1. GENERAL

1.1 Work Included

.1 This section describes the operation of the proposed UV disinfection system. The UV disinfection facility will be installed within the existing Deacon Booster Pumping Station (DBPS).

.2 This contract, referred to as the Installation Contract, includes but is not necessarily limited to the following:

- .1 Demolition of existing facilities in the Deacon Booster Pumping Station including piping, valves, stairways, and HVAC systems, etc. City forces will complete demolition of an existing pilot plant and related control room.
- .2 Supply, installation, and commissioning of piping and ancillary works.
- .3 Installation and commissioning of UV equipment, valves and flow meters supplied by others.
- .4 Supply, installation and commissioning of all interconnecting electrical, instrumentation and control systems.
- .5 Supply, installation and commissioning of new mechanical HVAC systems.

2. PRODUCTS

2.1 Process Equipment Numbering

.1 The process equipment has been numbered for identification as follows:

- .1 Existing pumps DE-041-PP-1 to DE-043-PP–3. Future pumps will be DE-044-PP–4 and DE-045-PP-5
- .2 UV Reactors on Branch I, UVR-1100 and UVR-1200
- .3 UV reactors on Branch II, UVR-2100, UVR-2200, UVR-2300, and UVR-2400

3. EXECUTION

3.1 General

.1 Two major operating scenarios exist. The first scenario is for unfiltered water, which will exist from startup to approximately January 2008 when the proposed water treatment plant is expected to be operational. The second scenario is for filtered water, which will exist indefinitely once the proposed water treatment plant is operational.

.2 The DBPS will operate as two independent pump stations; Branch I and Branch II. At present, pumps only exist for Branch II (tag #s DE-041-PP-1 thru DE-043-PP-3). For the existing Unfiltered case, Branch I operates by gravity using available head from the Deacon raw water reservoir cells. Branch II can operate by gravity (through the pumps) or by the existing pumps. For the future Filtered case, all flow in both branches will be pumped.

.3 Branch I delivers water primarily to the MacLean Reservoir and Branch II delivers water primarily to the McPhillips Reservoir. An interconnecting pipe does exist to allow flow from one aqueduct to the other.

.4 Flow through the UV reactors on each branch is set manually by adjusting inlet reservoir valve positions at both MacLean Reservoir and McPhillips Reservoir. The respective reservoir flow rates will be transmitted to the UV Master PLC at the Deacon BPS via the City's existing SCADA system. The UV Master PLC will determine the required number of UV reactors to be in service as well as the required flow split to each reactor.

.5 Branch I has a total of two (2) UV reactors (UV1100 and UV1200) and Branch II has a total of four (4) UV reactors (UV2100, UV2200, UV2300, UV2400). Each reactor has an associated isolation valve (DU-061-SIV-1 thru DU-066-SIV-6), flow meter (DU-061-FE thru DU-066-FE) and modulating valve (DD-061-FCV-1 thru DD-066-FCV-6). The Branch II reactors are configured into two groups with two (2) reactors each.

.6 The UV system shall be controlled through individual Control Power Panels (CPPs) for each reactor. The CPPs will be connected to a common network that uses Modbus Plus for communication to the UV Master PLC system and ultimately, to the Station PLCs and the SCADA system. The UV Master PLC and the individual UV Reactor PLCs will all be Modicon Quantum based systems.

The UV system shall be an automatic dose-paced control system, fully capable of allowing lamps to maintain a target UV dose based on flow rate, lamp intensity, and water quality conditions. The dose-pacing control strategy will be provided by the UV system manufacturer and will reside in each of the individual reactor PLCs. Changes to the proprietary built-in control programming of the UV reactors shall only be made with the approval of the supplier. The UV Master PLC and the existing SCADA system will only provide supervisory control of the UV Reactors.

Each reactor shall be capable of providing a dose of 28 mJ/cm^2 at the following combinations of flow rates and UV transmittance (UVT):

.1 Flow rate of 82 ML/d at UVT of 75% (unfiltered); and

.2 Flow rate of 125 ML/d in Branch I and 102 ML/d in Branch II at UVT of 90% (filtered).

In the event of disruption in power to the PLC controllers, they shall retain the control program in memory.

Alarms shall have adjustable time delays to avoid nuisance alarms.

3.2 Branch I Operating Scenario – Unfiltered Water

.1 Under gravity conditions, up to 109 ML/d of water will flow from the Deacon raw water reservoirs through the Branch I UV reactors and to the City.

.2 For flows up to 82 ML/d, only one (1) UV reactor will be on-line. A flow signal from the McPhillips Control Centre (MCC) will advise the master UV PLC of the flow through Branch I. The selected UV reactor PLC will determine the required number of lamps and power settings based on the design dose and the associated flow meter reading.

.3 For flow between 82 and 109 ML/d, two (2) UV reactors will be on-line. A flow signal from Maclean will advise the master UV PLC the total flow through the two UV reactors, with one reactor operating at maximum flow and the second reactor processing the remaining flow. The UV Master PLC will adjust the respective modulating valves to maintain the required flow rates through each reactor as measured on the associated flow meters.

.4 For flows above 109 ML/d, two (2) UV reactors will be on-line. One reactor will operate at maximum flow with the second reactor processing the remaining flow with the required number of lamps and power settings.

3.3 Branch I Operating Scenario – Filtered Water

.1 All flows though Branch I will be pumped by one or both Branch I pumps (DE-044-PP-4 and DE-045-PP-5). The maximum pumped flow is 250 ML/d.

.2 For flows up to 125 ML/d, one Branch I pump and one (1) UV reactor will be on-line. As described above, the selected UV reactor PLC will control the reactor based on the measured flow in the associated flow meter.

.3 For flows between 125 and 250 ML/d, two (2) UV reactors will be on-line. As described above, one reactor will operate at maximum flow with the other processing the remaining flow. The UV Master PLC will adjust the respective modulating valves to maintain the required flow rates through each reactor as measured on the associated flow meters.

3.4 Branch II Operating Scenario – Unfiltered Water

.1 Up to 209 ML/d will flow by gravity through Branch II. With one pump at low speed, flows will be 180 ML/d. With two (2) pumps at low speed, flows will be 327 ML/d. With two (2) pumps at high speed, flows will be 409 ML/d.

.2 For flows up to 82 ML/d, one (1) UV reactor will be on-line. As described above, the selected UV reactor PLC will control the reactor based on measured flows on the associated flow meter.

.3 For flow between 82 and 164 ML/d, two (2) UV reactors will be on-line, one from each group. One reactor will process the maximum reactor flow, with the other processing the remaining flow.

.4 For flows between 164 and 246 ML/d, three (3) reactors will be on-line, two from one group and one from the other. Two (2) reactors will each process the maximum reactor flows, with the third reactor processing the remaining flow.

.5 For flows between 246 and 328 ML/d, four (4) UV reactors will be on-line, two from each group. Three (3) reactors will process their maximum flow rates, with the fourth reactor processing the remaining flow.

3.5 Branch II Operating Scenario – Filtered Water

.1 All flows will be pumped in this scenario. Flows will vary from 102 ML/d to 409 ML/d.

.2 For flows up to 102 ML/d, one (1) UV reactor will be on-line and will be paced by the respective flow meter.

.3 For flows between 102 and 204 ML/d, two (2) UV reactors will be on-line; one from each group. One reactor will process the maximum reactor flow, with the other processing the remaining flow as described above.

.4 For flows between 204 and 306 ML/d, three (3) UV reactors will be on-line; two from one group and one from the second. Two reactors will process the maximum reactor flows, with the third reactor processing the remaining flow as described above.

.5 For flows between 306 and 408 ML/d, four (4) UV reactors will be on-line, two from each group. Three reactors will process the maximum reactor flows, with the fourth reactor processing the remaining flow as described above.

3.6 Reactor Control

.1 Each UV reactor control can be set in Manual or Automatic mode. When in Manual, the reactor is controlled by the individual CPP and will not respond to supervisory signals from the UV Master PLC. If necessary, the operator can manually control any number of reactors using this feature.

.2 When in Automatic, the reactor will accept set point adjustments from, and will start or stop treating as requested by the UV Master PLC. The reactor operation is fully automatic and controlled to maintain required UV dose for the flow rate and water quality conditions as described above.

3.7 Startup

.1 When the reactor receives a signal to start, lamps are started for a pre-set warm-up period of approximately 5 minutes, irrespective of control mode. After the timed warm-up period, the lamps are automatically switched to the required power setting based on flow rate and water quality.

3.8 Normal Operations

.1 Flow rate, or demand, from Deacon Booster Pumping Station is controlled by external signals generated by flow meters in the branch aqueducts. The flow rates are manually adjusted by City staff and are usually set for one or more days at a fixed rate. On receiving the external signal for increasing flow, or decreasing UVT or lamp intensity, the PLC/CPP's first increase power levels in operating UV reactors. If flow continues to increase, or UVT or lamp intensity continues to decrease, after operating units are at close to full power, additional reactors are energized to match the flow/dose requirement.

.2 On receiving a signal for decreasing flow, power levels are first reduced in operating reactors, then reactors are shut down to match dose requirements if flow continues to decrease.

.3 The modulating valves control the flow through each reactor. On increasing or decreasing demand, the modulating valves adjust to direct the required flow to each reactor. On increasing demand, the reactors are brought on-line at lowest power setting after warm-up. As flow increases, the power setting(s) of the reactor(s) is increased until the flow and/or power setting is at maximum after which other reactors are energized. Reactors and pumps shall be interlocked so that reactor warm-up and shutdown can be anticipated before pump startup or shutdown.

.4 Once all reactors are energized, the target dose is maintained by varying the reactor power settings. On decreasing demand, maximum flow is maintained through as many reactors as possible until the minimum allowable flow in one reactor is reached, after which that reactor is shut down, with power levels varying in the remaining operating reactors to maintain the target dose.

.5 Reactor power levels shall be controlled so that minimum power settings are maintained to achieve the target dose.

.6 Pump start will cause a flow through the reactors to increase, which the control system and reactors must be programmed to anticipate. Pump starts are currently manually initiated when there is increased flow demand. When a pump start sequence has been initiated, a time delay will be imposed to ensure that the required number of reactors will be in operation corresponding to the anticipated pump flow rate when the pump check valves are fully open.

3.9 Shutdown

.1 As noted above, on decreasing flow rates, power levels are first reduced in operating reactors before any reactors are shutdown to match decreasing UV requirements. Power levels are not reduced, and lamps are not shut down, until the flow rate through the reactor is reduced or stopped or, the reactor has been requested to shut down by the UV Master PLC.

3.10 Emergencies

.1 In the event of an emergency shutdown, all lamps shall be turned off and the modulating valves shall be opened. A critical alarm will be generated and registered on the plant SCADA system. A start-up can only be initiated when the alarm has been cleared.

.2 On power failure, the modulating valves will remain in their last positions and pump discharge check valves shall remain open.

3.11 Lamp Restart

.1 On power return, the start-up sequence for each reactor shall be initiated. Reactors that have not completed the shutdown sequence shall be bypassed in favour of reactors that have completed the shutdown cycle. The time for additional lamps in a reactor to come up to power is about 2 minutes. To activate a new reactor takes about 5 minutes.

END OF SECTION