1.00 LIFT STATION CONTROL PANEL – 3-PUMP WITH 5-FLOAT LOGIC

a) GENERAL

1) SCOPE

The scope of this section of the specifications includes the furnishing and installation of a Control Panel, as called for on the plans, complete as described herein, as manufactured by TEI Controls, Cedar Park, Texas (512) 259-2977. All Control Panels shall have the options listed below. The Control Panel shall be capable of controlling a three-pump lift station.

2) ENCLOSURE

The Control Panel electrical devices, components and wiring shall be housed in a Fiberglass Reinforced Polyester (FRP) enclosure with stainless steel hardware. The FRP enclosure shall be rated NEMA 4X. The FRP enclosure shall have a hasp or other attachment to enable the Owner to lock the enclosure with a padlock. No devices or components are to be mounted on the FRP enclosure door or the side, bottom, top or back enclosure walls.

3) DEADFRONT INSIDE DOOR

The Control Panel shall have a Deadfront Inside Door in the FRP enclosure door to limit direct access to the electrical devices, components, and wiring on a separate Backplate. The Deadfront Inside Door shall have graphical representation of a float controlled lift station employing three pumps. The Deadfront Inside Door shall be made of non-conducting plastic material. The maximum voltage attached to the wiring on the backside of the deadfront Inside Door shall not exceed 120 Vac nominal

4) BACKPLATE

The Control Panel shall have an aluminum Backplate inside the FRP enclosure behind the Deadfront Inside Door. The Backplate shall be raised off the back wall of the FRP enclosure. The Backplate shall hold the bulk of the electrical devices, components, and wiring. The Backplate shall have terminals for all connections external to the Control Panel with the exception that the motor starter terminals shall be used for connecting to the motor leads.

5) DOCUMENTATION

Documentation shall be provided on the Control Panel for:

i) Installation, configuration, and operating instructions
ii) Wiring schematic showing all devices and components
iii) Description of Control Panel functions
iv) Replacement parts list

6) INSTALLATION

The installation of the Control Panel and its external connection to the source of power, float switches, pump motors, alarm light and horn, Autodialer, and communications modem shall comply with the National Electrical Code, local supplemental codes, and the recommendations of the Control Panel manufacturer.

7) ACCEPTABLE MANUFACTURERS

i) TEI Controls, 212 Industrial Blvd., Cedar Park, TX 78613 (512) 259-2977
ii) Or pre-approved equal

b) MAJOR ELECTRICAL DEVICES AND COMPONENTS

1) DISTRIBUTION BLOCK

The Backplate shall contain a 240/480-Vac power distribution terminal block for receiving the incoming 240-Vac or 480-Vac power. The distribution block shall be capable of receiving single-phase or three-phase power. The distribution block terminals shall be capable of terminating a #4 AWG power supply conductor.

2) POWER TRANSFORMER

The Backplate shall contain a 240/480-Vac to 120-Vac transformer to supply control power to the Control Panel. The transformer shall have a 250-VA nominal rating. The transformer shall have over-current protection provided by two one-amp fuses on the high voltage coil and one three-amp fuse on the low voltage coil. The low voltage, non-fused output shall be grounded at the transformer and shall utilize white conductor as indicative of a neutral circuit.

3) MOTOR CIRCUIT PROTECTOR

The Backplate shall contain a Motor Circuit Protector for each pump motor. The circuit protector shall incorporate a transient inrush trip suppression mechanism to allow for sustained high transient inrush currents associated with energy efficient motors. The circuit protector shall operate to provide short circuit protection and tripping on low-level faults. The Motor Circuit Protector to be utilized shall be of the Cutler-Hammer HMCPE design or equivalent.

4) MOTOR CONTACTOR/STARTER

The Backplate shall contain a Motor Contactor/Starter for each pump motor.

i) The Motor Contactor/Starter shall include standard overload protection functions and additional detection/protection functions for phase loss and phase unbalance (when 3-phase power is used), and ground fault protection.

ii) The Motor Contactor/Starter shall have selectable trip class and automatic/manual reset of faults.

iii) The individual protection functions shall be capable of being deactivated.

iv) Heater elements shall not be utilized for overload protection.

v) The contactor/starter shall have a Normally-Open auxiliary contact to indicate when the contactor is closed.

vi) The Motor Contactor/Starter shall be connected to an H-O-A Module on the Deadfront Inside Door. The Motor Contractor/Starter faults shall be capable of being reset by push-button on the H-O-A Module without opening the Deadfront Inside Door.

vii) The Motor Contactor/Starter to be utilized shall be of the NEMA rated, non-reversing, Cutler-Hammer, Advantage series, smart-starter design or equivalent.

5) MOTOR STARTER CONTROL MODULE

The Deadfront Inside Door shall contain a Motor Starter Control Module for each pump motor starter. The module shall include H-O-A pushbuttons, a trip reset pushbutton, and indicator LED lights for overload alarm and trip. The Overload Alarm LED Light shall flash to indicate Starter detected overload conditions and shall go solid for an overload trip. The Trip LED Light shall go solid to indicate a

trip for Starter detected phase unbalance, phase loss, or ground fault. The Motor Starter Control Module shall be the Cutler-Hammer WPBFV4 or equivalent.

6) PROGRAMMABLE LOGIC CONTROLLER

The Backplate shall contain a Programmable Logic Controller (PLC). The PLC shall have a RS232 communications port for use with phone or radio serial modems if required. The PLC shall support two-way serial communication in an industry standard protocol such as MODBUS or DH485. The PLC shall contain the programmed logic to control the pumps in the functional manner listed in a following paragraph in this section. The PLC shall contain the programmed logic to detect abnormal conditions and report those conditions through an Autodialer or SCADA system for alarm conditions listed in a following paragraph in this section. The PLC shall have programmed logic to receive the following inputs and generate the following outputs:

i) Digital inputs for silence horn and reset alarms pushbuttons
ii) Digital inputs for pump 1, 2, & 3 running
iii) Digital inputs for pump 1, 2, & 3 over-temperature status
iv) Digital inputs for pump 1, 2, & 3 seal failure detection
v) Digital inputs for five floats
vi) Digital outputs for alarm horn and alarm light
vii) Digital outputs for starting pump 1, 2, & 3
viii) Digital outputs for four Autodialer alarms

7) OPERATOR INTERFACE CONSOLE

The PLC shall have a two-line Operator Interface Console (OIC) which shall allow display of elapsed run times for the pumps and a list of the most recent alarms. This OIC shall be viewable without having to open the Deadfront Inside Door.

8) LED LIGHTS

The PLC shall have LED lights to indicate the status of all digital inputs and outputs. The PLC shall have LED lights to indicate the operational status of the PLC: power on and PLC in run mode. The LED lights shall be viewable without having to open the Deadfront Inside Door.

9) MOISTURE LEAK DETECTION

The Backplate shall contain a moisture leak detector relay for each pump motor to detect seal failure. This relay may be a combination relay with the over-temperature relay for certain types of pumps.

10) OVERTEMPERATURE DETECTION

The Backplate shall contain an over-temperature relay for each pump motor to detect heat buildup in the motor windings.

11) CONTROL POWER SWITCH, PUSHBUTTONS AND FUSING

The Deadfront Inside Door shall have a switch to turn on and off the 120 Vac control power and shall have pushbuttons to silence the alarm horn and to reset the alarms in the PLC. The Backplate shall have a two amp fuse to protect the power circuit for the PLC's digital 120 Vac outputs and a two amp fuse to protect the power circuit going to the floats to drive the PLC's digital inputs.

c) FUNCTIONAL SPECIFICATIONS

1) FIVE FLOAT SYSTEM CONTROL AND OPERATING LOGIC

The pump starter(s) in the Lift Station Control Panel shall normally be controlled by the inputs to the PLC from a set of five floats detecting the liquid level in the wetwell. All floats shall be the "open-when-down" (normally open) type floats. The PLC shall create alarms for high and low level in the wetwell based on inputs from the float system. The PLC shall also provide failure detection of the floats based on two-out-of-three failure logic. The floats shall be placed at varying levels in the wetwell based on the specific design of the wetwell and the specific operational considerations to handle the waste flow.

i) **Low Level Float** – The Low Level Float shall operate as a backup to the Off Float and shall normally be placed at a wetwell level equal to the top of the motor housing of the submersible pump.

ii) **Off Float** – The Off Float shall, when hanging down, cause the PLC to unlatch the call for pump(s) and shall normally be placed at a level a small distance above the Low Level Float.

iii) **Lead Float** – The Lead Float shall, when raised, cause the PLC to latch the call for a lead pump and shall be placed at a level above the Off Float. In the event of Off Float failure, the PLC shall utilize the Lead Float as the Off Float.

iv) **Lag Float** – The Lag Float shall, when raised, cause the PLC to latch the call for a lag pump and shall be placed at a level above the Lead Float. In the event of Off Float failure or Lead Float failure, the PLC shall utilize the Lag Float as the Lead Float.

v) **High Level Float** – The High Level Float shall be placed at a level above the Lag Float. In the event of Off Float, Lead Float, or Lag Float failure, the PLC shall utilize the High Level Float as the Lag Float.

vi) **Float Condition Lights** – The PLC shall had LED Lights to indicate when an input to the PLC is true – the float is raised.

vii) **Fail To Close** – The PLC shall contain logic to determine if the Low Level Float, the Off Float, or the Lead Float failed in the open position.

viii) **Fail To Open** – The PLC shall contain logic to determine if the High Level Float, the Lag Float, or the Lead Float failed in the closed position.

ix) **Float Failure Alarm** – If the PLC detects a float failure, it shall remove the failed float from operational control and set the individual float's failure alarm. The PLC shall indicate the float failure to the Autodialer and to the OIC and shall flash the Alarm Light on a five-second on-off cycle. The PLC shall not activate the Alarm Horn.

x) **Float Failure Reset** – The failure alarm for a specific float shall be reset by the PLC when the digital input from the specific float closes, in the case of fail-to-close, or when the digital input opens, in the case of fail-to-open. All float failure alarms shall also be reset by the Alarm Reset pushbutton on the Deadfront Inside Door.

xi) **Low Level Alarm** – The PLC shall set the Low Level Alarm if the Low Level Float has not failed and if the digital input from the Low Level Float is "off". The Low Level Alarm shall be reset by the PLC when the Lead

Float digital input goes "on". The Low Level Alarm shall also be reset by the Alarm Reset pushbutton on the Deadfront Inside Door. The PLC shall indicate the Low Level Alarm to the Autodialer and to the OIC and shall flash the Alarm Light on a five-second on-off cycle. The PLC shall not activate the Alarm Horn.

xii) **High Level Alarm** – The PLC shall set the High Level Alarm if the High Level Float has not failed and if the digital input from the High Level Float is "on". The High Level Alarm shall be reset by the PLC when the Lead Float digital input goes "off". The Low Level Alarm shall also be reset by the Alarm Reset pushbutton on the Deadfront Inside Door. The PLC shall indicate the High Level Alarm to the Autodialer and to the OIC and shall flash the Alarm Light on a two-second on-off cycle. The PLC shall activate the Alarm Horn.

xiii) **Single Pump Operation** – When the Control Panel is operating a single pump four floats shall be employed instead of five. The fourth float shall be jumpered to the input for both the Lag Float and the High Level Float.

xiv) **Short Cycle Option –** The PLC shall have the internal logic to allow activation of a short pumping cycle. The logic shall include a "short-cycle" timer with a variable period of time, which will act in parallel with the "Lead Float". The short pumping cycle shall be triggered when the liquid level in the wetwell lifts the Off Float starting the short cycle timer, which then times out before the Lead Float is lifted "on".

2) PUMP CONTROL AND OPERATING LOGIC

The PLC shall control the automatic operation of one, two, or three pumps. In multi-pump applications, the PLC shall alternate pump operation to maintain balanced usage. The PLC shall call for a single pump when the Lead Float is raised. The PLC shall call for a second pump when the lag float is raised.

i) **Fail to Run** – The PLC shall have logic to detect when a pump starter has failed to close the contactor or when the pump starter has opened up the contactor under fault conditions. The PLC shall delay for 60 seconds before removing the pump from operation in such circumstances and enabling an alarm. The PLC shall display on the OIC the Fail-to-Run Alarm for that pump

ii) **Overload and Other Starter Detected Faults** – The PLC shall sense starter overload, phase unbalance, phase loss, and ground fault by the condition that the Motor Starter auxiliary contact does not close when the PLC signals the Pump to run. The PLC shall not have LED Lights to indicate these conditions since the indicator lights are already on the Motor Starter Control Module.

iii) **Seal Failure** – When moisture has been detected in the windings of a pump motor, the PLC shall enable an alarm. The PLC shall display on the OIC the Seal Failure Alarm for that pump. The PLC shall also activate for each pump an individual LED Light on its set of outputs to indicate a Seal Failure alarm for that pump.

iv) **Over Temperature** – When an over-temperature condition has been detected in the windings of a pump motor, the PLC shall enable an alarm

and remove that pump from operation. The PLC shall display on the OIC the Over Temperature Alarm for that pump. The PLC shall also activate for each pump an individual LED Light on its set of outputs to indicate an Over-Temperature alarm for that pump.

v) **Pump Failure Alarms** – The PLC shall flash the Alarm Light on a five-second on-off cycle when an alarm condition exists on a pump. The PLC shall not activate the Alarm Horn. The PLC shall indicate to the Autodialer that a pump failure alarm has been activated.

vi) **Pump Failure Reset** – The pump failure alarms shall be reset by the alarm-reset pushbutton on the Deadfront Inside Door. The closing of the Pump Starter auxiliary contact shall automatically reset the "fail to run" alarm. The closing of the Pump Starter auxiliary contact shall automatically reset the seal failure and over-temperature alarms when the "not in seal failure" PLC input is activated and the "not in over-temperature" PLC input is activated respectively.

vii) **Bounce Protection** – The PLC logic shall provide a delayed start on each pump to prevent the pump from being restarted without a rest period. The rest period shall be 60-seconds for Pump 1, 70-seconds for Pump 2 and 80-seconds for Pump 3, which will also eliminate simultaneous start of two pumps when power is restored after an electrical outage.

viii) **Pump Elapsed Run Time Meter** – The PLC logic shall provide accumulators to record the cumulative elapsed run times (ETM) of each pump in hours and minutes. The PLC shall display the ETM on the OIC.

ix) **Number of Pumps** – The PLC program shall have the flexibility to properly operate one, two, or three pumps.

x) **Alternation of Pumps** – If a pump has failed, the PLC shall take the pump out of the alternation routine. The PLC shall not run more than two pumps simultaneously. In a three-pump system, the PLC shall replace the failed pump in both the lead and lag call position.

xi) **Pump Call** - The PLC shall activate for each pump an individual LED Light on its set of outputs to indicate when that pump is being called to run.

xii) **Running and Off** – The Motor Starter Control Module shall activate a individual LED light to indicate when the pump motor is "running" (Red) and when it is "off" (Green).

3) ALARMS AND MISCELLANEOUS FUNCTIONS

Autodialer alarm outputs shall be **normally closed contacts**. If all four contacts open simultaneously, then the multiple alarm condition shall indicate either loss of the Autodialer common voltage, PLC failure, or loss of power to the PLC.

i) **Alarm Output 1** – The PLC shall generate a signal for an Autodialer to indicate level in the wetwell is not high. The PLC shall also activate a LED Light to indicate Autodialer Alarm Output 1 is normal.

ii) **Alarm Output 2** – The PLC shall generate a signal for an Autodialer to indicate all pumps are normal. The PLC shall also activate a LED Light to indicate Autodialer Alarm Output 2 is normal.

iii) **Alarm Output 3** – The PLC shall generate a signal for an Autodialer to indicate all floats are functioning properly. The PLC shall also activate a LED Light to indicate Autodialer Alarm Output 3 is normal.

iv) **Alarm Output 4** – The PLC shall generate a signal for an Autodialer to indicate level in the wetwell is not low. The PLC shall also activate a LED Light to indicate Autodialer Alarm Output 4 is normal

v) **Silence Horn** – The PLC shall lock out the Alarm Horn from continuing to sound when the Silence Horn Pushbutton is pushed. The silence horn latch shall be released after the current high wetwell level alarm condition is cleared.

vi) **Reset Alarms** – The PLC shall reset all alarm latches when the Reset Alarms Pushbutton is pushed. If an alarm condition continues to exist the alarm latch will be reset.

vii) **PLC Operation** – The PLC shall energize a LED Light to indicate that the processor is in run mode.