

Part 1 General

1.1 MEASUREMENT AND PAYMENT

- .1 **METHOD OF MEASUREMENT** – Measurement for "Booster Pump Station" will be based on lump sum of the centrifugal pump station supplied and installed as indicated on the plans and drawings and described in the Specifications. Centrifugal pump (2 units), pressure maintenance pump, electrical connections, panel, controls, VFDs, suction and discharge piping, intake screen, valves, and all associated appurtenances shall be considered incidental to "Booster Pump Station".
- Measurement for "Submersible Pumps" will be based on unit price of the submersible pumps supplied and installed as indicated on the plans and drawings and described in the Specifications. Submersible pumps (3 units), electrical connections, valves, piping, connections, split flange, cables, and all associated appurtenances shall be considered incidental to "Submersible Pumps".
- .2 **BASIS OF PAYMENT** – Payment for "Booster Pump Station" shall be based on the Contract Unit Price for "Booster Pump Station" measured as specified herein which shall be payment in full for those operations described on the plans and drawings and in the Specifications for those operations incidental to the Work for which no price or prices or provisions for payment are included in the Contract.
- Payment for "Submersible Pumps" shall be based on the Contract Unit Price for "Submersible Pumps" measured as specified herein which shall be payment in full for those operations described on the plans and drawings and in the Specifications for those operations incidental to the Work for which no price or prices or provisions for payment are included in the Contract.

1.2 SUBMITTALS

- .1 **Shop Drawings:** Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .1 Pump: make, model, weight, and horsepower.
- .2 Complete catalogue information, descriptive literature, specifications, dimensions, and identification of materials of construction.
- .3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately design points, head, capacity, horsepower demand, and overall efficiency at duty point.
- .1 Provide the above data curves in both single pump and parallel pumping operation.
- .2 Show system curve and multiple pump speed curves on graph
- .4 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances.
- .5 Power and control wiring diagrams, including terminals and numbers.
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- .6 Complete motor nameplate data, as defined by NEMA, from motor manufacturer.
 - .7 Factory finish system.
 - .8 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances
 - .9 Sequence of operations document describing the system operation to be used as the basis for the programming of the control system.
 - .10 Start-up instructions including lubricant requirements, electrical requirements, etc.
 - .11 List special tools, materials, and supplies furnished with equipment for use prior to and during start-up and for future maintenance, if any.
- .2 Quality Control Submittals:
- .1 Factory test reports.
 - .2 Special shipping, storage and protection, and handling instructions.
 - .3 Suggested spare parts list to maintain equipment in service for period of one (1) year and five (5) years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

Part 2 Products

2.1 PRESSURE MAINTENANCE PUMP: PM-1

- .1 Pressure maintenance pump to be submersible with stainless steel body, impeller, and motor; materials suitable for ocean-water applications.
- .2 Leak detection and over-temperature detection
- .3 Provide appropriate length submersible power cable from manufacturer to extend full distance from pump location to booster pump station, field-confirm this power cable length requirement.
- .4 Built-in non-return valve and 50mm (2") NPT discharge
- .5 Enclose pressure maintenance pump in 150mm (6") diameter PVC flow sleeve c/w stainless steel intake screen.
- .6 Performance: 0.95 L/s @ 91.4m (15 USgpm @ 300 ft) of head, 1.1 kW (1.5 HP) motor, 600V/3ph.
- .7 Cut-in pressure shall be 758 kPa (110 psi). Cut-out pressure shall be 827 kPa (120 psi).
- .8 Acceptable product: Grundfos 16S or approved equal

2.2 BOOSTER PUMPS: BP-1, BP-2

- .1 Provide outdoor application rated self-priming centrifugal irrigation booster pumps intended for clear water and surface water. Pumps shall be piped in parallel and capable of the following design condition:
 - .1 Total flowrate with both pumps running simultaneously: 82 L/s (1300 USgpm) at 108 m T.D.H. (355 ft w.c.)
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- .2 Minimum flow rate (at minimum VFD speed) with one pump running: 3.2 L/s (50 USgpm) at 85 m T.D.H. (280 ft w.c.)
- .3 Ability to run dry, and self-prime with static lift of 3 m (10 ft) and 250mm (10") diameter suction pipe length of 20 m (67 ft)
- .2 Furnish pump with 75kW (100 hp) TEFC electric motor rated at 600V, 60 cycle, three phase, sized to be non-overloading for the selected impeller size it's the maximum RPM.
 - .1 The motors shall be inverter duty rated for use with a VFD, and capable of driving the pumps continuously through the entire range of pump operation without increasing the temperature of the windings above the insulation rating. Pump units shall be supplied with sufficient length of operating cable for connection to panel.
- .3 Horizontal pump discharge, stainless steel construction, replaceable wear rings, 416 stainless steel shaft sleeve, solids handling [12.7mm (½") diameter] impeller
- .4 Maximum working pressure 1724 kPa (250 psi)
- .5 Seal: Run-Dry oil lubrication system. Single mechanical seal with Viton elastomers, stainless steel hardware and tungsten- vs. silicon-carbide seal faces
- .6 Check Valve: SwingFlex® Val-Matic®
- .7 Bearings: Heavy duty, grease lubricated, deep groove ball bearings, with a minimum of 50,000 hours bearing life
- .8 Hardware: Stainless steel float linkage. A positive seating vacuum priming valve prevents water carry-over to the vacuum, pump or atmosphere
- .9 Vacuum Pump – 85 standard m³/hr (50 SCFM) Maximum
- .10 Acceptable product: Cornell 2.5YH c/w Redi-Prime system
- .11 Pumps and appurtenances to be mounted on a single skid, delivered to site ready for connection to irrigation pipe and reservoir pipes.
- .12 Pump supplier to be on-site for commissioning, testing, and adjustment.

2.3 SUBMERSIBLE PUMPS: SP-1, SP-2, SP-3

- .1 Provide submersible pumps intended for clear water and surface water. Pumps shall be piped in parallel and capable of the following design condition:
 - .1 Total flowrate of each pump: 31.5 L/s (500 USgpm) at 15.2 m T.D.H. (50 ft w.c.)
 - .2 System design to have pumps cycling with 2 pumps operating at a time at a flow rate of 63 L/s (1000 USgpm) and 15.2 m T.D.H. (50 ft). Controls to alternate for Pump Cycle #1: SP-1 and SP-2, Pump Cycle #2: SP-1 and SP-3, Pump Cycle #3: SP-2 and SP-3, etc. Option for pump maintenance and operation of only 2 pumps to be included.
 - .3 Pumps to be set with pump intake at maximum Elev. 354.5 m.
 - .2 The pump shall be selected such that the duty point of each pump during parallel operation does not exceed the end-of-curve condition for single pump operation.
 - .3 The pumps shall be constant speed.
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- .4 The three submersible pumps will operate based on water level in the reservoir using a float.
- .5 Each pump to have a drain to allow for draining of the discharge line when not in service.
- .6 Acceptable product: Berkeley 6MTH10-450
- .7 Pump supplier to be on-site for commissioning, testing, and adjustment.
- .8 Submersible pump controls to be combined with booster pump station controls.
- .9 Pumps to be fitted with a saddle or trolley to ensure pump intake is not in direct contact with the HDPE casing. This fitting to be according to pump supplier recommendation and not to prohibit installation of the pump within the casing.
- .10 The pumps are to be fitted with 2 – 9.5 mm stainless steel cable. One cable to attach to the split flange to hang the pump within the casing. The other cable to extend through the flange, with loop and sleeve to facilitate pulling of the pump out of the casing.
- .11 Pump riser pipe to be 150 mm diameter SDR 21.

2.4 BOOSTER PUMPS AND SUBMERSIBLE PUMPS: CONTROL PANEL

- .1 Provide new NEMA 4 rated enclosure for the control panel. Refer to Section 260531 – Splitters, Junction, Pull Boxes and Cabinets for specification of cabinet requirements.
 - .2 Cabinet shall be equipped with environmental controls to suit operation of equipment with 40°C ambient air temperature, and to suit storage of equipment with -40°C ambient air temperature.
 - .3 Provide an internal door to mount all operating mechanisms for disconnect switches indicated on electrical single line diagram. All disconnect switches shall have padlock provisions when switch is in the opened position. Internal door shall be dead front rated.
 - .4 Provide an external main disconnect switch suitable for electrical service entrance, rated for 400 amps, 600 Volts, 3 phase, 3 wire.
 - .5 Provide variable frequency drives (VFD) as indicated on the drawings. VFDs shall be Toshiba AS1 series or approved equivalent.
 - .6 Provide full voltage non-reversing (FVNR) starters for the well/irrigation pumps, and the pressure maintenance submersible pump in accordance with Section 262910 – Motor Starters to 600 V.
 - .7 Distribution equipment shall include a panelboard to house bolt-on breakers to supply all equipment as indicated on electrical single line diagram.
 - .8 Provide LED luminaire within the enclosure controlled by a door switch to illuminate enclosure interior.
 - .9 Provide a Surge Protection Device (SPD) connected to the 600 V distribution with the following ratings and features:
 - .1 Maximum rated surge current of 120kA per phase and 60kA per mode
 - .2 Safety listed to UL-1449 third edition for type 1 and type 2 locations
 - .3 200kA IC short circuit current rating
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- .4 Response time less than 1 nanosecond
 - .5 One status indicating light per phase and component level fusing
 - .6 30 year unlimited replacement warranty
 - .7 Acceptable material includes Total Protection Solutions, ServiceTrack Series or approved equivalent.
 - .8 The SPD shall be mounted as close as possible to branch circuit breaker, with maximum lead length of 300mm.
 - .10 Harmonic filters shall be provided on the line side of the VFDs for harmonic mitigation to suit Manitoba Hydro Power Quality Specification PQS2000. Acceptable materials include Mirus Lineator AUHF series or approved equivalent, sized to suit motor horsepower rating. If harmonic filters are mounted external to the control panel, they shall be equipped with a Type 3R enclosure.
 - .11 Load reactors shall be provided on the load side of the VFDs, sized to suit motor horsepower rating, with 3% impedance. If load reactors are mounted external to the control panel, they shall be equipped with a Type 3R enclosure.
 - .12 Skid should be pre-wired except for the well pumps, jockey pump (pressure maintenance pump), level switches and power supply wiring.
 - .13 Provide a Programmable Logic Controller (PLC) with sufficient inputs and outputs to accommodate all discrete and analog signals, and with programming to meet the requirements for the operation of the well pumps and booster pumps. Programming shall include but not limited to the following:
 - .1 Pressure control between the pressure transducer and the booster pumps through a PID loop, with pressure set-points adjustable through the HMI.
 - .2 Record flow information for daily, monthly, and annual flow totals based on a pulse input from the flow transmitter.
 - .3 Control all pump start/stop operations based on process requirements and record pump run time.
 - .4 Monitor level in reservoir through four (4) level switches and start/stop well/irrigation pumps as required. Level switches shall provide the following functions:
 - .1 High-high level for well/irrigation pump shutdown directly connected to motor control circuits, and a signal to the PLC.
 - .2 High level for well/irrigation pump stop.
 - .3 Low level for well/irrigation pump start.
 - .4 Low-low level for booster pump shutdown directly connected to the VFD control circuits, and a signal to the PLC.
 - .5 All pumps shall operate on a rotational lead/lag basis to achieve even run time for all pumps.
 - .6 Monitor fault/overload status for all pumps, generate an alarm on the HMI and start an alternate pump if required.
 - .7 Monitor control panel phase imbalance, phase loss, and phase reversal.
 - .8 Record event log of last 300 events with time, date, pressure and flow stamp.
 - .9 Record last 100 alarms with time, date stamp.
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- .14 Install HMI suitable for outdoor installation and on the exterior door of control panel, complete with a 10" colour touch screen.
- .15 Provide all cable tray, wiring and cables as indicated on the drawings associated with contractor supplied control panel and pumps.
- .16 Provide terminal blocks for terminating all field wiring and cables.
- .17 Provide training for local operators on new system and controls.
- .18 Space should be provided for future remote access hardware.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product bulletins, handling, storage, installation instructions, and datasheets.

3.2 EQUIPMENT INSTALLATION

- .1 Dimensions shown on the Drawings for equipment bases and piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided.
- .2 Supply and install all necessary shims, gaskets, any other items required to complete the installation.
- .3 Provide all necessary lifting and loading equipment and all tools required to complete the installation.
- .4 All defects in the operation of the pump shall be made good. Provide 1 year warranty.
- .5 All equipment shall be standard finished and painted at the factory before shipment.

3.3 TESTING

- .1 Pumps shall be subjected to an operating test after installation in accordance with Section 22 14 29.18 – Performance Verification Mechanical Piping Systems. Electrical data on pump performance shall be documented and confirmed acceptable.

END OF SECTION

Part 1 General

1.1 MEASUREMENT AND PAYMENT

METHOD OF MEASUREMENT – No separate measurement will be made for this item. Mechanical piping, valves, and appurtenances associated with the pump stations are incidental to "Booster Pump Station" and "Submersible Pumps".

BASIS OF PAYMENT – No separate payment will be made for this item. Mechanical piping, valves, and appurtenances associated with the pump stations are incidental to "Booster Pump Station" and "Submersible Pumps"

1.2 QUALITY ASSURANCE

- .1 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations latest current editions.
- .2 Use welders fully qualified and licensed by Provincial Authorities.
- .3 Non-specified pipe joining and pipe fitting methods such as T-drill and press fit are not permitted.

1.3 REFERENCED STANDARDS

- .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose
- .2 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings
- .3 ANSI/ASME B31.3, Process Piping
- .4 ANSI/ASME B36.19M, Stainless Steel Pipe
- .5 MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
- .6 ASTM F714-10, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

Part 2 Products

2.1 BOOSTER STATION AND SUBMERSIBLE PUMP STATION STAINLESS STEEL PIPING

- .1 Pipe
 - .1 40mm (1½") and under: 304L stainless steel, ASTM A312 seamless, sch 40s
 - .1 Use sch 80s nipples for threaded instrument connections
 - .2 50mm (2") and over: 304L stainless steel, ASTM A312 seamless, sch 10s
- .2 Fittings and joints
 - .1 Fittings

- .1 40mm (1½") and under: 304L stainless steel, ASTM A182, 3000#, socket-welded
- .2 50mm (2") and over: 304L stainless steel, ASTM A403, sch 10s, butt-welded
- .3 Use long radius elbows (1.5 diameter radius) unless shown otherwise on drawings.
- .4 Branch connections:
 - .1 Equal to main size: tee fitting
 - .2 Down to half of main pipe size: reducing tee fitting
 - .3 Less than half of main pipe size: olet fitting
- .2 Joints: Flanges, as shown on drawings
 - .1 304L Stainless steel, ANSI B16.5 150 lb, flat-face, weld-neck or slip-on
 - .1 Flange facing shall match connecting valve. Use raised-face flanges at wafer or lug-type valves.
 - .2 Flange Gaskets: Full-face gasket, neoprene elastomer, 3mm (1/8") thick, suitable for B16.1 125 lb and B16.5 150 lb flanges
 - .3 Flange Bolting: stainless steel bolts (ASTM A193 B8M class 2) and nuts (ASTM A194 8M)

2.2 RESERVOIR HDPE PIPING

- .1 Mechanical HDPE piping scope:
 - .1 BP-1 and BP-2 suction piping from reservoir to booster station to be HDPE
 - .2 PM-1 discharge piping from reservoir to booster station to be HDPE
 - .3 Pressure relief / drain piping from booster station into reservoir to be HDPE
- .2 Pipe
 - .1 HDPE PE4710 c/w UV protection for outdoor applications
 - .1 Acceptable product: Sandale Utility Products or approved equal
 - .2 Sizes and DR rating as shown on mechanical drawings
- .3 Fittings and joints
 - .1 Provide flanged end-fitting to match connecting 304SS, sch 10s, ANSI Class 150 pipe
 - .2 HDPE stub-ends with coated steel backing rings

2.3 PIPE SUPPORTS

- .1 Pipe supports shall conform to MSS SP-58.
- .2 Pipe support structural attachments, saddles, U-bolt fasteners, nuts, anchors, and accessories shall be stainless steel.
- .3 Support piping using adjustable stanchion saddle-type supports with U-bolt clamp and baseplate. Anchor baseplate to concrete.
 - .1 In lieu of U-bolt clamp for HDPE piping, install Anvil Fig. 432 or equivalent pipe guide clamp with rubber lining.

- .4 Acceptable product: FM Stainless Fasteners pipe supports and fasteners or approved equal

2.4 VALVES

- .1 Ball Valves, 50mm (2") and under:
 - .1 6895 kPa (1000 psi) minimum working pressure, stainless steel ball and 3-piece body, full port, socket-weld connections, PTFE seat
 - .2 Acceptable Products: Flow-Tek, MAS, Apollo, or approved equal
- .2 Butterfly Valves, 75mm (3") to 200mm (8"):
 - .1 1890 kPa (275 psi) minimum pressure rating, ANSI Class 150 lug style flanged connections, quarter-turn handle, bidirectional bubble-tight shutoff, stainless steel body, disc, and stem, resilient seated, PTFE seat
 - .2 Acceptable Product: Dezurik BHP or approved equal
- .3 Check Valves, 50mm (2") to 200mm (8"):
 - .1 ASME class 150 rating, non-slam spring-assisted, center-guided flanged wafer check valve c/w stainless steel body, seat, disc & bushing, 316 SS spring, RF wafer ends, tapped holes in body for lifting lugs
 - .2 Acceptable Product: DFT Inc. ALC or approved equal
- .4 Pressure Relief Valves, 100mm (4"):
 - .1 Pilot operated pressure relief valve, full port, ASME class 150 rating, flanged connections, angle pattern, bronze body
 - .2 Stainless steel stem, nut spring, disc guide, seat & cover bearing, and pilot system materials
 - .3 Buna-N disc and diaphragm
 - .4 1034 kPa (150 psi) set point
 - .5 Minimum relieving flow capacity: 37.9 L/s (600 USgpm)
 - .6 100mm (4") inlet and 100mm (4") outlet.
 - .7 Provide pilot sensing line
 - .8 Acceptable Products: Cla-Val or approved equal

2.5 PRESSURE AND VACUUM GAUGES

- .1 Outdoor application-rated 316 SS dry gauge c/w 150mm (6") dial with $\pm 1\%$ accuracy of full scale, non-liquid filled case, dynamically dampened pointer, 316 SS wetted materials, 316 stainless steel safety case, safety glass lens, 316 SS socket, Buna N gaskets and plugs, 12.7mm ($\frac{1}{2}$ ") bottom NPT connection
- .2 Scale: 0-2000 kPa (0-300 psi) dual scale.
- .3 Provide 30" Hg/kPa vacuum dual scale gauge as shown on drawings for vacuum gauges.
- .4 Acceptable product: Ashcroft c/w Plus! Performance option

2.6 PRESSURE TRANSMITTER: PT-1a, PT-1b

- .1 Outdoor application rated gauge pressure transmitter c/w stainless steel construction, 12.7mm (½") bottom NPT connection, -100 to 2000 kPa (-14.2 to 300 psi) dual scale measurement and local LCD display, 0.025% span accuracy, 4-20mA output.
- .2 Acceptable Product: Ashcroft or approved equal

2.7 FLOWMETER AND TRANSMITTER, FM-1

- .1 Flowmeter:
 - .1 Inline magnetic type flow meter c/w ANSI Class 150 / ASME B16.5 flanged connections, ebonite liner, and local mounted display and transmitter
 - .2 Stainless steel
 - .3 0 to 10 m/s (0 to 32.8 fps) measurement range with 0.2 % ± 2.5 mm/s (0.5 fpm) accuracy
 - .4 Medium temperature: -20°C to 70°C (-4°F to 158°F)
 - .5 Max operating pressure: 1600 kPa (232 psi)
 - .6 Hastelloy C-276 electrodes
 - .7 IP67 (NEMA 4X/6) fibreglass terminal box with two (2) 16mm (½") NPT conduit connections
- .2 Flow transmitter:
 - .1 IP67 (NEMA 4X/6) enclosure with display, and four (4) 16mm (½") NPT conduit connections
 - .2 115 to 230VAC power supply at 50/60 Hz
 - .3 4-20mA output ranged 0 – 100 L/s, with HART communication interface
 - .4 Maximum error shall be less than 1% of flow rate with flow rate between 0 L/s and 100 L/s
 - .5 Contractor to confirm length of cable required between flow meter and flow transmitter. Assume cable length of 15 metres for quote purposes.
- .3 Provide stainless steel instrument tags for flow meter and flow transmitter and fasten to equipment with a twisted stainless steel wire.
- .4 Acceptable Product: Siemens MAG5100 series flow meter, MAG5000 series transmitter, remote wall mount kit, and cable kit, or approved equal

Part 3 Execution

3.1 MATERIAL CONTROL, HANDLING, AND STORAGE

- .1 Precautions shall be taken during handling, fabrication, storage, loading, and installation to protect flange surface finishes and all ends from damage. All ends shall be capped when delivered.
- .2 Piping which has been coated with paint prior to erection shall be handled with care to avoid damage to coatings. Slings protected with fabric or hose sleeves shall be used for lifting.

- .3 Shipping protection provided for pipe, pipe spools, and piping components shall be visually inspected by Contractor when material is received at the site before unloading from truck. Any damaged or deficient protection shall be brought to the attention of Owner for resolution.
- .4 Raw materials, equipment and components shall be protected at all times against exposure to salt water or spray, rain, and moisture from an industrial atmosphere.
- .5 Raw materials and fabricated components shall preferably be stored inside a warehouse. Where this is not possible, storage shall be such that it is out of contact with the ground and has adequate moisture proof coverage. All fabricated items shall have all openings blanked or otherwise sealed with water and moisture tight covers.
- .6 Stainless steel shall be kept out of contact with carbon steel during storage, handling, fabrication, and erection. Carbon steel wire brushes, or grinding wheels that have been previously used on carbon steel, shall not be used on stainless steel.

3.2 WELDING

- .1 Welding shall be in accordance with approved welding procedures registered by or acceptable to the Authority having Jurisdiction.
- .2 Welding shall be performed by certified welders or welding machine operators holding a current pressure welders' authorization issued by or acceptable to the Authority having Jurisdiction. The welder or welding machine operator shall not perform welding utilizing procedure for which he has not been duly authorized.
- .3 Following welding, all oxide scale and heat tint discolouration shall be removed from stainless steel.

3.3 FABRICATION AND ERECTION

- .1 Flange bolt holes shall straddle the vertical centerlines or horizontal north-south, east-west centerlines defined on the piping drawings.
- .2 Pipe spool tolerances shall be as defined in PFI Standard ES-3.
- .3 Longitudinal seams in adjoining lengths of welded pipe shall be staggered and located to clear branch connections and external attachments
- .4 Slip-on flanges shall be seal welded inside, and the weld ground smooth
- .5 The use of backing rings is prohibited.
- .6 Threaded joints shall be tapered pipe threads in accordance with ANSI B2.1
- .7 Threads shall be clean cut with no burrs or stripping
- .8 All threads on piping and fittings shall be thoroughly cleaned of cuttings, dirt and oil before applying pipe dope or tape
- .9 Welding and post-weld heat treatment shall satisfy requirements of the codes and regulatory agencies having jurisdiction over the work. Welding shall be in accordance with approved welding procedures registered by or acceptable to the Authority having Jurisdiction
- .10 Welding shall be performed by certified welders or welding machine operators holding a current pressure welders' authorization issued by or acceptable to the Authority having

Jurisdiction. The welder or welding machine operator shall not perform welding utilizing procedure for which he has not been duly authorized

- .11 Submit Welding Procedure Specifications (WPS), and matching Procedure Qualification Records (PQR), to Departmental Representative for approval. Procedures shall not be submitted for approval until they have been registered with or accepted by the Authority having Jurisdiction. Evidence of this registration or acceptance shall accompany each WPS and PQR submitted to Departmental Representative
- .12 Pipe, pipe spools, and in-line components shall be inspected internally during final installation to ensure they are free of any foreign material. Material shall be removed prior to installation and bolting or welding in place
- .13 Monitor alignment of driver and driven machine shaft coupling with the piping connected and disconnected. Any variation in alignment caused by the piping shall be corrected by modifying the piping until the alignment is within the tolerances specified by the driven equipment manufacturer. Contractor's plan for any corrective work shall be approved by Departmental Representative who will monitor the corrective work
- .14 Bolting - The use of washers or other packing to use up excessive length of flange bolts is not acceptable. The length of machine and stud bolts shall be such that nuts are fully engaged with a minimum of two full threads protruding and that studs are centered
- .15 Lines containing butterfly valves shall be checked to ensure that the interior of mating pipe and flanges are free of any obstructions such as internal weld protrusions before installing the valves. The mating flanges at resilient seat butterfly valves shall be sufficiently separated for ease of installation. The valve shall not be forced or wedged into position which could damage the resilient surfaces. Butterfly valves shall be installed and the disk set in the open position prior to tightening the bolts. After the bolts are tight, the operation of the valve shall be checked through a complete open and shut cycle to ensure that the disk has not been jammed during installation.

3.4 INSTALLATION

- .1 Install valves, flow meters, pressure relief valves, and all equipment as per manufacturer's instructions and recommendations.
- .2 Pipe, pipe spools, and in-line components shall be inspected internally for foreign material during final installation. Material shall be removed prior to installation and bolting or welding in place.
- .3 End protectors shall not be removed from piping and equipment until ready for final connection. Weld end and gasket surfaces shall be inspected for damage when covers are removed. Departmental Representative shall be informed of any damage. Repairs shall not be made without approval of Departmental Representative.
- .4 Piping shall be properly supported to prevent excessive deflection during handling and installation.
- .5 Bolting - The use of washers or other packing to use up excessive length of flange bolts is not acceptable. The length of machine and stud bolts shall be such that nuts are fully engaged with a minimum of two full threads protruding and that studs are centered.
- .6 Valve actuators shall be installed at the orientation indicated on the piping drawings. Actuators shall not obstruct operating aisles or walkways.

- .7 Field-routed piping shall be located such that it does not obstruct walkways, or equipment operation, maintenance, or removal.
- .8 Provide threaded plug in end of all vent and drain valves, material to match valve body.
- .9 Provide dielectric type connections wherever joining dissimilar metals.
- .10 Flanges:
 - .1 Protection of flange face surface finish is required. Precautions shall be taken throughout handling and fabrication operations to protect the gasket surface finish of the flanges.
 - .2 Loose flanges and fittings, other than installing materials, that require attachment by field welding, shall be shipped tack-welded to the piece to which they are to be welded at the point marked FW (field weld) or FFW (field-fit weld).
- .11 Provide additional 16mm electrical conduit from flow meter to flow transmitter to accommodate cables. All conduits shall be same material, installed in similar fashion and along same route as existing conduit system between the flow meter and flow transmitter.

3.5 CLEANING

- .1 Clean interior and exterior of all systems including strainers.
- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.6 INSPECTION AND TESTING

- .1 Inspect and test all piping, valves, flow meters, and all equipment as per the manufacturer's instructions and recommendations.
- .2 Hydrostatically test all lines normally used for the conveyance of liquid using water as the test medium.
- .3 Ensure all lines are filled with water. Bleed air from all high spots using the taps provided specifically for that purpose.
- .4 Zero leakage is permitted throughout the specified test period for all piping
- .5 Inspection and testing standard: ASME B31.3, Normal Fluid Service
- .6 Radiographic examination of welds: 5%
- .7 Test Conditions:
 - .1 Hydrotest stainless steel and HDPE piping, on discharge side of pumps, at 1.5 times design pressure
 - .2 Air-test stainless steel and HDPE piping upstream of BP-1 and BP-2 at full vacuum
 - .3 Design pressure: 1034 kPa (150 psi)
- .8 Give the Departmental Representative 24 hours notice prior to testing

END OF SECTION

Part 1 General

1.1 PUMPING SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform system performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 2 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions
 - .1 Simultaneous parallel pump operation.
 - .1 Duty/standby operation
 - .2 Single pump operation

1.2 SUBMERSIBLE PUMPS – SEQUENCE OF OPERATIONS

- .1 Under normal operating conditions, the submersible pumps operate to maintain the water level in the reservoir between the LWL and HWL, with one of the well pumps being redundant.
- .2 Pump cycling: 2 pumps operating at a time at a total flow rate of 63 L/s (1000 USgpm) and 15.2 m T.D.H. (50 ft). Controls to alternate for Pump Cycle #1: SP-1 and SP-2, Pump Cycle #2: SP-1 and SP-3, Pump Cycle #3: SP-2 and SP-3, etc. Option for pump maintenance and operation of only 2 pumps to be included
- .3 Pumps to operate based on float system within reservoir operating based on LWL and HWL as shown on the Drawings.

1.3 BOOSTER PUMP STATION – SEQUENCE OF OPERATIONS

- .1 PT-1a and PT-1b pressure transmitters are redundant. In the event of a failure of one of the pressure transmitters, the pressure readings used for the sequence of operations shall be taken from the functional pressure transmitter.
- .2 Normal design condition:
 - .1 Under the normal design condition, a single lateral will be operational at a time:
 - .2 If flow at FM-1 drops to less than 1.3 L/s (20 USgpm), then:
 - .1 BP-1 and BP-2 shut off
 - .2 PM-1 works to maintain a pressure of 793 kPa (115 psi) at PT-1a/1b as follows:
 - .1 PM-1 cuts in when pressure drops to 758 kPa (110 psi)
 - .2 PM-1 cuts out when pressure rises to 827 kPa (120 psi)
 - .3 If flow at FM-1 rises to 1.3 L/s (20 USgpm) or greater, OR the pressure at PT-1a/1b drops to 689 kPa (100 psi) or less, then:

- .1 PM-1 shuts off
- .2 BP-1 and BP-2 operate in a duty-standby configuration with VFD varying speed of the duty pump to the following setpoints at PT-1a/1b based on flow detected at FM-1:

FM-1 flowrate, L/s (USgpm)	Corresponding PT-1a/1b setpoint, kPa (psi)
9.5 (150)	800 (116)
18.9 (300)	807 (117)
31.5 (500)	827 (120)
41 (650)	841 (122)

- .3 BP-1 and BP-2 operate in a duty-standby configuration with automatic switchover every 24 hours to ensure equal usage of pumps.
- .4 In the case of automatic switchover during duty pump operation:
 - .1 The standby pump shall speed up while the duty pump is slowing down to ensure smooth flow operation during switchover without flow interruption.
- .3 Future design condition:
 - .1 Under the future design condition, two laterals could be operational simultaneously:
 - .2 If flow at FM-1 drops to less than 1.3 L/s (20 USgpm), then:
 - .1 BP-1 and BP-2 shut off
 - .2 PM-1 works to maintain pressure of 793 kPa (115 psi) at PT-1a/1b as follows:
 - .1 PM-1 cuts in when pressure drops to 758 kPa (110 psi)
 - .2 PM-1 cuts out when pressure rises to 827 kPa (120 psi)
 - .3 If flow at FM-1 rises to 1.3 L/s (20 USgpm) or greater, OR the pressure at PT-1a/1b drops to 689 kPa (100 psi) or less, then:
 - .1 PM-1 shuts off
 - .2 BP-1 and BP-2 operate in a duty-assist (lead-lag) configuration with VFD varying speed of the corresponding pump(s) to the following setpoints at PT-1a/1b based on flow detected at FM-1:

Pump Operation	FM-1 flowrate, L/s (USgpm)	Corresponding PT-1a/1b setpoint, kPa (psi)
Duty pump only	9.5 (150)	800 (116)
Duty pump only	18.9 (300)	807 (117)
Duty pump only	31.5 (500)	827 (120)
Duty pump only	41 (650)	841 (122)
BP-1 & BP-2	44 (700)	848 (123)
BP-1 & BP-2	57 (900)	883 (128)
BP-1 & BP-2	69 (1100)	924 (134)
BP-1 & BP-2	82 (1300)	965 (140)

- .3 BP-1 and BP-2 operate in a duty-assist (lead-lag) configuration with automatic switchover of the duty pump every 24 hours to ensure equal operation of the pumps. The assist pump shall engage when a flowrate of 44.2 L/s (700 USgpm) or greater is detected at FM-1.
- .4 In the case of automatic switchover during duty-only pump operation:
 - .1 The standby pump shall speed up while the duty pump is slowing down to ensure smooth flow operation during switchover without flow interruption.
- .4 PM-1 remains off while BP-1 OR BP-2 are operating.
- .5 All setpoints for PT-1a, PT-1b, and FM-1 shall be field adjustable.
- .6 Contractor shall confirm that each hydrant (H1 through H6) is provided with a minimum supply pressure of 345 kPa (50 psi) throughout the range of flows and sequence of operations listed above. If necessary, setpoints at PT-1a and PT-1b shall be adjusted to achieve this minimum pressure. Document all changes and send to the Departmental Representative.

1.4 PUMPING SYSTEM CAPACITY TEST

- .1 Perform pumping system capacity tests after:
 - .1 Verification of operating, limit, safety controls.
 - .2 Verification of primary and secondary pump flow rates.
 - .3 Verification of accuracy of temperature and pressure gauges.
 - .4 Verification of accuracy of pressure transmitter, PT-1a/1b.
 - .5 Verification of accuracy of flow meter, FM-1.
- .2 Calculate system capacity at test conditions. Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .3 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .4 Verify automatic switchover of parallel pumps in the case of a fault condition detected with one pump, the other parallel pump automatically starts.
- .5 Simultaneous parallel pumping operation system capacity test:
 - .1 Measure the following for each pump for VFD speeds of 100%, 75%, 50%, and minimum speed:
 - .1 Flowrate
 - .2 Amperage draw
 - .3 Suction and discharge pressures
 - .4 Record outdoor ambient temperature and pressure
 - .2 Measure and record flow rate and pressure at which pressure relief valve opens and shuts.
- .6 Single pump operation system capacity test:

- .1 Measure the following for each pump for VFD speeds of 100%, 75%, 50%, and minimum speed:
 - .1 Flowrate
 - .2 Amperage draw
 - .3 Suction and discharge pressures
 - .4 Record outdoor ambient temperature and pressure
- .2 Measure and record flow rate and pressure at which pressure relief valve opens and shuts.

1.5 REPORTS

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports
 - .1 Use data obtained from the system capacity tests to generate system curves showing variable speed and parallel operation plotted with the manufacturer's provided pump curve for the provided impeller size.
 - .2 Plot duty points of each point tested during the capacity test.

1.6 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O&M Personnel

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION