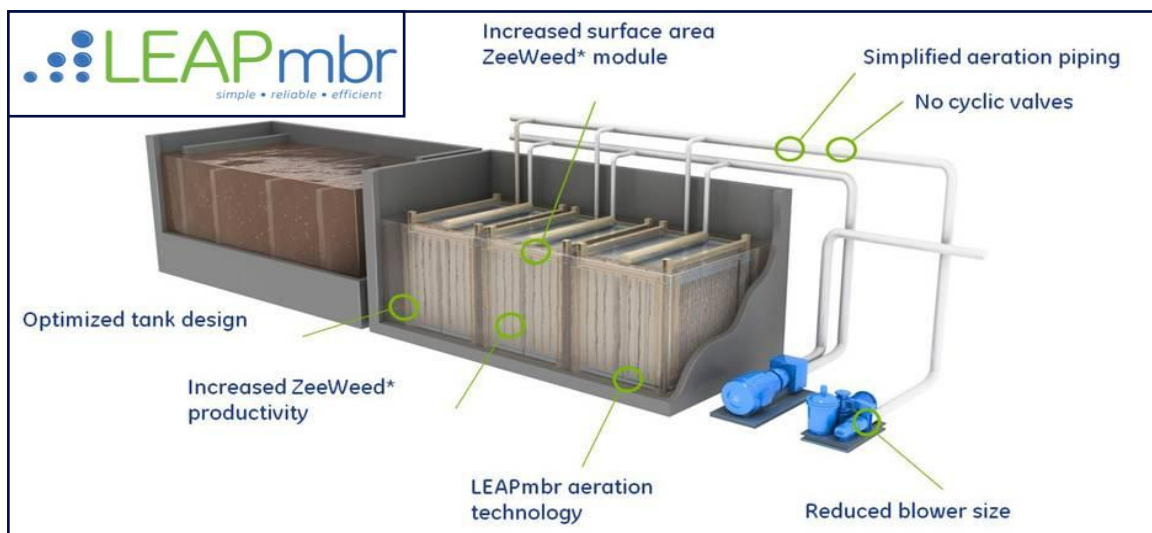
At the heart of a low lifecycle MBR system are the two most important parameters: efficient MBR design and operation and SUEZ's ZeeWeed 500 membrane technology.

4.2 LEAPmbr... simple, reliable, efficient

SUEZ's ZeeWeed system is designed to incorporate the latest innovations of LEAPmbr technology making it the most energy efficient and productive MBR that SUEZ is able to provide to owners.

LEAPmbr's combined initiatives will directly impact your plant design by:

- improving your productivity by 15%;
- decreasing your membrane system footprint by 20%;
- removing equipment needed to provide aeration to your membranes by 50%;
- saving you over 30% in membrane aeration power costs.



4.3 membrane life, cleanability & replacement

SUEZ's ZW500 membrane technology has the following key benefits to ensure an owner's peace of mind for the life of their MBR facility:

- ❑ ZeeWeed MBR membrane with a proven membrane life and high resistance to upset conditions;
- ❑ system designed with multiple cleaning options to ensure the highest chance of achieving maximum membrane life;
- ❑ SUEZ as a single point of responsibility provides an integrated supply chain between the system & membrane warranty provider and the membrane manufacturer;
- ❑ a straightforward membrane warranty with clear performance triggers.

4.4 simple MBR operations

The ZeeWeed UF is designed to ensure the system is simple to operate without compromising any operational robustness.

The operators have a range of flexible options to ensure the MBR system is able to meet varying operating conditions should they arise.

4.5 membrane aeration system design

Aeration is one of the most important operating parameters for successful long term MBR operations and is a significant component of operating cost.

Suez's ZeeWeed UF utilizes a very simple aeration strategy which minimizes the amount of instrumentation and controls required to achieve energy efficient membrane aeration.

No complex control loops or complicated airflow measurement devices are required for LEAPmbr aeration technology to achieve energy efficiency.

4.6 membrane cleaning systems

SUEZ has developed MBR design principles based on best engineering practices that ensure the permeability of the membrane is maintained over the life of the membranes.

A fully automated suite of membrane maintenance procedures will ensure long-term, successful operation, including:

- ❑ in situ chemical membrane cleaning performed directly in the membrane process tanks so your operators don't waste time moving cassettes;
- ❑ the ability to increase or decrease the frequency of maintenance cleans to fit the operating conditions;
- ❑ the ability to backpulse, when needed, to greatly improve your operator's ability to recover from non-design conditions.

The above cleaning systems are automated resulting in operators having available a full suite of comprehensive cleaning systems which are simple to use and initiate.

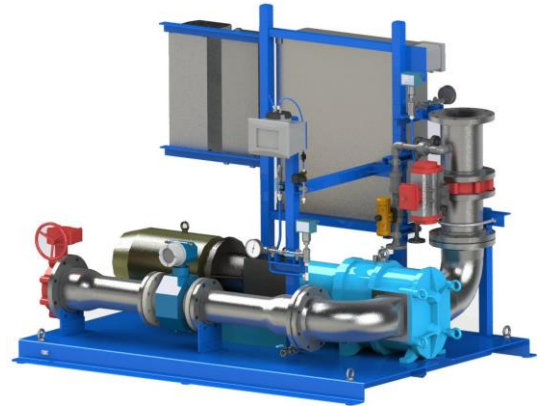
5 Z-MOD robust design basis

The Z-MOD pump skids are designed to ensure operators have a system with sufficient design robustness to accommodate a wide range of potential conditions.

5.1 positive displacement process pumps

Z-MOD pump skid uses positive displacement process pumps to draw permeate through the membranes.

- The positive displacement design of these pumps allows for variations within the hydraulic profile that will not adversely affect the pump performance;
- The pumps come complete with an ability to backpulse the membranes should sludge conditions deteriorate;
- A wide range of pump turndown provides the operator to wide window of flow adjustment for a variety of situations.



This pump selection provides a high level of security and flexibility for engineers and operators.

5.2 permeate for membrane cleaning

Z-MOD pump skid ensures a volume of clean permeate is always stored ready for use for membrane cleaning.

- takes permeate from its production cycle and stores this treated water in the backpulse tank (or pipe of a similar volume) ready for use. This ensures no reliance or costs from a potable water system to supply cleaning solution to the site for the membrane cleaning process;
- systems include a backpulse tank which provides the operations staff with a readily available source of water for cleaning whenever it is required.

This allows cleaning processes to occur automatically while allowing the operator flexibility to select different cleaning methods.

5.3 mixed liquor concentration range

SUEZ MBR/UF systems rely solely on the pore size of the membrane to effect filtration of the mixed liquor. This allows the MBR to operate at a wide range of mixed liquor concentrations.

This removes the need for mixed liquor concentration to be within the intended range during start-up process or low flow scenarios.

5.4 electrical design

Z-MOD pump skids are designed with the following electrical architecture:

- ☐ central PLC and common equipment I/O panel;
- ☐ remote I/O panel, VFD and disconnect mounted on the process pump skid

This design basis allows the system to readily accommodate additional trains and allows operators to isolate or troubleshoot individual trains without the loss of the central PLC.

6 basis of design

This proposal is offered based on SUEZ supplying one membrane bioreactor (MBR) system utilizing Z-MOD L equipment for the English River Property Management (ERPM) Wastewater Treatment Facility (WWTF).

The following tables summarize the main design parameters on which the system has been designed.

6.1 influent flow data

The English River Property Management WWTF influent flows are listed below:

Parameter	phase 1	phase 2	unit
average day flow (ADF)	188	288	m3/d
maximum month flow (MMF)	282	432	m3/d
maximum day flow (MDF)	376	576	m3/d
maximum flow with one train off-line for maintenance and membrane cleaning for less than 1 day	376	576	m3/d

Note: Any flow conditions that exceed the above-noted flow limit must be equalized prior to treatment in the membrane bioreactor unit.

- ADF – The average flow rate occurring over a 24-hour period based on annual flow rate data.
- MMF – The average flow rate occurring over a 24-hour period during the 30-day period with the highest flow based on annual flow rate data.
- MDF – The maximum flow rate averaged over a 24-hour period occurring within annual flow rate data.

6.2 influent quality

The design solution proposed is based on the wastewater characteristics detailed below.

parameter	quantity			unit
minimum influent temperature	9.0			°C
	average day	max month	max day	
COD	714	508	408	
BOD ₅	350	250	200	mg/L
TSS	350	250	200	mg/L
VSS ¹	280	200	160	
TKN	55	34	34	mg/L
NH ₃ -N	32	20	20	mg/L
TP	11	5.6	5.6	mg/L
alkalinity ^{1, 2}	250			mg/L as CaCO ₃

note 1: Parameter value assumed.

note 2: SUEZ is assuming that influent alkalinity is insufficient to ensure proper performance of the biological

system and has included in the design a backup NaOH dosing system for pH control. Supply of the NaOH dosing equipment is not included in Suez's price and can be quoted at a later time.

6.3 effluent quality

The following performance parameters are expected upon equipment startup and once the biological system has stabilized, based on the data listed in Sections 6.1 and 6.2.

Parameter	Value	units
BOD ₅	≤ 5	mg/L
TSS	≤ 5	mg/L
NH ₃ -N	≤ 1	mg/L
NO ₃	≤ 10	mg/L
TP ¹	≤ 1	mg/L
fecal coliform and total coliform	≤ 200	MPN/100 mL
turbidity	≤ 0.3 monthly average	NTU

Note 1: With coagulant addition

6.4 influent variability

Influent wastewater flows or loads in excess of the design criteria defined above must be equalized prior to entering the membrane tanks. In the event that the influent exceeds the specifications used in engineering this proposal, or the source of influent changes, the ability of the treatment system to produce the designed treated water quality and/or quantity may be impaired. Buyer may choose to continue to operate the system but assumes the risk of damage to the system and/or additional costs due to increased membrane cleanings, potential for biological upset and/or increased consumable usage.

6.5 biological system design

The biological design was developed to treat the maximum monthly flow given in Section 6.1 above and the anticipated maximum month water quality given in Section 6.2 above. The design also accounts for the higher TKN and TP loadings at the average day condition with higher coagulant and pH adjustment chemical flows. The same biological volume is used in both Phase 1 and 2 with differing MLSS concentrations.

Parameter	Phase 1	Phase 2	units
total anoxic volume	26		m ³
total aerobic volume (excluding membranes)	110		m ³
total reactor volume (excluding membranes)	136	136	m ³
minimum biological tank water depth	3.52	3.79	m

bioreactor mixed liquor suspended solids	8,000	10,000	mg/L
SRT – aerobic/total (excluding membranes)	17/21	13/16	days
total HRT (excluding membranes)	11.6	7.6	hours
Bioreactor MLSS	8,000	10,000	mg/L
Sludge wasting rate	5.3	7.0	m3/day

6.6 ultrafiltration system design

The ultrafiltration system design is summarized in the table below. Membrane modules are assembled into cassettes and cassettes are assembled into trains installed in concrete tanks supplied by buyer.

Parameter	Phase 1	Phase 2
type of membrane	ZW500D 422 ft ²	
number of membrane trains	2	2
number of ZMOD L skids	2	2
number of cassette spaces per train	2	
number of cassettes installed per train	1	2
number of modules per cassette	16	16
number of modules installed per cassette	14	12
total number of modules installed per train	14	24
total number of modules installed per plant	28	48
total number of cassettes installed per plant	2	4
membrane Tank Dimensions (each) m	2.540 x 2.134 x 4.760 (LxWxH)	

Note 1: Dimensions are preliminary only and may change after detailed engineering design.

6.7 equipment description

The following is a description of the equipment included in SUEZ's scope of supply. Pre-assembled components include the Z-MOD process pump skids, membrane cassette assemblies, and chemical addition system skids. Critical items that will be shipped loose for installation by buyer include the master control panel, backpulse tank, blowers, RAS pumps and other equipment. Please refer to Section 7 for a complete list of SUEZ supplied equipment.

master PLC panel

An Allen-Bradley CompactLogix Programmable Logic Controller (PLC) and PanelView Plus 6 1250 Human Machine Interface (HMI), installed in the UL type 12 main control panel, monitors and manages all critical process operations.

The master PLC panel communicates using Ethernet TCP/IP and includes I/O for common equipment items such as membrane blowers, air compressors, RAS pumps and other items (if included in SUEZ Scope).

Level controls monitor the level of mixed liquor in the process tanks and transmit this information to the SUEZ PLC. The PLC will automatically adjust the flow of the Z-MOD trains based on proportional control to the process or membrane tank levels.

screening system

Trash and non-biodegradable solids, such as hair, lint, grit and plastics may foul or damage the membranes if allowed to pass into the membrane chamber. An internally-fed drum screen with wire-mesh or punched-hole openings less than or equal to 2-mm in size with no possibility of bypass or carryover is absolutely required to maintain both membrane warranty, and optimal MBR operation.

One duty 2-mm internally fed drum screens and one standby have been included for this purpose including compactor.

process pump equipment

One reversible process pump per train is used to draw water through the membranes. The process pump, associated valves, and piping for the train are mounted on a factory assembled, epoxy-coated carbon steel skid.

Each process pump skid is designed to include a remote I/O panel UL type 4, which distributes control wiring to the pump, skid mounted VFD UL type 4X and instrumentation including magnetic flowmeter required to operate the pump system, all located on the process pump skid.

A dedicated effluent turbidity analyzer will be supplied on each skid to monitor effluent water quality and alert operators if effluent turbidity rises beyond acceptable set point.

membrane scour aeration system

One duty membrane blower per train will be supplied with one common standby blower to be shared by all trains.

Blowers will typically come complete with required isolation valves, check valves, pressure relief valve, pressure indicators and flow indicators.

process aeration system

The process aeration blowers provide air for the biological tank and ensure that sufficient oxygen is available to maintain the biological processes in the tank. The process aeration blowers are shipped loose for installation on site.

fine-bubble diffusers

A fine-bubble diffused aeration system delivers air from the process aeration blowers to the aerobic zone of the process tank.

mixed liquor recirculation equipment

Mixed liquor flows by gravity from the bioreactors to the membrane tanks, Return activated sludge (RAS) is pumped from the membrane tanks to the bioreactors. The recirculation (RAS) pumps will be supplied as well as check valves, isolation valves, magmeters and pressure indicators.

sludge wasting system

Sludge wasting is accomplished by periodically diverting mixed liquor from the RAS return line via manual control. The frequency of wasting is a function of influent characteristics, reactor design and operator preference. In certain operating circumstances, bioreactors can be designed to accommodate client preferences with regards to wasting frequencies; however, the preferred fashion of wasting would be continuous 24-hour bleeding at a fixed flow rate.

TWAS aeration system

The thickener waste tank drop legs, diffuser, and blowers provide air to ensure little to no sludge settling.

SUEZ has provided 1 duty blower and coarse bubble diffusers.

sodium hypochlorite dosing system

The sodium hypochlorite dosing system is used for membrane cleaning to remove organic foulants from the membrane surface.

citric acid dosing system

The citric acid dosing system is used for membrane cleaning to remove inorganic scaling from the membrane surface.

pH adjustment system

The pH control system doses sodium hydroxide into the process tank in order to maintain a desired pH for optimal biological performance. A sodium hydroxide system has been accounted for in the current MBR design for procurement, installation and use at a later date.

coagulant addition system

The coagulant dosing system is used to feed a metal salt to assist in precipitating (converting to a particulate form) influent phosphorus. This precipitate is then filtered by the ultrafiltration membranes and removed with waste activated sludge, preventing phosphorus from entering the effluent stream.

effluent flow measurement

Each train will include a magnetic flow meter to provide daily discharge flow measurements.

UV

UV disinfection will be provided as post treatment to ensure fecal and total coliform levels achieved in the effluent.

SUEZ has provided 1 UV system in Phase 1.

InSight Pro – process consulting service

Water and process applications generate vast amounts of operating data. InSight, SUEZ's easy-to-use, cloud-based knowledge management platform, captures and transforms your plant data into meaningful and actionable information, ultimately providing the knowledge you need to maximize performance, avoid operational interruptions, optimize your processes, and reduce the total cost of operation.

InSight Pro – process consulting service has been provided with your MBR/UF system for two (2) years of operation. InSight Pro pairs you with a SUEZ process expert and provides you a level of personal attention that is currently not available in the market. Your process expert is specifically assigned to your plant and will monitor key parameters on a regular rhythm using InSight. The process expert will be in frequent contact with key members of your operations team to discuss and resolve performance, process and operational issues. While supporting your team with day-to-day operations, the process expert will use InSight to focus on long term trends and provide you with recommendations that will help maximize membrane and equipment life and reduce costs. As part of the service, your process expert will provide process and performance review reports that contain insights to help you improve performance, optimize your process parameters and avoid operational downtime. If the need for troubleshooting does arise, you will have a SUEZ process expert on your team, deeply familiar with your system and empowered with information to assist.

7 scope of supply

7.1 SUEZ scope of supply – Phase 1

The following items are included in SUEZ's scope of supply. All equipment is shipped loose for installation by others. The following sections should be read in conjunction with the Piping & Instrumentation Drawings. If there is a discrepancy between the drawings and the scope table, the P&ID's take precedence with regards to SUEZ scope.

table 6.1 scope of supply by SUEZ ⁽¹⁾

Quantity	tag number	description	SUEZ Scope	Scope by Others
screens/integral compactor & associated equipment (506752-WTS-PR-T02-8521-DS-101)				
4	03-HV-202-A/B 03-HV-203-A/B	fine screen & compactor wash water influent isolation valves	√	
2	03-PY-201-A/B	fine screen influent pressure relief valves	√	
2	03-PI-201-A/B	fine screen influent pressure indicators	√	
2	03-SCR-201-A/B	fine screens with compactors (package) incl. mechanical weir, overflow sensor and local e-stops	√	
2	NA	screenings baggers	√	
lot	NA	bins for bagger		√
lot	NA	screen/compactor access stairs and platforms		√
1	NA	influent flow meter		√
2	03-HV-201-A/B	fine screen inlet valves		√
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-8521-DS-101		√
membrane blowers & associated equipment (506752-WTS-PR-T02-8521-DS-102)				
3	20-B-201-A/B/C	membrane blowers & associated filters & instrumentation (includes enclosures) (2 duty + 1 standby)	√	
3	20-FSL-201-A/B/C	membrane blower discharge flow switch low	√	
3	20-HV-201-A/B/C	membrane blower discharge isolation valve	√	
lot	Various	other valves and items generally		√

Quantity	tag number	description	SUEZ Scope	Scope by Others
		as noted on DWG: 506752-WTS-PR-T02-8521-DS-102		
process & WAS blowers & associated equipment (506752-WTS-PR-T02-8521-DS-103)				
3	16-B-501-A/B 16-B-801	biological process (1 duty + 1 standby) & WAS blowers & associated filters & instrumentation (includes enclosures)	√	
3	16-FSL-501-A/B 16-FSL-801	biological process & WAS blower discharge flow switch low	√	
3	16-HV-501-A/B 16-HV-801	biological process & WAS blower discharge isolation valve	√	
1	16-HV-503	bypass valve	√	
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-103		√
bioreactor tanks & associated equipment (506752-WTS-PR-T02-8521-DS-104)				
1	16-MX-211	anoxic zone mixer	√	
1	10-HV-610	Alum dosing isolation valves		√
1	15-HV-605	NaOH dosing isolation valves		√
lot	NA	Sprayer system (if required)		√
2	16-HV-505-1/2	air to aerobic tank diffuser grid isolation valve	√	
2	NA	fine bubble diffuser grid including drop leg piping	√	
2	16-AE-405-1/2	DO meter	√	
2	16-AE-402-1/2	pH meter	√	
2	16-AIT-405-1/2	DO & pH controller	√	
2	16-LSHH-401-1/2	aerobic tank level switches	√	
2	16-LIT-403-1/2	aerobic tank level transmitter	√	
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-104		√
membrane tanks & associated equipment (506752-WTS-PR-T02-8521-DS-105)				
lot	NA	membrane cassette installation hardware for membrane tank (excludes wall anchors)	√	
2	NA	ZeeWeed 500D 16- module membrane cassettes (1 cassette per membrane tank Phase 1)	√	

Quantity	tag number	description	SUEZ Scope	Scope by Others
28	NA	Membrane modules (14 modules per cassette Phase 1)	√	
lot	NA	blank headers	√	
2	NA	air distribution spools	√	
2	20-FV-205-1/2	air distribution control valves	√	
4	20-HV-204A/B-1/2	cassette air isolation valves	√	
4	20-HV-310A/B-1/2	cassette permeate isolation valves	√	
2	NA	permeate header assembly	√	
2	20-FV-209-1/2	membrane tank influent butterfly valve		√
2	NA	membrane tank influent deflector plate		√
2	20-LSHH-201-1/2	membrane tank level switches - high	√	
2	20-LSLL-201-1/2	membrane tank level switches – low	√	
2	20-LIT-203-1/2	membrane tank level transmitters	√	
2	20-HV-307-1/2	effluent header PIT isolation valve	√	
2	20-PIT-301-1/2	permeate header pressure indicating transmitter	√	
2	20-FV-501-1/2	RAS/WAS/Drain tank isolation valve	√	
2 ea.	20-E-801-1/2 20-FV-801-1/2 20-HV-801-1/2 20-FV-802-1/2 20-F-801-1/2 20-HV-802-1/2	air ejector systems including ejector assembly and air supply assembly	√	
2	23-HV-803-1/2	Instrument air bleed ball valve	√	
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-105		√
process pump & associated equipment (506752-WTS-PR-T02-8521-DS-106)				
2	90-HV-010-1/2	instrument air isolation valve	√	
2	23-FV-102-1/2	sodium hypochlorite injection pneumatic isolation valve	√	
2	23-FV-302-1/2	citric acid injection pneumatic	√	

Quantity	tag number	description	SUEZ Scope	Scope by Others
		isolation valve		
2	23-CV-101-1/2	sodium hypochlorite injection check valve	√	
2	23-CV-301-1/2	citric acid injection check valve	√	
2	20-FV-302-1/2	process pump suction isolation valve w/ pneumatic actuator	√	
2	20-PI-304-1/2	process pump suction pressure gauges	√	
2	20-HV-304-1/2	process pump suction pressure gauge isolation valves	√	
4	20-PSH-302-1/2 20-PSH-301-1/2	process pump pressure high switch (inlet and outlet)	√	
2	20-P-301-1/2	rotary lobe process pumps (VFD not included)	√	
2	NA	ZMOD-L skids (including skid base, piping/support, local IO panel; ; excluding VFD and local e-stops)	√	
2	20-PI-303-1/2	process pump discharge pressure gauge	√	
2	20-HV-303-1/2	process pump discharge pressure gauge isolation valve	√	
4	20-HV-306-1/2 20-HV-305-1/2	process pump suction and discharge drain valves	√	
2	20-FIT-307-1/2	process pump flow transmitters	√	
2	20-HV-301-1/2	process pump discharge isolation butterfly valves	√	
2	20-HV-320-1/2	process turbidimeters isolation ball valve	√	
2 ea.	20-AE/AIT-320-1/2	process turbidimeters and controller	√	
2	20-HCV-320-1/2	process turbidimeter flow control valve	√	
2	20-FV-320-1/2	process turbidimeter solenoid valve	√	
2	20-FV-609-1/2	Backpulse isolation valve with pneumatic actuator	√	
2	20-CV-301-1/2	permeate to UV check valve	√	
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-106		√

Quantity	tag number	description	SUEZ Scope	Scope by Others
backpulse tank & associated equipment (506752-WTS-PR-T02-8521-DS-107)				
1	20-HV-609	backpulse tank effluent to permeate pump isolation valve	√	
1	23-FV-161	sodium hypochlorite influent to backpulse tank isolation valve	√	
1	23-CV-110	sodium hypochlorite influent to backpulse tank check valve	√	
1	20-TT/TW-001	permeate temperature transmitter with thermowell	√	
1	20-FV-641	backpulse tank fill valve with pneumatic actuator	√	
1	20-LIT-603	membrane Backpulse Tank level transmitter	√	
1	20-HV-611	membrane Backpulse Tank level transmitter isolation valve	√	
1	20-TK-601	membrane Backpulse tank	√	
1	20-HV-608	membrane Backpulse Tank drain valve	√	
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-107		√
RAS/WAS/Drain pump & associated equipment (506752-WTS-PR-T02-8521-DS-108 sheet 1 of 2)				
4	20-HV-504/503-A/B	RAS pump influent/effluent pressure gauge isolation valve	√	
4	20-PI-504/503-A/B-1/2	RAS pump influent/effluent pressure gauge including diaphragm seals	√	
4	20-HV-506-1/2 20-HV-505-1/2	RAS pump influent and effluent drain valves	√	
2	20-P-501-1/2	RAS/WAS pumps	√	
2	20-CV-501-1/2	RAS effluent check valves	√	
2	20-HV-501-1/2	RAS effluent isolation valves	√	
2	20-FIT-507-1/2	RAS effluent flow meter	√	
1	20-FV-807	RAS effluent isolation valve	√	
1	20-HV-407	WAS effluent isolation valve	√	
1	20-FIT-401	WAS flow meter	√	
1	20-FV-701	WAS to sludge handling isolation valve	√	
lot	Various	other valves and items generally		√

Quantity	tag number	description	SUEZ Scope	Scope by Others
		as noted on DWG: 506752-WTS-PR-T02-8521-DS-108 sheet 1 of 2 vacuum breaker not supplied by SUEZ		
TWAS storage tank & associated equipment (506752-WTS-PR-T02-8521-DS-108 sheet 2 of 2)				
1	NA	diffuser grid & drop leg	√	
2	16-LSH-703 16-LSHH-703	TWAS storage tank level switches		√
1	16-LIT-701	TWAS storage tank level transmitter		√
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-108 sheet 2 of 2		√
UV system (506752-WTS-PR-T02-8521-DS-109)				
1	38-FIT-101	UV influent flow meter	√	
1	38-HV-101	UV influent service water line isolation valve	√	
2	38-SV-101 38-SV-102	UV drain valve	√	
1	38-UV-101-1	UV system	√	
1	38-HV-102	UV effluent isolation valve	√	
2	38-HV-103 38-HV-104	Manual bypass and isolation butterfly valves	√	
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-109		√
chemical skids (506752-WTS-PR-T02-8521-DS-110 sheet 1 of 2 and 2 of 2)				
2	23-CV-101 23-CV-301	chemical feed foot valve	√	
1	10-CV-601	chemical feed foot valve	√	
2	23-LSL-101 23-LSL-301	chemical tank level switch	√	
1	10-LSL-601	chemical tank level switch	√	
1	NA	panel mounted chemical dosing pumps & associated instrumentation and valves – Sodium Hypochlorite 2 pumps on 1 panel	√	

Quantity	tag number	description	SUEZ Scope	Scope by Others
		(chemical day tanks and secondary containment not included in SUEZ scope)		
1	NA	panel mounted chemical dosing pumps & associated instrumentation and valves – Citric Acid 2 pumps on 1 panel (chemical day tanks and secondary containment not included in SUEZ scope)	√	
1	NA	panel mounted chemical dosing pumps & associated instrumentation and valves – Alum 2 pumps on 1 skid (chemical day tanks and secondary containment not included in SUEZ scope)	√	
lot	NA	Chemical day tanks and secondary containment		√
1	23-PSV-109	pressure safety valve		√
3	23-PCV-101 23-PCV-301 10-PCV-601	pressure control valves	√	
1	10-FIT-601	Alum flow indicating transmitter		√
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-110 sheet 1 of 2		√
membrane air compressors & associated equipment (506752-WTS-PR-T02-8521-DS-111)				
1 skid	90-AC-001-A/B 90-F-001-A/B	skidded compressors w/ filters and local control panel containing starters and control wiring [includes 90-TK-001, 90-FV-001, 90-PI-001, 90-PSL-001, 90-PSV-001, 90-HV-001]	√	
1	90-HV-004 90-DPI-001 90-F-020 90-HV-005 90-HV-006 90-PSL-003 90-PY-001 90-PSLL-002	filter air panel	√	

Quantity	tag number	description	SUEZ Scope	Scope by Others
2	90-HV-002-A/B	refrigerated air drier influent isolation valves	√	
2	90-DR-001-A/B	refrigerated air driers	√	
2	90-HV-003-A/B	refrigerated air driers effluent isolation valves	√	
1	90-HV-XXX	isolation valve to locally mounted solenoids		√
1	90-FV-011	condensate drain valve		√
lot	Various	other valves and items generally as noted on DWG: 506752-WTS-PR-T02-8521-DS-111		√
electrical & control components				
1	NA	CompactLogix Processor with IO	√	
1	NA	MCP NEMA 12 Panel with UPS	√	
2	NA	Remote IO enclosures (mounted on ZMOD-L skids)	√	
lot	NA	Field wiring of SUEZ-supplied equipment (except for skid-mounted equipment wired to remote IO panel)		√
lot	NA	VPN-secured high-speed internet for Insight and remote support from SUEZ ⁽²⁾		√
lot	NA	RS4000 VPN router (if required)	<i>Additional charges will apply if required</i>	
lot	NA	Local e-stops (except for the fine screen/compactor units)		√
Lot	NA	VFDs		√
lot	NA	SCADA system incl. alarm call-out functionality		√
General				
Included	Operating & maintenance manuals		√	
Included	FAT testing for SUEZ ZMOD-L skids (Suez standard testing)		√	
Included	field service and start-up assistance for 30 days over 3 site visits from SUEZ field-service personnel for commissioning, plant start-up, and operator training ⁽³⁾		√	
Included	on-site operational support: 5 days on-site operational support over 5 site visits from		√	

Quantity	tag number	description	SUEZ Scope	Scope by Others
	SUEZ field service professionals for the first 2 years			
Included	InSight Pro monitoring service – 2 years		√	
Included	24/7 telephone technical support service – 2 years		√	
Included	Equipment warranty – 1 year (parts and labour included)		√	
Included	Membrane warranty – 2 year cliff + 8 year pro-rated (freight and labour included as defined in Appendix)		√	
Included	Equipment shipment CIP customer job site per INCOTERMS 2010		√	

note 1: All SUEZ supplied equipment is designed for installation in an unclassified area.

note 2: To receive complete 24/7 Emergency Telephone Technical Support Service and to allow for InSight

note 3: Additional hours will be billed separately from the proposed system capital cost at a rate of \$1,600 per 8-hour day plus living and traveling expenses. Detailed SUEZ service rates are available upon request.

7.2 buyer scope of supply

The following items are for supply by buyer and will include, but are not limited to:

- ☐ Overall plant design responsibility
- ☐ Installation on site of all SUEZ-supplied skids and loose-shipped equipment
- ☐ Review and approval of design parameters related to the membrane separation system
- ☐ Review and approval of SUEZ-supplied equipment drawings and specifications
- ☐ Detail drawings of all termination points where SUEZ equipment or materials tie into equipment or materials supplied by others
- ☐ Equipment foundations, civil work, full floor coverage, equipment contact pads, buildings, etc.
- ☐ Receiving, unloading and safe storage of SUEZ -supplied equipment at site until ready for installation
- ☐ HVAC equipment design, specifications and installation (where applicable)
- ☐ UPS, Power Conditioner, Emergency power supply and specification (where applicable)
- ☐ Lifting devices including Crane able to lift 2 ton for membrane removal, lifting davit crane and guide rails for submersible mixers and pumps, hoists, etc.
- ☐ Membrane tanks including RFP covers (as required)
- ☐ Biological tanks including RFP covers (if required)

- ☐ Equalization tank if required
- ☐ Influent splitter box
- ☐ All chemical storage tanks, day tanks, and containments
- ☐ Treated water storage tank – as required
- ☐ Sludge drainage pumps
- ☐ Sludge storage tank – as required
- ☐ VFDs and motor starters for all pumps, blowers, and compressors
- ☐ Process and utilities piping, pipe supports, hangers, valves, etc. including but not limited to:
 - Piping, pipe supports and valves between SUEZ-supplied equipment, between SUEZ-supplied equipment and other plant process equipment, between SUEZ-supplied skids and tanksProcess tank aeration system air piping, equalization tank system piping, sludge storage tank piping, etc.
- ☐ Electrical wiring, conduit and other appurtenances required to provide power connections as required from the electrical power source to the SUEZ control panel and from the control panel to any electrical equipment, pump motors and instruments external to the SUEZ-supplied enclosure
- ☐ Electrical grounding of SUEZ-supplied equipment and skids
- ☐ SCADA system, integration of the SUEZ program/alarms in the SCADA, remote access and alarm call-out
- ☐ suitable, secure remote internet connection for 24/7 emergency telephone technical support service and InSight remote monitoring & diagnostics service
- ☐ All bolts, brackets and fasteners to install SUEZ-supplied equipment. Seismic structural analysis and anchor bolt sizing.
- ☐ Alignment of rotating equipment
- ☐ Raw materials, chemicals, and utilities during equipment start-up and operation
- ☐ Supply of seed sludge for process start-up purposes
- ☐ Disposal of initial start-up wastewater and associated chemicals
- ☐ Weather protection as required for all SUEZ supplied equipment. Skids and electrical panels are designed for indoor operation and will need shelter from the elements
- ☐ laboratory services, operating and maintenance personnel during equipment checkout, start-up and operation
- ☐ touch up primer and finish paint surfaces on equipment as required at the completion of the project
- ☐ All permits

8 commercial

8.1 system price

The pricing to supply equipment and services as described in this proposal is as follows.

Pricing for the proposed equipment and services is summarized in the table below. All pricing is based on the operating conditions and influent analysis that are described in this proposal Section 6 and scope of supply as outlined in Section 7.

Table 8.1 – Firm Pricing for Phase 1 Design

price: equipment and services	
ZeeWeed 500D UF-MBR system (Phase 1 Design)	\$ 1,357,670 CAD
Engineering Design & Drawing Submittals (previously completed)	- \$107,000 CAD
Total Base Price	\$ 1,250,670 CAD
Additional Design Engineering and additional Engineering submittals ¹	\$190/hour

Note 1: The SUEZ project execution team assigned to this project will work with the awarded Contractor to address any questions and discussions throughout the project life. Engineering design has been completed and the drawing package has been submitted. A copy of the drawing submittal package will be provided to the Contractor. Additional charges will apply should additional engineering design services be required.

Please note that the presented pricing does not include any provision for any procurement restrictions imposed on Seller by Buyer's funding parties. Should these restrictions be required, Seller reserves the right to adjust the pricing herein upon review of the restrictions.

8.2 price validity

The quoted system price (Table 8.1) will be valid until December 16th, 2020. If a formal Purchase Order or Procurement Agreement is not received and accepted within this Validity Period, both the pricing and delivery schedule are subject to review and adjustment.

The proposed system pricing is based upon receipt of a Notice to Proceed (NTP) for Manufacturing/Equipment Procurement being provided by February 15th, 2021. In the event the NTP for Manufacturing/Equipment Procurement is not received before this date, the equipment and service prices contained herein will be subject to adjustment for any increase in the North American Consumer Price Index (CPI) + 1.0%. This adjustment will be from the end of the proposal validity date to the date of the NTP for Manufacturing/Equipment Procurement is received.

If a formal NTP for Manufacturing/Equipment Procurement is not received and accepted within 3 months of the NTP date referenced above, Seller will be afforded the right to review and adjust the scope of supply, pricing and delivery schedule offered herein.

8.3 taxes

Pricing provided herein does not include any taxes or duties.

Buyer shall be directly responsible, and reimburse Seller, for the gross amount of any present, for future sales, use, excise, value-added, environmental, or other similar tax or duty applicable to the price, sale or delivery of any equipment or services furnished under this proposal. Unless Buyer has furnished Seller with evidence of tax exemption or direct pay permit acceptable to taxing authorities prior to the execution of any Purchase Order / Agreement or Seller's acceptance of Buyer's Purchase Order (as applicable), Buyer shall pay all taxes as invoiced by Seller and Seller is relieved of any obligation to (i) apply any tax exemption or direct pay permit, and/or (ii) refund the Buyer any tax paid by the Seller.

Seller's price and schedule shall be based on applicable Federal and Provincial laws, local ordinances, codes, and standards as well as duties, sales or use taxes in effect as of the date of Seller's proposal. Should such laws, codes, taxes and standards change and increase the cost of performing the work or impact the schedule, Seller shall, upon notice to Buyer of such, be entitled to an equitable adjustment of price and /or schedule. Similarly, should such laws, codes, taxes and standards change and decrease the cost of performing the work, Buyer shall be entitled to an equitable adjustment of price.

8.4 order confirmation centre

In order to facilitate efficient order handling, Seller has instituted an Order Confirmation Centre (OCC). All Purchase Orders or Contracts being issued to Seller are to be directed to OCC following the methods indicated below:

- ☐ via email: WTS.equipmentpo@suez.com
- ☐ via facsimile: 905-469-2236
- ☐ via courier: SUEZ Water Technologies & Solutions Canada
3239 Dundas Street West
Oakville, Ontario, L6M 4B2
Attn: OCC

8.5 delivery

The following freight terms for delivery of equipment used are as defined by INCOTERMS.

All pricing is CIP designated Project site **English River, SK**. Delivery to the project site is conditional upon provision of access roads of a nature that will permit access by tractor-trailers. Off-loading and positioning of equipment at the job-site is not included.

8.6 shipment to storage

If any part of the equipment cannot be delivered when ready due to any cause not attributable to Seller, Buyer shall designate a climate-controlled storage location and Seller shall ship such equipment to storage. Upon shipment to the storage location then (i) title and risk of loss shall thereupon pass to the Buyer if it had not already passed; (ii) any amounts payable to the Seller upon delivery or shipment shall become payable upon presentation of Seller's invoice(s); (iii) any amounts otherwise payable to Seller, such as for preparation for storage, handling, inspection, preservation, insurance and any taxes shall be payable by Buyer upon submission of Seller's invoice(s); (iv) the Services provided herein shall subsequently charged at the rate prevailing at the time of actual use and Buyer shall pay the net increase; and (v) Buyer is responsible for direct payment of all costs for storage of the equipment and subsequent transportation from the storage facility to their place of installation.

8.7 bonds

A Performance and/or Labor & Material Payment Bonds are not included in the system price. These bonds can be purchased on request but will be at additional cost.

8.8 payment terms

The pricing quoted in this proposal is based upon the following payment terms, subject to approval of Buyer credit (all payments are net 30 days):

Equipment – Purchase price

- ☐ 5% with Purchase Order;
- ☐ 20% on Notice to Procure Equipment;
- ☐ 65% on shipment of equipment (partial shipments permitted);
- ☐ 10% on completion of commissioning, or net 60 days from equipment shipment whichever occurs first.
- ☐ No financial allowance has been made for any Holdbacks on submitted invoices.

The Buyer shall have the right to terminate Seller's Contract for convenience at any time upon 30 days written notice to Seller. Upon receipt of such termination notice by Seller, payment to Seller shall include:

- ☐ payment in full for unpaid invoices presented by Seller to Buyer to date of termination notice.
- ☐ payment for Seller's costs not yet invoiced to date of termination notice, plus 10% termination fee.
- ☐ payment to Seller for any restocking costs and Seller's costs to terminate orders with Seller's suppliers, plus 10% termination fee regarding such costs.

Seller shall only proceed with procurement and production of equipment and materials upon receipt of a formal Purchase Order and a written Notice to Proceed with

Manufacturing/Equipment Procurement from the Buyer.

8.9 proposed project schedule

Equipment shipment is estimated at 20 to 24 weeks after notice to procure. The buyer and seller will arrange a kick-off meeting after contract acceptance to develop a firm shipment schedule.

typical drawing submission and equipment shipment schedule

	3 weeks	1-2 weeks	2 weeks	20-24 weeks		2 weeks
acceptance of PO & project setup and kickoff						
review of SUEZ engineering drawing package (previously completed)						
notice to procure						
equipment manufacturing						
equipment shipment						
plant operations manuals						

The delivery schedule is presented based on current workload backlogs and production capacity. This estimated delivery schedule assumes no more than 2 weeks for buyer review of submittal drawings. Any delays in buyer approvals or requested changes may result in additional charges and/or a delay to the schedule.

If a formal Purchase Order is not approved within the period of validity of this proposal, the delivery schedule is subject to review and adjustment.

Seller would like to note that under the current exceptional circumstances under the COVID 19 Pandemic situation, Seller may not be in a position to guarantee and comply with the planned schedule for project delivery or performance and that should there be any new measures taken by any governmental authority which may impede or delay the said schedule or performance, Seller reserves the right to modify the schedule / contract accordingly. Seller will promptly inform you of any changes which may impact the contract or the project.

8.10 membrane module replacement price

The price of replacement ZeeWeed 500 membrane modules for this project is \$1200 CAD per module. Seller will guarantee this price for ten (10) years from the start date of the membrane warranty. Pricing for replacement modules is subject to adjustment for inflation from the date of this proposal according to the North American Consumer Price

Index (CPI) + 1.0%. If the same module is not available due to product improvements, an equivalent price per gallon of treatment capacity will be used.

The membrane replacement price quoted refers to replacement of installed membranes under the following two scenarios;

- ☐ replacement of membrane modules during the warranty period,
- ☐ replacement of membrane modules no longer under warranty but still within the guaranteed membrane replacement price period.

Under the first scenario, membrane modules replaced under warranty shall assume the remainder of the warranty for the membrane modules being replaced, with such warranty to be not less than a two (2) year full replacement warranty from the date of replacement with a new membrane module.

Under the second scenario, unless specified otherwise, membrane modules purchased to replace a membrane module whose warranty has expired shall be provided with a standard two (2) year full replacement warranty.

The membrane module replacement price is not applicable for membrane modules purchased for any non-replacement purposes, such as for flux reduction or hydraulic capacity increase. Modules purchased under these scenarios will be purchased at the list price at the time of order.

Membrane module replacement price does not include bagging, boxing, crating, and will be shipped on the basis of INCOTERMS 2010 FCA SUEZ Manufacturing Facility. Membrane module replacement price is quoted without taxes.

8.11 royalty and license fees

8.11.1 application patents

Seller has a number of patents covering the products, equipment and applications offered in this proposal.

8.11.2 non-exclusive royalty free license

Seller grants Buyer a non-exclusive, non-terminable, royalty free license to use the intellectual property embedded in the equipment delivered to and paid for by the Buyer, as well as any drawings, design or data delivered to and paid for by the Buyer, for the purposes of owning, financing, using, operating, and maintaining the relevant equipment at Buyer's site. Such license may only be assigned to a subsequent owner of the equipment or to an operations and maintenance sub-contractor. Such license does not extend to the re-creation of the equipment or the manufacture of spares or consumables by Buyer or third parties.

Any software Seller owns and provides pursuant to this proposal shall remain Seller's property. Seller provides to Buyer a limited, non-exclusive and terminable royalty free project-specific license to such software for the use, operation or maintenance at Buyer's site of any equipment purchased hereunder to which software is a necessary component. Buyer agrees not to copy, sub-license, translate, transfer or reverse

engineer, or decode the software. Single user versions of software may be used on one CPU. LAN/WAN versions may be used on a single server with only the number of concurrent users as agreed to by the Parties. Unless otherwise expressly agreed by Seller, this license shall terminate and the software shall be returned to Seller as soon as the Buyer no longer operates the equipment as sold, or upon the material breach of these terms.

Furthermore, the chemistries used in the manufacture of Seller's ultrafiltration and microfiltration membranes sold under the ZeeWeed brands are proprietary and the Buyer undertakes not to analyze these membranes or to permit analysis of these membranes by a third party.

8.12 terms and conditions

By accepting our proposal, the Buyer agrees to include Seller's proposal as a Contract document in any Purchase Order or Procurement Agreement.

This proposal has been prepared and is submitted based on Seller's General Terms and Conditions of Sale as attached in Appendix D.

It should be noted that once the Buyer's Terms and Conditions are received, the final Terms and Conditions can be negotiated to the mutual agreement of Seller and the Buyer. Buyer's Terms & Conditions may typically include specific bonding requirements, liquidated damages, cancellation clauses, equipment warranty requirements and other contractual liabilities for which Seller has made no provision in the pricing provided herein. Seller therefore reserves the right to adjust the pricing herein upon review of any Buyer supplied Terms and Conditions.

appendix a P&IDs & Layouts

As submitted to MPE during Engineering Design Phase.

appendix b - warranties

appendix b warranties

introduction

The seller offers a comprehensive three-part warranty for the English River First Nation MBR as follows:

- ❑ **mechanical warranty:** seller will repair or replace any device or part thereof that was supplied by the seller that proves to be defective. This warranty excludes the membrane modules.
- ❑ **membrane warranty:** This warranty provides protection and assurances to the buyer/owner with respect to the membrane modules.
- ❑ **performance warranty:** This warranty provides protection and assurances to the buyer/owner with respect to the ability of the seller's system to meet the established performance criteria.

The start date for all warranties is upon substantial completion or six (6) months from equipment shipment, whichever occurs first. Substantial completion is defined as when the buyer/owner makes beneficial use of the equipment supplied by the seller.

mechanical warranty

material and workmanship warranty

The mechanical warranty is only applicable to equipment supplied by the seller. Seller's obligation under this warranty is to the repair or replace, at its factory, of any device or part thereof, which shall prove to have been thus defective. The mechanical warranty period on all equipment supplied, unless otherwise noted, is twelve (12) months from the date of substantial completion or eighteen (18) months from equipment shipment, whichever occurs first. Warranty repair, replacement or re-performance by seller shall not extend or renew the applicable warranty period.

Seller assumes no liability for any damage to equipment caused by inadequate storage or handling per manufacturer's recommendations in supplied technical literature, or by defective or sub-standard workmanship or materials provided by the buyer/owner or any other third party responsible for handling, storing or installing the equipment.

The buyer/owner undertakes to give immediate notice to seller if goods or performance appear defective and to provide seller with reasonable opportunity to make inspections and tests. If seller is not at fault, the buyer/owner shall pay seller the costs and expenses of the inspections and tests.

Goods shall not be returned to seller without seller's permission. Seller will provide buyer/owner with a "return goods authorization" (RGA) number to use for returned goods. All returns are F.C.A. – Oakville, Ontario, Canada. All costs associated with the removal and shipment of the defective part from the buyer/owner's facility to the seller's factory and all costs related to return shipment to the buyer/owner's facility and installation of a repaired or replacement part shall be the buyer/owner's responsibility.

Implied warranties, including but not limited to warranties of fitness for particular purpose, use or application, and all other obligations or liabilities on the part of the seller, unless such warranties, obligations or liabilities are expressly agreed to in writing by seller, are null and void.

membrane warranty

A ten (10) year prorated warranty is offered on the membrane modules with the first twenty-four (24) months offered as a full replacement warranty and the remaining ninety-six (96) months as a prorated warranty. Refer to “seller’s warranty – ZeeWeed membrane modules” in appendix B for a detailed description of the membrane warranty offered.

warranty provisions

In addition to the membrane warranty limitations as defined in the “seller’s warranty – ZeeWeed membrane modules”, the membrane warranty is subject to the following provisions:

- ☐ the equipment is operated and maintained at all times in accordance with the seller’s operations and maintenance manual,
- ☐ the equipment is operated within the mixed liquor characteristics defined in table 1 of this section,
- ☐ seller has, until performance of its obligation herein is met, reasonable access to the equipment and the operational data relating thereto,
- ☐ the buyer/owner furnishes adequate and competent operating, supervisory and maintenance staff, and necessary laboratory facilities with test equipment and personnel,
- ☐ the buyer/owner utilizes the services of seller until its performance obligations are met,
- ☐ the buyer/owner supplies all necessary raw materials and services of a quantity and of a quality specified by the seller,
- ☐ an adequate and continuous power supply is available that will enable operation of all required equipment,
- ☐ the following pre-treatment guidelines are followed:
 - **fats, oil and grease (FOG)** – FOG concentration shall not exceed 150 mg/L of emulsified FOG in the feed with no free oil and less than 10 mg/L of mineral or non-biodegradable oil.
 - **pretreatment** - A punched hole or woven wire mesh screen with a maximum size opening of no greater than 2 mm and without possibility of bypass of any particle larger than 2 mm in all directions must be included in the headwork’s. Seller must be consulted regarding the type, capacity, and size opening of the screens that are to be installed.

- **process chemical additives** - The use of any chemicals added to the wastewater treatment process (e.g.: polymers, flocculants, coagulants, antifoams) that may come in contact with the ZeeWeed membranes must be approved by seller prior to use. This includes chemicals used in processes outside of the seller's system that may be transferred to the seller's system, such as in solids handling facilities.

table 1: mixed liquor characteristics for warranty purposes

parameter	design value	accepted operating range
mixed liquor temperature (°C)	9	9 – 30
MLSS concentration in membrane tanks (mg/L) ¹	10,000	≤ 12,000
pH of mixed liquor in membrane tanks (SU)	7.0	6.5 – 7.5
soluble cBOD ₅ concentration in mixed liquor entering membrane tanks (mg/L)	5	≤ 5
NH ₃ -N concentration in mixed liquor entering membrane tanks (mg/L)	0.5	≤ 1.0
colloidal TOC (cTOC) concentration in mixed liquor entering membrane tanks (mg/L) ²	7	≤ 10
soluble alkalinity of mixed liquor entering membrane tanks (mg/L as CaCO ₃)	100	50 – 150
time to filter (TTF) of mixed liquor in membrane tanks ³	100	≤ 200
material greater than 2-mm in size in mixed liquor in membrane tanks (mg/L) ⁴	0	≤ 1
fats, oil & grease (FOG) (mg/L)	Refer to Note 6	

1. Membrane tank MLSS concentration of 12,000 mg/L is permissible during MDF and PHF events only. Membrane tank MLSS concentration to be ≤ 10,000 mg/L during all other flow conditions.
2. Colloidal TOC (cTOC) is the difference between the TOC measured in the filtrate passing through a 1.5 µm filter paper and the TOC measured in the ZeeWeed membrane permeate.
3. Per seller's standard time to filter (TTF) procedure (available upon request).
4. Per seller's standard sieve test procedure (available upon request).
5. Chemicals that are not compatible with the ZeeWeed PVDF membrane are not permitted in the membrane tank.
6. FOG concentration shall not exceed 150 mg/L of emulsified FOG in the feed with no free oil and less than 10 mg/L of mineral or non-biodegradable oil.

membrane performance

Seller warrants, subject to the provisions set forth above, that after stable operation of the seller's system has been attained and operators have acquired reasonable skills, the membrane modules supplied for this project will be capable of producing the results set forth in table 2.

table 2: guaranteed membrane filtration system performance

parameter	guaranteed values
membrane filtration system hydraulic capacity	
average day flow, ADF, with all trains in service (m ³ /d) ¹	≤ 188
maximum month flow, MMF, with all trains in service (m ³ /d) ¹	≤ 282
maximum day flow, MDF, with all trains in service (m ³ /d) ¹	≤ 376
flow with one membrane train out of service for maximum duration of 24-hours (m ³ /d)	≤ 376
membrane filtration system permeate quality	
TSS (mg/L)	≤ 5
turbidity (NTU)	≤ 1

- The flow conditions are defined as follows:

Average Day Flow (ADF) – The average flow rate occurring over a 24-hour period based on annual flow rate data.

Maximum Month Flow (MMF) – The average daily flow rate occurring during the 30-day period with the highest flow based on annual flow rate data.

Maximum Day Flow (MDF) – The maximum flow rate that occurs over a 24-hour period based on annual flow rate data.

performance warranty

This warranty provides protection and assurances to the buyer/owner with respect to the ability of the seller's MBR system to meet the established performance criteria. Based on the influent wastewater and/or mixed liquor characteristics and system operating parameters specified in this document, the equipment offered herein will be capable of meeting the performance defined below.

The performance warranty period, is twelve (12) months from the date of substantial completion or eighteen (18) months from membrane shipment, whichever occurs first. Once the performance warranty period has expired, mechanical and membrane warranty provisions shall apply.

biological treatment system

Subject to the terms defined above, the influent wastewater characteristics defined in table 3, and the biological treatment system operating parameters specified in table 4, the equipment offered herein will be capable of meeting the permeate quality defined in table 5.

table 3: influent wastewater characteristics for biological treatment system

parameter	design value	accepted operating range
wastewater flow (m ³ /d) ¹	282	See note 1
wastewater temperature (°C)	9	≥ 9.0
total suspended solids, TSS (kg/d)	71	64 – 78
volatile suspended solids, VSS (kg/d)	57	51 - 63
biochemical oxygen demand, cBOD ₅ (kg/d)	71	64 – 78
total kjeldahl nitrogen, TKN (kg/d)	9.5	8.6 - 10.5
ammonia, NH ₃ -N (kg/d)	6.0	5.4 – 6.6
total phosphorous, TP (kg/d)	1.6	1.4 – 1.8
pH (SU)	7.0	6.5 – 7.0
alkalinity (mg/L as CaCO ₃)	100	50 - 150
cBOD ₅ :TKN ratio (-) ²	7.4	≥ 6.0
rDON (mg/L) ⁴	1.0	≤ 1.0

1. The biological system design considers the maximum monthly flow (MMF) as the design flow condition. Refer to the membrane filtration system design (Table 2) for other flow conditions.
2. The ratio of cBOD₅ to TKN needs to be maintained at the stated design value to assure nitrogen removal performance. If the ratio drops below the design value, methanol (or other supplemental carbon source) consumption may increase to compensate for the loss of the carbon source required to meet the total nitrogen discharge limit.
3. rDON refers to recalcitrant (not biologically degradable) dissolved organic nitrogen.

table 4: biological system operating parameters for warranty purposes

parameter	design value	accepted operating range
mixed liquor temperature in bioreactor (°C)	9.0	≥ 9.0
MLSS concentration in bioreactor (mg/L)	8,000	≤ 8,000
MLVSS/MLSS ratio in bioreactor (-)	0.8	0.7 – 0.9
solids retention time, SRT (d)	21	19 – 23
pH of mixed liquor in bioreactor (SU)	7.0	6.5 – 7.5
dissolved oxygen (DO) concentration in anoxic zones (mg/L)	0.2	≤ 0.2
dissolved oxygen (DO) concentration in aerobic zones (mg/L)	2.0	≥ 1.5

table 5: guaranteed biological treatment system performance

parameter	guaranteed values ¹
biochemical oxygen demand, cBOD ₅ (mg/L)	≤ 5
ammonia, NH ₃ -N (mg/l)	≤ 1
nitrate, NO ₃ (mg/L)	≤ 10
E. Coli (MPN/100 mL)	≤ 1 ²
fecal coliform/total coliform (MPN/100 mL)	≤ 200 ²

1. Guaranteed concentrations are based on a monthly average value of a minimum of four (4) 24-hour composite samples collected at regular intervals with testing performed to applicable industry-approved standards.
2. After UV disinfection. Microbiological parameters may be subject to regrowth in the permeate piping (by contractor). Any exceedance of microbiological parameters due to re-growth or improper operation or maintenance of the treatment system are excluded from the warranty.

seller's warranty - ZeeWeed membrane modules standard full replacement

This schedule sets out the warranty with respect to ZeeWeed Membrane Modules ("Membrane Modules"). No other warranties, expressed or implied are made in connection with the sale of these products, including, without limitation, warranties as to fitness for any particular purpose or use or merchantability of these products. The warranty provided herein will be the exclusive and sole remedy of the Buyer, and in no event will the Seller be liable for any special, direct, indirect or consequential damages, including, without limitation, loss of profits. Buyer is not entitled to extend or transfer this warranty to any other party, without the express written consent of Seller.

1 product

This warranty applies to only the Membrane Modules supplied under the contract of sale. Membrane Module means the fibers and potted plastic header(s). This warranty does not cover air piping to the Membrane Module, permeate piping from the Membrane Module, piping connection fittings, connecting hardware and cassette frames with their associated components including but not limited to spacers, aerator tubes, aerator assemblies, screen, module dummies or module blanks.

Identification: Membrane Modules are shipped by the Seller with a serial number identification which confirms their place in the cohort set of Membrane Modules covered by this Membrane Module warranty.

2 seller

"Seller as SUEZ Water Technologies & Solutions Canada" is the name of the Seller, and means a business component of, or legal entity within the SUEZ Water Technologies & Solutions business (SUEZ) which is selling ZeeWeed modules. The Seller may assign this warranty to other SUEZ affiliates.

3 buyer

Buyer is English River 1st Nations Reserve, and means the party purchasing the ZeeWeed modules from the Seller.

4 project

Project means English River 1st Nations Reserve MBR

5 contract of sale

Contract of sale means the sales contract governing the sale of Membrane Module(s) between the Buyer and the Seller or its SUEZ affiliate.

6 scope of warranty

The Seller warrants that its Membrane Module(s) will be free of defects due to faulty materials or errors in manufacturing workmanship.

Regular Membrane Module inspection and normal fiber repair shall be the responsibility of the Buyer.

All replacement Membrane Modules will be shipped on the basis of INCOTERMS 2010 FCA SUEZ membrane manufacturing facility.

All ancillary costs including but not limited to bagging, boxing, crating, freight, freight insurance, applicable taxes, import duties, brokerage, receiving, forklift services, storage at site, re-attachment hardware, hose/clamp/camlock replacement, crane services, installation, fiber repair materials, glycerin flushing, commissioning and waste disposal are the responsibility of Buyer.

full replacement – Full replacement means that in the case of a valid warranty claim for a Membrane Module failure, the Buyer receives a replacement Membrane Module and does not pay for the value of use of the Membrane Module prior to failure.

prorated replacement – Prorated replacement means the Buyer pays for actual use of a membrane module from which the Buyer has derived value over time. See **section 12 membrane module replacement price – prorated replacement** for the formula for calculating the prorated amount payable. Prorated replacement allows the Seller to pay reasonable compensation under warranty for any product use not enjoyed by the Buyer due to premature failure.

The ratio of full replacement to prorated replacement in this warranty is set out in **section 8 warranty duration**.

7 warranty start date

This warranty will start on the earlier of:

- a) the date that installation of the original Membrane Module(s) has been substantially completed, or
- b) six (6) months from the date of shipment of the original Membrane Module(s) to the Buyer as per supplied bill of lading date

For replacement Membrane Modules, this warranty will start the earlier of:

- a) the date of installation as provided in writing by Buyer to Seller, or
- b) one (1) month from the date of delivery by Seller to the plant site

8 warranty duration

total warranty duration: a total of **one hundred twenty (120) months** composed of a base period and an extended period.

base period with full replacement: twenty-four (24) months

All purchasers of ZeeWeed Membrane Modules are entitled to this base period of full replacement warranty coverage without purchasing an extended Seller's warranty.

extended period with prorated replacement: a total of **ninety-six (96) months** following the base period

Replacement Membrane Modules are covered by warranty only for the balance of the warranty of the original Membrane Module which has been replaced. At all events, this warranty shall expire and be of no force or effect **one hundred twenty (120) months** following the warranty start date.

9 notification of claim

All claims filed under this warranty shall be made in writing by the Buyer within thirty (30) days of identifying a defect.

The Buyer shall provide the following information:

- a) a description of the defect giving rise to the claim
- b) photographs showing the manufacturing defect
- c) the serial number(s) of the Membrane Module(s) which is (are) the subject of the warranty claim and
- d) operating data and repair history for the life of Membrane Modules which are the subject of a warranty claim

10 verification of claim

After receipt of written notification of a defect, the Seller will promptly undertake such investigations as, in the Seller's opinion, are necessary to verify whether a defect exists. The Seller reserves the right to require additional data as necessary to validate claims. Buyer may, in the course of these investigations, be requested to return Membrane Module(s) to the Seller for examination. The Seller may also conduct reasonable tests and inspections at the Buyer's plant or premises. If the results of the investigation do not validate the defect claimed, the Buyer will reimburse the Seller for all reasonable expenses associated with said investigation, including expenses for all tests, inspections, and associated travel.

11 satisfaction of claims

The Seller will have the right to satisfy claims under this warranty in a flexible manner. Such flexibility may include the repair of existing Membrane Modules or changes in operating protocols or Membrane Module replacement or by upgrading failed Membrane Modules with newer Membrane Module(s) that may embody design and efficiency improvements. The Buyer consents to the supply of replacement Membrane Modules which may be of a different design than original Membrane Modules.

12 membrane module replacement price – prorated replacement

The base Membrane Module Replacement Price (MMRP) used to calculate the prorated amount to be paid by the Buyer to replace defective Membrane Modules under warranty shall be as specified in the contract or, if not so specified, the price determined by Seller from time to time.

For Membrane Modules supplied under valid warranty claims, the prorated share that the Buyer will pay is calculated as follows:

prorated share of price	=	number of whole months elapsed between the membrane module replacement date and the warranty start date	x	membrane module replacement price
		warranty duration in months		

13 operating information

To maintain the Membrane Module warranty, membrane system operation records from initial start-up date until claim must be maintained by the Buyer and made available to the Seller upon request. Records must be provided in sufficient detail to verify uninterrupted compliance with the Seller's operations and maintenance manual prepared by the Seller and supplied to the Buyer as part of the contract. At a minimum, operation data must include information on feedwater quality, temperatures, flows, trans-membrane pressures, aeration rates, permeate quality, cleaning intervals, cleaning chemical concentrations, elapsed time since start-up, relevant analytical data and reporting of any screen bypass events.

The Buyer shall maintain and share access to a single reference copy in electronic form of a Membrane Module map containing the history of activity by Membrane Module. The Buyer shall log its procedures performed related to a Membrane Module including relocation of Membrane Modules, repairs, replacements and any other noteworthy events.

The Buyer authorizes the Seller to conduct any reasonable review of operation and maintenance records or to inspect facilities where Membrane Modules are installed, upon reasonable notice to the Buyer. Such reviews and/or inspections are intended to also assist the Seller and the Buyer in detection of membrane system faults and to optimize the care and operation of the Membrane Modules.

14 limitation of warranties

Occurrence of any of the following as reasonably determined by the Seller will void this warranty:

- a material failure to operate the membrane system in accordance with Seller's operations and maintenance manual supplied to the Buyer as part of the contract, including material failure to adhere to the Seller's specified Membrane Module cleaning procedures and the use of anything other than Seller-approved Membrane Module cleaning agents
- failure to adhere to the preventive maintenance program as presented in the Seller's operations and maintenance manual, and all published product manuals & specifications
- failure to adhere to all transportation and module storage recommendations as outlined by Seller
- failure to ensure correct operation and/or functioning of the screening equipment.
- introduction of destructive foreign materials into the Membrane Modules and/or associated membrane tanks. Destructive foreign materials may include natural or man-made materials that are introduced into the membranes originating from construction and maintenance activities or from inadequate pretreatment or from aquatic species including clams and snails or from damage to the tank or tank coating. The Buyer shall be responsible to maintain correct function of the screen mechanism and to flush membranes and tanks of any accumulated foreign materials.
- failure to install and maintain operating data acquisition and electronic data transmission functions at the plant

- g) physical abuse or misuse, incorrect removal or installation of Membrane Modules by non-Seller personnel including fiber damage caused by operator error in handling of Membrane Modules or cassettes
- h) unauthorized alteration of any components or parts originally supplied by the Seller
- i) intentional damage

15 return procedure

In the event that the return of a Membrane Module is required pursuant to this warranty, the Buyer will first obtain a Return Goods Authorization (RGA) number from the Seller. Membrane Module(s) shipped to the Seller for warranty examination must be shipped freight prepaid. If the Buyer desires temporary replacement Membrane Module(s) to replace those alleged to be defective and returned to the Seller for warranty examination, the Buyer shall be responsible for the cost associated with any such replacements until examination of the returned Membrane Modules pursuant to this warranty is complete. Any Membrane Module examined by Seller as part of a warranty claim where the Membrane Module is subsequently found to be performing as warranted or where a Membrane Module failure is not covered under the warranty will be returned to the Buyer, freight collect.

appendix c - cutsheets

As submitted to MPE during Engineering Design Phase in BOM & Cutsheet Package.

appendix d – SUEZ Terms & Conditions

general terms and conditions of sale – sale of capital equipment

1. Exclusive Terms and Conditions.

Together with any other terms the Parties agree to in writing, these General Terms and Conditions – together with the last proposal in order of time issued by the Seller – form the exclusive terms ("Agreement") whereby Buyer agrees to purchase, and Seller agrees to sell products and equipment (jointly "Equipment") and to provide advice, instruction and other services in connection with the sale of that Equipment ("Services"). If Buyer sends to Seller other terms and conditions to which Seller may not respond, including but not limited to those contained in Buyer's purchase order, such shall not apply. This Agreement may only be revised by a change order approved in writing by both Parties. All terms not defined herein shall be defined in Seller's proposal.

2. Equipment and Services. The Equipment to be delivered and the Services to be provided shall be as set out in this Agreement. Unloading, handling, storage, installation, and operation of Buyer's systems or the Equipment are the responsibility of Buyer. Buyer shall not require or permit Seller's personnel to operate Buyer's systems or the Equipment at Buyer's site.

3. Prices and Payment. Buyer shall pay Seller for the Equipment and Services in accordance with the payment schedule (as set forth in Seller's proposal or, if applicable, in any special conditions agreed to in writing by the Parties). Unless otherwise specified in writing, payment is due net thirty (30) days from the date of Seller's invoice. Seller may require a Letter of Credit or other payment guarantee, in which case the stated amount of the guarantee will be adjusted by Buyer in the event of any currency-based adjustment to prices or payment amounts per the Payment Schedule, and Buyer shall deliver the adjusted guarantee within five (5) days of request by Seller. Buyer agrees to reimburse Seller for collection costs, including 2% (two percent) interest per month (not to exceed the maximum amount permitted by applicable law), should Buyer fail to timely pay. Buyer shall have no rights to make any deduction, retention, withholding or setoff relating to any payments due under this Agreement.

4. Taxes and Duties Seller shall be responsible for all corporate taxes measured by net income due to performance of or payment for work under this Agreement ("Seller Taxes"). Buyer shall be responsible for all taxes, duties, fees, or other charges of any nature (including, but not limited to, consumption, gross receipts, import, property, sales, stamp, turnover, use, or value-added taxes, and all items of withholding, deficiency, penalty, addition to tax, interest, or assessment related thereto, imposed

by any governmental authority on Buyer or Seller or its subcontractors) in relation to the Agreement or the performance of or payment for work under the Agreement other than Seller Taxes ("Buyer Taxes"). The Agreement prices do not include the amount of any Buyer Taxes. If Buyer deducts or withholds Buyer Taxes, Buyer shall pay additional amounts so that Seller receives the full Agreement price without reduction for Buyer Taxes. Buyer shall provide to Seller, within one month of payment, official receipts from the applicable governmental authority for deducted or withheld taxes. Buyer shall furnish Seller with evidence of tax exemption acceptable to taxing authorities if applicable, prior to execution of the Agreement by both Parties or issuance by the Seller of the order acceptance. Buyer's failure to provide evidence of exemption at time of order will relieve Seller of any obligation to refund taxes paid by Seller.

5. Delivery, Title, Risk of Loss. Unless otherwise specified in this Agreement, Seller shall deliver all Equipment to Buyer FCA (Incoterms 2010) Seller's facility. The time for delivery of the Equipment to Buyer shall be specified in this Agreement. Seller's sole liability for any delay in delivery of the Equipment shall be as expressly set out in this Agreement. The place of delivery specified herein shall be firm and fixed, provided that Buyer may notify Seller no later than forty-five (45) days prior to the scheduled shipment date of the Equipment of an alternate point of delivery, Buyer shall compensate Seller for any additional cost in implementing the change. If any part of the Equipment cannot be delivered when ready due to any cause not attributable to Seller, Buyer shall designate a climate-controlled storage location, and Seller shall ship such Equipment to storage. Title and risk of loss shall thereupon pass to Buyer, and amounts payable to Seller upon delivery or shipment shall be paid by Buyer along with expenses incurred by Seller. Services provided herein shall be charged at the rate prevailing at the time of actual use and Buyer shall pay any increase, and Buyer shall pay directly all costs for storage and subsequent transportation. Failure by Buyer to take delivery of the Equipment shall be a material breach of this Agreement.

Title and risk of loss to the Equipment shall be transferred from Seller to Buyer at the point of delivery upon handover in accordance with this Agreement. Title and risk of loss to the Services shall pass as they are performed.

6. Warranties and Remedies. Seller warrants that Equipment shall be delivered free from defects in material, workmanship and title and that Services

shall be performed in a competent, diligent manner in accordance with any mutually agreed specifications. Seller's warranty does not cover the results of improper handling, storage, installation, commissioning, operation or maintenance of the Equipment by Buyer or third parties, repairs or alterations made by Buyer without Seller's written consent, influent water which does not comply with agreed parameters, or fair wear and tear.

Unless otherwise expressly provided in this Agreement, the foregoing warranties are valid:

- (a) for chemicals and Services, for six (6) months from their date of delivery or the provision of Services;
- (b) for consumables, including filters and membranes (other than membranes for process treatment), twelve (12) months from their date of delivery;
- (c) for membranes for process treatment, ninety (90) days from their date of delivery, ;
- (d) for Equipment other than chemicals and consumables, the earlier of, fifteen (15) months from delivery or shipment to storage, or twelve (12) months from start-up/first use;
- (e) for software, ninety (90) days from the date of receipt;
- (f) for Equipment not manufactured by Seller, the warranty shall be the manufacturer's transferable warranty only,

Any claim for breach of these warranties must be promptly notified in writing, and Buyer shall make the defective item available to the Seller, or the claim will be void. Seller's sole responsibility and Buyer's exclusive remedy arising out of or relating to the Equipment or Services or any breach of these warranties is limited to repair at Seller's facility or (at Seller's option) replace at Seller's facility the defective items of Equipment, and re-perform defective Services. In performance of its obligations hereunder, Seller will not control the actual operation of either Buyer's systems or the Equipment at the Buyer's site.

Warranty repair, replacement or re-performance by Seller shall not extend or renew the applicable warranty period.

The warranties and remedies are conditioned upon (a) proper unloading, handling, storage, installation, use, operation, and maintenance of the Equipment and Buyer's facility and all related system in accordance with Seller's instructions and, in the absence, generally accepted industry practice, (b) Buyer keeping accurate and complete records of operation and maintenance during the warranty period and providing Seller access to those records, and (c) modification or repair of Equipment or Services only as authorized by Seller in writing. Failure to meet

any such conditions renders the warranty null and void.

Buyer is not entitled to extend or transfer this warranty to any other party. The warranties and remedies set forth in this article are in lieu of and exclude all other warranties and remedies, statutory, express or implied, including any warranty of merchantability or of fitness for a particular purpose.

Unless otherwise expressly stipulated in this Agreement, Seller gives no warranty or guarantee as to process results or performance of the Equipment, including but not limited to product quality, flow, production, capacity, membrane life, chemical consumption, regulatory compliance or energy consumption.

7. General Indemnity. Seller shall indemnify and hold harmless Buyer from claims for physical damage to third party property or injury to persons, including death, to the extent caused by the negligence of Seller or its officers, agents, employees, and/or assigns while engaged in activities under this Agreement. Buyer shall likewise indemnify and hold harmless Seller from claims for physical damage to third party property or injury to persons, including death, to the extent caused by the negligence of the Buyer, its officers, agents, employees, and/or assigns. In the event such damage or injury is caused by the joint or concurrent negligence of Seller and Buyer, the loss shall be borne by each Party in proportion to its negligence. For the purposes of this article (i) "Third party" shall not include Buyer or any subsequent owner of the Equipment, their subsidiaries, parents, affiliates, agents, successors or assigns including any operation or maintenance contractor, or their insurer; and (ii) no portion of the Equipment is "third party property".

8. Compliance with Laws and Permits. All permits, authorizations, and licenses which are required to construct, install and/or operate Buyer's facility or equipment, to use the Equipment, or to manage and dispose of any wastes, discharges, and residues resulting from Buyer's use of the Equipment, shall be obtained and maintained by Buyer at Buyer's sole expense. Buyer is responsible for compliance with all laws and regulations applicable to the storage, use, handling, installation, maintenance, removal, registration, and labeling of all Equipment after delivery of the Equipment, as well as for the proper management and disposal of all wastes, discharges, and residues.

9. Buyer's Site Conditions. Buyer warrants that any data furnished to the Seller concerning conditions at Buyer's site (including but not limited to any existing Buyer facility, equipment or processes, influent water or other substances to be treated or measured with the Equipment) is accurate and complete, and the Seller reserves the right to utilize

the most appropriate design compatible with generally accepted engineering practices, and to make changes in details of design, manufacture and arrangement of Equipment unless precluded by any limitations specified in this Agreement. Seller shall notify Buyer of (1) any conditions at Buyer's site which materially differ from those indicated in the data furnished by Buyer, (2) any previously unknown physical conditions at Buyer's site of an unusual nature, not revealed by previous investigations and differing from those ordinarily encountered in the type of work provided for in this Agreement, and (3) the presence of any Hazardous Materials (as defined below), the existence of a contaminated soil, unexploded ordnance, or archaeological remains. If such conditions cause an increase in Seller's cost or in the time required for the performance of Seller's obligations, Seller shall be entitled to an equitable adjustment in the Agreement Price and an extension in the time for performance.

10. Hazardous Materials and Wastes. In the event that Seller encounters any Hazardous Materials (meaning toxic substances, hazardous substances, pollutants, contaminants, regulated wastes, or hazardous wastes as such terms may be defined or classified in any law, statute, directive, ordinance or regulations promulgated by any applicable governmental entity) at Buyer's site, other than Hazardous Materials introduced by Seller or that are otherwise the express responsibility of Seller under this Agreement, Buyer shall immediately take whatever precautions are required to legally eliminate such Hazardous Materials so that the Seller's work under this Agreement may safely proceed. At no time shall Seller be deemed to have taken title to or the responsibility for the management or disposal of any wastes, Hazardous Materials, influent water, any resultant product streams, wastewater streams, discharges, cleaning materials, or any other materials or substances processed by the Equipment or otherwise located at Buyer's site. Seller does not take responsibility for and hereby expressly disclaims responsibility for the characterization of wastes, Hazardous Materials, or for the identification, selection, or management of disposal facilities for any wastes.

11. Excusable Delays. Seller shall not be liable nor in breach or default of its obligations under this Agreement to the extent performance of such obligations is delayed or prevented, directly or indirectly, due to causes beyond the reasonable control of Seller, including, but not limited to: acts of God, natural disasters, unusually severe weather, fire, terrorism, war (declared or undeclared) epidemics, material shortages, insurrection, act (or omissions) of Buyer or Buyer's suppliers or agents, any act (or omission) by any governmental authority, strikes, labor disputes, transportation shortages, or vendor

non-performance. The delivery or performance date shall be extended for a period equal to the time lost by reason of delay or non-performance, plus such additional time as may be necessary to overcome the effect of the delay or non-performance. If delivery or performance is delayed for a period exceeding 180 (one hundred and eighty) days, either Party may terminate this Agreement without further liability provided that Seller shall be paid an amount equal to that which would be payable to Seller under the article entitled "Termination". If Seller is delayed by any acts (or omissions) of Buyer, or by the prerequisite work of Buyer's other contractors or suppliers, Seller shall be entitled to an equitable adjustment in schedule, price and/or performance, as applicable.

12. Emergencies. If the safety of Seller's personnel is threatened or likely to be threatened by circumstances outside the reasonable control of Seller, including but not limited to war, armed conflict, civil unrest, riots, terrorism, kidnapping, presence of or exposure to hazardous materials, unsafe working conditions, or by the threat of such circumstances or a lack of adequate protections against such circumstances, Seller shall be entitled to take all necessary steps to ensure the security and safety of its personnel including the evacuation of personnel until such circumstances no longer apply. Any such occurrence shall be considered an excusable delay event. Buyer shall reasonably assist in the event of any such evacuation.

13. Confidentiality, Intellectual Property. Both Parties agree to keep confidential the other Party's proprietary non-public information, if any, which may be acquired in connection with this Agreement. Buyer will not, without Seller's advance written consent, subject Equipment to testing, analysis, or any type of reverse engineering. Seller retains all intellectual property rights including copyright which it has in all drawings and data or other deliverables (including the Equipment) supplied or developed under this Agreement. Buyer agrees that it will not file patent applications on the Equipment or any development or enhancement of the Equipment, or of processes and methods of using the Equipment, without Seller's express prior written permission. Buyer further agrees that in any event any such patents will not be asserted against Seller or its other buyers based upon purchase and use of such Equipment. Seller grants to Buyer a non-exclusive, non-terminable, royalty free license to use the intellectual property embedded in Equipment delivered to and paid for by the Buyer, as well as any drawings, design or data delivered to and paid for by the Buyer, for the purposes of owning, financing, using, operating and maintaining the relevant Equipment at Buyer's site. Such license may only be assigned to a subsequent owner of the Equipment or to an operations and maintenance subcontractor. Such license does not extend to the re-

creation of the Equipment or the manufacture of spares or consumables by Buyer or third parties

Any software Seller owns and provides pursuant to this Agreement shall remain Seller's property. Seller provides to Buyer a limited, non-exclusive and terminable royalty free project-specific license to such software for the use, operation or maintenance at Buyer's site of any Equipment purchased hereunder to which the software is a necessary component. Buyer agrees not to copy, sub-license, translate, transfer, reverse engineer, or decode the software.

Seller shall indemnify and hold harmless Buyer from any rightful claim of any third party that any Equipment or Service infringe a patent in effect in the USA, or country of delivery (provided there is a corresponding patent issued by the USA), or USA copyright or copyright registered in the country of delivery. If the Buyer notifies the Seller promptly of the receipt of any such claim, does not take any position adverse to the Seller regarding such claim and gives the Seller information, assistance and exclusive authority to settle and defend the claim, the Seller shall, at its own expense and choice, either (i) settle or defend the claim and pay all damages and costs awarded in it against the Buyer, or (ii) procure for the Buyer the right to continue using the Equipment or Service, or (iii) modify or replace the Equipment or Service so that it becomes non-infringing, or (iv) remove the infringing Equipment and refund the price. The above paragraph shall not apply to any misuse of Equipment or Equipment which is manufactured to the Buyer's design, or to alleged infringement arising from the combination, operation, or use of any Equipment or Services with other equipment or services when such combination is part of any allegedly infringing subject matter. The foregoing list of sub-sections (i), (ii), (iii), and (iv) and related terms state the entire liability of the Seller for intellectual property infringement by any Equipment or Service.

14. Limitations on Liability. Notwithstanding anything else contained in this Agreement, to the maximum extent permitted by law, and regardless of whether a claim is based in contract (including warranty or indemnity), extra-contractual liability, tort (including negligence or strict liability), statute, equity or any other legal theory:

(a) THE TOTAL LIABILITY OF THE SELLER AND OF ITS INSURER FOR ALL CLAIMS ARISING OUT OF OR RELATING TO THE PERFORMANCE OR BREACH OF THIS AGREEMENT OR USE OF ANY EQUIPMENT OR SERVICES SHALL NOT EXCEED THE TOTAL PRICE PAID BY BUYER UNDER THIS AGREEMENT OR (IN THE CASE OF AN AGREEMENT FOR SERVICES WITH A TERM OF MORE THAN ONE YEAR) THE ANNUAL PRICE PAYABLE BY BUYER UNDER THIS AGREEMENT;

(b) IN NO EVENT SHALL SELLER BE LIABLE FOR ANY LOSS OF PROFITOR REVENUES, LOSS OF PRODUCTION, LOSS OF USE OF EQUIPMENT OR SERVICES OR ANY ASSOCIATED EQUIPMENT, INTERRUPTION OF BUSINESS, COST OF CAPITAL, COST OF REPLACEMENT WATER OR POWER, DOWNTIME COSTS, INCREASED OPERATING COSTS, CLAIMS OF BUYER'S CUSTOMERS FOR SUCH DAMAGES, OR FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL, INDIRECT, PUNITIVE OR EXEMPLARY DAMAGES;

(c) SELLER'S LIABILITY SHALL END UPON EXPIRATION OF THE APPLICABLE WARRANTY PERIOD, PROVIDED THAT BUYER MAY CONTINUE TO ENFORCE A CLAIM FOR WHICH IT HAS GIVEN NOTICE PRIOR TO THAT DATE BY COMMENCING AN ACTION OR ARBITRATION, AS APPLICABLE UNDER THIS AGREEMENT, BEFORE EXPIRATION OF ANY STATUTE OF LIMITATIONS OR OTHER LEGAL TIME LIMITATION BUT IN NO EVENT – TO THE EXTENT PERMITTED BY APPLICABLE LAW – LATER THAN FIVE (5) MONTHS AFTER EXPIRATION OF SUCH WARRANTY PERIOD.

For the purposes of this article, "Seller" shall mean Seller, its affiliates, subcontractors and suppliers of any tier, and their respective agents and employees, individually or collectively. If Buyer is supplying Seller's Equipment or Services to a third party, Buyer shall require the third party to agree to be bound by this article. If Buyer does not obtain this agreement for Seller's benefit for any reason, Buyer shall indemnify and hold Seller harmless from all liability arising out of claims made by the third party in excess of the limitations and exclusion of this article.

15. Termination. This Agreement and any performance pursuant to it may be terminated by either Party, and the consequences of such termination shall be as set out in the next paragraph, if the other Party

(a) becomes insolvent, makes an assignment for the benefit of its creditors, has a receiver or trustee appointed for the benefit of its creditors, or files for protection from creditors under any bankruptcy or insolvency laws; or

(b) fails to make any payment when due or to establish any payment security required by this Agreement, or commits a material breach or defaults in its material obligations under this Agreement, and such default is not cured within thirty (30) days of written notice from the other Party.

Upon the termination of this Agreement by Buyer for cause (i) Seller shall reimburse Buyer the difference between that portion of the Agreement price allocable

to the terminated scope and the actual amounts reasonably incurred by Buyer to complete that scope, and (ii) Buyer shall pay to Seller (a) the portion of the Agreement price allocable to Equipment completed, and (b) amounts for Services performed before the effective date of termination. Upon the termination of this Agreement by Seller for cause Buyer shall pay to Seller within thirty (30) days of receipt of invoice the price of all Equipment or Services delivered at the date of termination, plus an amount equal to all costs and expenses incurred in the engineering, sourcing, financing, procurement, manufacture, storage and transportation of the Equipment including materials, work in progress and any cancellation charges assessed against Seller by Seller's suppliers including reasonable overhead and profit on all such costs and expenses. Alternatively, if any schedule of termination payments has been agreed between the Parties, Buyer shall pay to Seller within thirty (30) days of receipt of invoice the amounts set out in that schedule.

16. Governing Law, Dispute Resolution. This Agreement shall be governed by the substantive laws of the State of New York. In the event of a dispute concerning this Agreement, the complaining Party shall notify the other Party in writing thereof. Management level representatives of both Parties shall meet at an agreed location to attempt to resolve the dispute in good faith. Should the dispute not be resolved within thirty (30) days after such notice, the complaining Party shall seek remedies exclusively through arbitration. The seat of arbitration shall be the federal district court in Philadelphia, PA, and the rules of the arbitration will be the Commercial Arbitration Rules of the American Arbitration Association, which are incorporated by reference into this article

Notwithstanding the foregoing, each Party shall have the right to commence an action or proceeding in a court of competent jurisdiction, subject to the terms of this Agreement, in order to seek and obtain a restraining order or injunction to enforce the confidentiality intellectual property provisions set forth in the first two paragraphs of article 13; nuclear use restrictions set forth in article 17, or to seek interim or conservatory measures not involving monetary damages.

17. No Nuclear Use. Equipment and Services sold by Seller are not intended for use in connection with any nuclear facility or activity, the Buyer warrants that it shall not use or permit others to use the Equipment or Services for such purposes, without the advance written consent of Seller. If, in breach of this, any such use occurs, Seller (and its parent, affiliates, suppliers and subcontractors) disclaims all liability for any nuclear or other damage, injury or contamination, and, in addition to any other rights of Seller, Buyer shall indemnify and hold Seller (and its parent, affiliates, suppliers and subcontractors) harmless against all such liability.

18. Export Control. Seller's obligations are conditioned upon Buyer's compliance with all USA and other applicable trade control laws and regulations. Buyer shall not trans-ship, re-export, divert or direct Equipment (including software and technical data) other than in and to the ultimate country of destination declared by Buyer and specified as the country of ultimate destination on Seller's invoice.

19. Changes. Each Party may at any time propose changes in the schedule or scope of Equipment or Services. All changes to the Equipment or Services shall be subject to mutual agreement via a written change order or variation, which shall only become effective once signed by both Parties. The scope, Agreement price, schedule, and other provisions will be equitably adjusted to reflect additional costs or obligations incurred by Seller resulting from a change, after Seller's proposal date, in Buyer's site-specific requirements or procedures, or in industry specifications, codes, standards, applicable laws or regulations. It shall be acceptable and not considered a change if Seller delivers Equipment (including Equipment replacement under warranty) that bears a different, superseding or new part or version number compared to the part or version number listed in the Agreement, provided that in no circumstance shall this affect any other of Seller's obligations including those set forth in article 6.

20. Conflicts; Survival, Assignment. If there is any conflict between this Agreement and any written proposal or quotation provided by Seller, then the terms and conditions set forth in this Agreement shall prevail. If any term or condition of this Agreement or any accompanying terms and conditions are held invalid or illegal, then such terms and conditions shall be reformed to be made legal or valid, or deleted, but the remaining terms and conditions shall remain in full force and effect, and this Agreement shall be interpreted and implemented in a manner which best fulfills Parties' intended agreement. Those provisions which by their nature remain applicable after termination shall survive the termination of this Agreement for any reason. Seller may assign or novate its rights and obligations under the Agreement, in whole or in part, to any of its affiliates or may assign any of its accounts receivable under this Agreement to any party without Buyer's consent, and the Buyer hereby agrees, by signing this Agreement, to such assignment and to execute any document that may be necessary to complete Seller's assignment or novation. This Agreement shall not otherwise be assigned by either Party without the other Party's prior written consent, and any assignment without such consent shall be void

Seller may (i) manufacture and source the Equipment and any part thereof globally in the country or countries of its choosing; and (ii) may subcontract

portions of the Services, so long as Seller remains responsible for such.

21. No third party beneficiary. Except as specifically set forth in the article entitled "Limitations on Liability" and "No Nuclear Use", this Agreement is not intended to, and does not, give to any person who is not a party to this Agreement any rights to enforce any provisions contained in this Agreement.

22. Entire Agreement. This Agreement embodies the entire agreement between Buyer and Seller and supersedes any previous documents, correspondence or agreements between them. No modification, amendment, revision, waiver, or other change shall be binding on either Party unless agreed in writing by the Party's authorized representative. Any oral or written representation, warranty, course of dealing, or trade usage not specified herein shall not be binding on either Party. Each Party agrees that it has not relied on, or been induced by, any representations of the other Party not contained in this Agreement.

23. USA Government Contracts. This article 23 applies only if the Agreement is for the direct or indirect sale to any agency of the USA Government and/or is funded in whole or in part by any agency of the USA Government. Buyer agrees that all Equipment and Services provided by Seller meet the definition of "commercial-off-the-shelf" ("COTS") or "commercial item" as those terms are defined in Federal Acquisition Regulation ("FAR") 2.101. To the extent the Buy American Act, Trade Agreements Act, or other domestic preference requirements are applicable to this Agreement, the country of origin of Equipment is unknown unless otherwise specifically stated by Seller in this Agreement. Buyer agrees that any Services offered by Seller are exempt from the Service Contract Act of 1965 (FAR 52.222-41). Buyer represents and agrees that this Agreement is not funded in whole or in part by American Recovery Reinvestment Act funds unless otherwise specifically stated in the Agreement. The version of any applicable FAR clause listed in this Section 18 shall be the one in effect on the effective date of this Agreement. If Buyer is an agency of the USA Government, then as permitted by FAR 12.302, Buyer agrees that all paragraphs of FAR 52.212-4 (except those listed in 12.302(b)) are replaced with these Terms and Conditions. Buyer further agrees the subparagraphs of FAR 52.212-5 apply only to the extent applicable for sale of COTS and/or commercial items and as appropriate for the prices under this Agreement. If Buyer is procuring the Equipment or Services as a contractor, or subcontractor at any tier, on behalf of any agency of the U.S Government, then Buyer agrees that FAR 52.212-5(e) or 52.244-6 (whichever is applicable) applies only to the extent applicable for sale of COTS and/or commercial items

and as appropriate for the prices under this Agreement.

appendix e – aftermarket services

appendix e: Aftermarket Services Detailed

SUEZ is a proven leader in delivering tangible value to our clients over the life of the plant. Our measure of success is how well we deliver solutions that help our clients meet their critical business objectives in each and every year of operation.

SUEZ has distinguished itself from other UF membrane manufacturers with the quality and range of post-commissioning service support offered to its clients. After initial project start-up and commissioning is complete, SUEZ equipment system owners have access to comprehensive support through flexible, responsive, and professional service packages. SUEZ has developed the systems and technical expertise necessary to anticipate and resolve any process or equipment problem.

For ZeeWeed membrane systems alone, SUEZ has 110 service staff in North America including:

- ☐ technical support staff for 24/7 emergency telephone support;
- ☐ process support engineers and technicians;
- ☐ system controls staff;
- ☐ local field service representatives;
- ☐ pre- or post-commissioning training staff;
- ☐ spare parts personnel;
- ☐ warranty support and service planning specialists, and
- ☐ regional lifecycle managers.

1.1.1 24/7 telephone technical support

SUEZ's 24/7 telephone technical support provides operators with access to a team of specialists who provide operations, control, or process support to help to keep plants online if the MBR systems are forced to operate outside of design conditions.

Plant operators can call the telephone number provided below for technical support.

Telephone, toll free in North America:	+1 866-271-5425
Outside North America:	+1 905-469-7723
Daytime Hours email address	Suez.technicalsupport.wts@suez.com

calls during business hours

For the life of the system, Plant operators have telephone access to a skilled SUEZ technical support specialist who will assist plant operators in troubleshooting of system problems such as electrical (PLC/HMI), mechanical and process control issues.

calls after-hours - emergency telephone technical support

Our technical support team is always on call and is equipped with system information to effectively talk a plant operator through an emergency, potentially averting loss of plant production and expensive call outs. The telephone technical support group maintains access to all plant drawings for rapid reference during 24/7 support calls. The telephone technical support group has portable computers equipped to access the plant control

system remotely, in order to gain a better understanding of the situation, and to make any necessary adjustments to control set-points or software. Remote access requires a high-speed internet connection at your facility and requires that you have permissions set up in advance. The technical support specialist will manage the resources needed within SUEZ to assist you in resolving your plant issues. All client issues are tracked through to resolution using SUEZ's state-of-the-art issue tracking software.

1.1.2 InSight

InSight leverages the power of the internet to monitor plants and ensure ease of operability and maintainability. SUEZ's cloud-based knowledge management platform provides the means to capture and translate data into valuable information, ultimately providing the knowledge you need to get the most out of your water and process applications that support production assets, at the lowest total cost of operation.

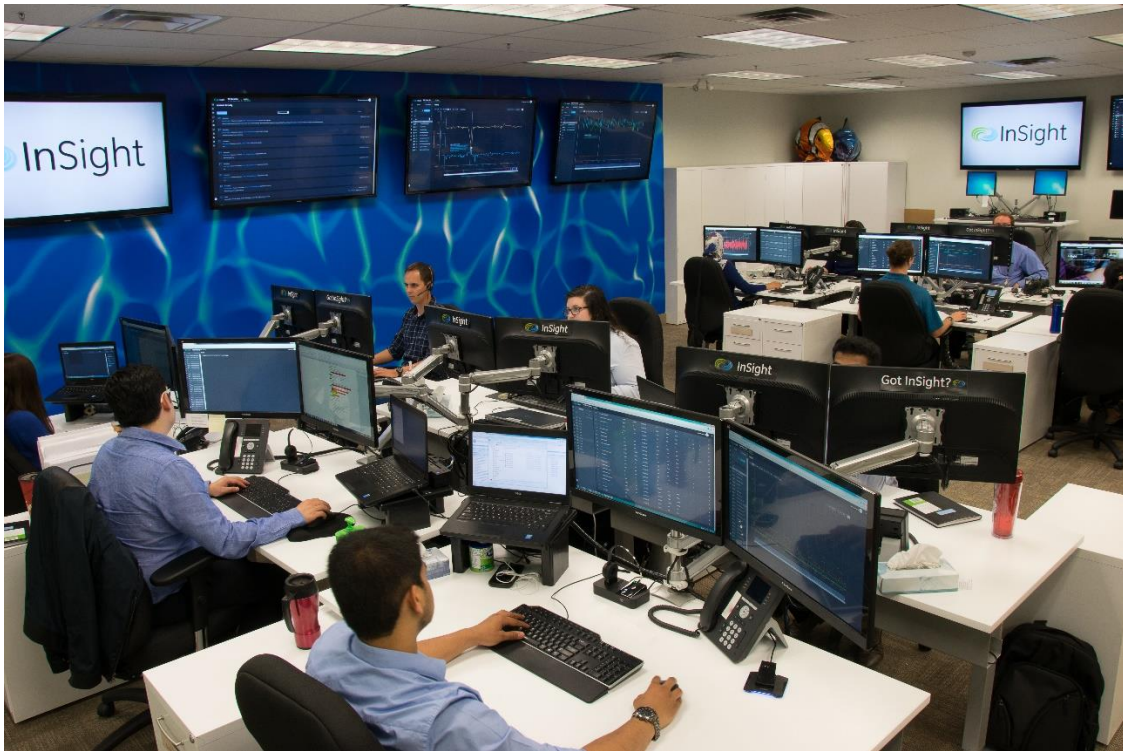
You are leading your team away from a model where when something breaks, we fix it, to a model where we predict and prevent equipment from breaking in the first place. As manager of a membrane treatment process, you are challenged to lead with foresight and prudent decision-making, maintaining a watchful eye on the long term issues of your plant:

- ❑ Avoiding operational interruptions and loss of revenue moving with our customers toward zero unscheduled downtime
- ❑ Maximizing the useful life of membranes and equipment
- ❑ Reducing operating and maintenance costs including chemical and energy costs
- ❑ Reducing non-value added labor – optimizing operator efficiency and usage

InSight provides:

- ❑ **analytics:** InSight allows review of historical and current plant performance against success criteria.
- ❑ **early detection and alarming:** InSight helps operators detect emerging problems, so that action can be taken before a failure is experienced in the future.
- ❑ **productivity:** InSight's automated data collection reduces the tedious work of entering and reporting operator-collected data, including data required for membrane warranties. InSight helps staff get more done with tools that enhance their personal productivity, enabling them to see and do more.
- ❑ **reporting:** InSight's automated performance reports highlight operational details for key performance indicators.
- ❑ **membrane replacement strategy:** InSight data provides the information needed to plan a cost effective strategy for membrane replacement and upgrades with a deep understanding of factors affecting membrane performance
- ❑ **mobility:** Provides smartphone or tablet access allowing the user the same abilities to see system health, current data, trends, reports and even enter operational data and notes.
- ❑ **security:** Archives all plant data securely in an off-site central database. Data is password protected.

- **data sources:** Allows for data to be acquired from a wide range of sources and modes of capture – including automatic (wired and wireless) and direct manual data entry



InSight Pro

InSight Pro puts a professional SUEZ process expert onto your team, collaborating to empower your operating team to apply the power of InSight.

The process expert is specifically assigned to your plant and will monitor key parameters on a regular rhythm using the InSight platform. The process expert will be in regular contact with the key members of your operations team to discuss and resolve performance, process and operational issues. While supporting your operations team with day-to-day issues, the process expert will also use InSight to bring attention to long term trends and provide operational recommendations.

As part of InSight pro, the process expert provides bi-weekly process reports with analysis of key trends and recommendations to support plant operation, membrane cleaning and overall performance. In addition, an annual summary performance report is provided.

If the need for troubleshooting does arise, your SUEZ process expert is accessible, familiar with your system and empowered with accurate information to assist.

1.1.3 site visits

SUEZ and English River 1st Nations Reserve will cooperatively plan the time allotted to service visits to complete priority activities identified by English River 1st Nations Reserve or selected from the scope of service below and produce maximum value from the service visit. Not all items in this scope or checklist are necessarily performed on

every visit. The SUEZ field service representative (FSR) and the plant operators will initially define priority deliverables and jointly revise these priorities as required. Activities to monitor, diagnose and repair membrane issues will take precedence over other activities.

process monitoring

- ☐ Inspect and confirm proper operation of the membrane system in accordance with the SUEZ operation & maintenance manual.
- ☐ Review operating logs, analytical tests and InSight data (if available) with the operator(s). Discuss operator concerns and SUEZ issues emerging from this review.
- ☐ Discuss imminent seasonal shifts. Plan and implement forward looking adjustments.
- ☐ Advise the operations manager of technical updates as they become available from SUEZ.

membrane integrity

- ☐ Evaluate the aeration patterns in the tank, inspect tank walls and floors.
- ☐ Lift and inspect membrane cassettes, as required to assess condition.
- ☐ Assess pressure decay test or bubble test data as it correlates to the membrane condition and/or permeate water quality. Assist plant operators to repair membrane fibers as required.
- ☐ Assess the effectiveness of on-going membrane cleaning procedures (air scouring, recovery cleaning, maintenance cleaning, relaxation and/or back-pulsing) and provide recommendations to the plant operators as necessary.

controls

- ☐ Review system alarm history, discuss any related issues with operator(s) and recommend appropriate actions to be taken.
- ☐ Perform limited PLC code modifications as planned in advance, secured by proper documentation, dial-in capabilities and file backup precautions.
- ☐ Verify operation of all safety interlock/controllers, pressure switches and temperature switches.

verification of instrument calibration

- ☐ Review set points, verify the condition of all control instruments, sensors, probes, and transmitters, including switching action and output. Assist operators with re-calibration, as necessary.
- ☐ Collaborate with the plant operator in maintaining a log of calibration activities.

preventive maintenance planning

- ☐ Develop a preventive maintenance plan with the plant operator.
- ☐ Review the spare parts provisions with the plant operator and identify any additional parts to provide the desired level of security, including spares related to non-SUEZ equipment.

training

SUEZ recognizes the critical role that training can play in contributing to plant success. While training is integral to the commissioning process, there are times over the life of a plant when additional training is not only desirable but essential. During scheduled site visits, the SUEZ service representative can provide operators with informal training on any areas of concern; to explain the operation, process, maintenance or troubleshooting activities and, in general, to enhance operator ability and confidence.

reporting

SUEZ will provide a report to record membrane condition, tasks accomplished during the visit and identify key operating and maintenance issues.

spares

The SUEZ service representative will review the spares provisions with the plant operator to identify any additional spare parts which should be brought into inventory to provide the desired level of security to the plant including spares related to non-SUEZ equipment.

1.1.4 membrane warranty support

To quickly manage warranty claims, SUEZ Lifecycle Services has a Warranty Coordinator dedicated to that function and that function only. Our Warranty Coordinator has access to all SUEZ resources to ensure timely resolution of problems that may occur.

1.1.5 lifecycle services team

At SUEZ, you can be assured your calls will be answered by a passionate group of individuals who truly believe that a warm and professional response to callers will help in the resolution of the most impactful issues to your plant.

Our team of specialists is comprised of Technicians, Technologists and Engineers with years of field service and commissioning experience that can help you resolve process, mechanical, electrical and programming issues.

partnership communication

SUEZ knows the importance and long-term implications involved in selecting a membrane supplier. SUEZ is committed to building a partnership with English River 1st Nations Reserve and believes communication is the essential ingredient to achieve this. SUEZ invests in the partnership through the following communication mechanisms,

- ☐ Access to a Regional Lifecycle Manager (RLM)
- ☐ Participation in the ZeeWeed Users Group
- ☐ Customer Forums
- ☐ Dedicated Warranty Coordinator

1.1.6 regional lifecycle manager – SUEZ water services

The Regional Lifecycle Manager (RLM) will act as the SUEZ Water Services “quarterback”, engaging in frequent communication with plant staff, ensuring timely access to all the technical resources provided by SUEZ. The RLM will also design a schedule and package of services suited to your needs and budget, including:

- ☐ Additional years of 24/7 Telephone Technical support coverage
- ☐ Additional years of InSight
- ☐ Greater frequency of site visits and or special provisions for emergency site visits
- ☐ Plant optimization and plant upgrades
- ☐ Membrane replacement planning/budgeting
- ☐ Membrane cleaning studies