SECTION 443200

SUPEROXYGENATION SYSTEM

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Section 432105 – Pumps, General

B. Section 400513 – Piping, General

C. Section 400524 – Valves, General

1.02 REFERENCE STANDARDS

A. The following is a list of standards which may be referenced in this section:
   1. Occupational Safety and Health Administration (OSHA)
   2. National Fire Protection Association (NFPA) 53
   3. Compressed Gas Association (CGA) G-4.1
   4. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section VIII, Div. 1
   5. ASME B16.1/B16.5 Pipe Flanges and Flanged Fittings.

1.03 SYSTEM DESCRIPTION

A. The SuperOxygenation System (System) shall be designed to elevate dissolved oxygen (D.O.) levels in one of the two Central Park Pump Station force mains at a time to reduce dissolved sulfides and subsequent vapor phase hydrogen sulfide (H2S) levels in the sewer collection system.
   1. The System will be designed to achieve an oxygen transfer efficiency of greater than 90 percent. To achieve this goal, the System shall provide a large oxygen/water mixing zone where the system produces a counter current of water flowing down through a velocity gradient allowing the gaseous oxygen to remain in the system until it is completely dissolved.
   2. The mixing zone does not have an oxygen headspace but is fully mixed with oxygen/water. This action provides enough oxygen/water contact time that the gaseous oxygen is completely dissolved into the wastewater before being blended back into the force main flow.

B. The System shall contain no internal nozzles, mixers, media, or inner baffles that are prone to clogging and all openings shall be a minimum of 6 inches in diameter to pass raw wastewater.
   1. The SuperOxygenation System shall not be pressurized above the operating discharge pressure of 100 ft of head.
   2. No pure oxygen headspace shall be developed inside of the dissolution vessel.
   3. No devices may be placed within the force main to aid dissolution as said devices may become fouled and/or otherwise adversely affect force main flow characteristics.

C. The Supplier shall provide all labor, materials, equipment and incidentals as specified and indicated herein and as required to meet the specified performance requirements to furnish:
   1. One (1) complete SuperOxygenation System and appurtenances complete and operational. Components are to include:
      a. One (1) SuperOxygenation cone.
      b. One (1) PLC based Process Control Panel.
      c. One (1) Oxygen Control Panel.
      d. One (1) Side stream pump and pump starter panel.
   2. All mechanical components shall be designed and constructed in accordance with the latest edition and revision of all applicable codes and regulations, including the following:
      a. ASTM
      b. ANSI
      c. ASME
   3. Equipment Materials:

a. All components of the System shall be compatible with the conditions and chemicals to which they will be subjected to during normal operation.
b. Compounds with which the materials of construction must be compatible include, but are not limited to:
1) Hydrogen sulfide.
2) Sulfuric acid.

D. Unit Responsibility and Scope of Supply:
1. The products shall be the end product of one responsible System manufacturer or responsible System supplier.
2. The System manufacturer shall provide components suitable for the service conditions listed herein.
3. The Contractor shall be responsible for coordinating with System manufacturer for Contractor's Scope of Supply.
4. The Contractor shall be responsible to provide and install, but not limited to, the following:
a. Interconnecting raw sewage piping including valves and accessories.
b. Oxygen feed piping to the System, and accessories.
c. Installation and assembly of all equipment and instrumentation components for a complete system including labor.
d. Site preparation
e. Utility requirements, including main electrical service and field wiring.

1.04 SYSTEM SUPPLIER

A. The SuperOxygenation system shall be furnished by a single System Supplier. The System Supplier shall have a minimum of 15 years of experience in similar installations with a minimum of 10 permanently installed and operating systems adding a similar amount of oxygen to what are required per these specifications.

B. The System Supplier shall be ECO Oxygen Technologies, LLC of Indianapolis, IN., or approved equal.

1.05 SUBMITTALS

A. Action Submittals:
1. Detailed mechanical and electrical drawings showing equipment dimensions, system fabrication, arrangement, assembly, including locations and type of connections and weights of major equipment and components.
2. Power and control wiring diagrams, including terminals and numbers.
3. Factory finish system.
4. External utility requirements such as air, water, power, drains, etc., for each component.
5. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
6. Control panel elevation drawings showing panel face layout, construction, and placement of operator interface devices and other elements.
7. Power and control wiring diagrams, including terminals and numbers and bill of materials
8. Complete set of engineered drawings for system I/O and Process control.
9. Make, model, weight, and horsepower of each pump assembly.
10. Complete pump and motor catalog information, descriptive literature, specifications, and identification of materials of construction.
11. Performance data curves at nominal pump speed sowing head, capacity, horsepower demand, NPSH required, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity.
12. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
13. Installation Manual.
14. Installation history and experience –The manufacturer shall provide a list of names and dates of installations for verification by the Engineer or City's Representative.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance.
2. Warranty Certificate
3. Operation and Maintenance Manuals (3 hard copies, 1 electronic copy).
4. Manufacturer's Certificate of Proper Installation.
5. Equipment Testing and Field Startup Report.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. The System Supplier shall have a minimum 15 years' experience at manufacturing the specified equipment with a minimum of 10 permanent and operational installations with similar equipment. Five of the 10 systems need to be in operation greater than 5 years.
   2. Similar projects:
      a. The System Supplier shall provide a list of five installations of similar application in terms of oxygen addition per the Submittals requirements.
      b. The list shall include contact names, telephone numbers and length of service for each named installation.
      c. Installations shall be of comparable size to the type specified for this Project.
   3. The manufacturer must be able to provide the Owner with training as specified herein.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All materials and equipment shall be shipped, stored, handled and installed in such a manner as to not degrade quality, serviceability or appearance.

B. All exposed equipment openings shall be properly protected.

C. Appropriate measures shall be taken to prevent the entrance of moisture or water to equipment during shipment and storage onsite.
   1. Control panels should be stored in an enclosed place, safe from the weather until installed.

1.08 PATENTS

A. The manufacturer shall warrant that the use of their system and its equipment, in the process for which the system has been expressly designed, will not infringe on any U.S. or foreign patents or patents pending. In the event of any claim of infringement, the manufacturer shall defend and indemnify the Owner free from any liabilities associated with the use of the patented equipment or process.

B. The manufacturer hereby grants to the City, in perpetuity, a paid-up license to use any inventions covered by patent or patents pending owned, or controlled by the manufacturer in the operation of the facility being constructed in conjunction with the equipment supplied under this Contract, but without the right to grant sublicenses.

1.09 WARRANTY

A. The manufacturer shall guarantee that the SuperOxygenation system will perform in accordance with the specifications when operated within the specified design conditions.

B. The manufacturer shall guarantee all materials and equipment to be free from all defects due to faulty materials or workmanship for a period of one (1) year from the date of startup and shall be limited to the repair or replacement of the SuperOxygenation system.

1.10 PERFORMANCE GUARANTEE

A. SuperOxygenation System Supplier shall guarantee that the System shall provide a minimum oxygen transfer efficiency of 90% or greater.
   1. One-time performance testing as described in the FIELD TESTING section shall be means of proving performance criteria is met.

PART 2 PRODUCTS

2.01 SERVICE CONDITIONS

A. The SuperOxygenation System shall be capable of designed to provide treatment to one force main at a time but not both simultaneously and shall operate under the following operating conditions:

Process Parameter	Value	Value
Nominal Diameter of Force Main (inches)	24	16
Length of Force Main to be Treated (ft)	9750	4,602
Total Dynamic Head at Force Main Connection Under Average Flow Conditions (ft)	80	28
Static Head at Connection to Force Main (ft)	67	4
Force Main Pump Operation	Fill / Draw	Fill / Draw
Daily Average Flow (gpm)	2,100	2,100
Pump Flow Rate (gpm)	1,950 - 2,600	1,950 - 2,600
Max Hydraulic Retention Time (hrs)	4	1.5
Existing Dissolved Sulfides (mg/L)	2	2
Site Elevation Above Sea Level (ft)	900	900
Max Temperature of Sewage (°C)	25	25
Daily Oxygen Addition Required Based on Above Parameters (lbs O_2/day)	620	420
Instantaneous Oxygen Feed Rate (lbs O_2/day)	1,450	1,100

2.02 PERFORMANCE CRITERIA

A. The SuperOxygenation System shall be designed to achieve an oxygen transfer efficiency of greater than 90%.
   1. The System Supplier shall submit performance data from a minimum of 10 permanently installed and operational systems that prove a minimum oxygen transfer efficiency of greater than 90% under actual operating conditions. Data from factory tests with clean water or data from temporary pilot tests is not acceptable.
   2. To achieve the high oxygen transfer efficiency, the system shall provide a large oxygen/water interface generated by an intense bubble swarm to achieve oxygen dissolution such that the gaseous oxygen is completely dissolved into the wastewater before being blended back into the force main flow.
   3. Systems with a pressurized pure oxygen headspace defined by an instrument-controlled water level shall not be considered.
   4. Systems which insert venturis, nozzles, diffusers, mixers, or other such devices into the force main will not be considered.
   5. Discharge D.O. levels shall be measured upon system start-up to confirm transfer efficiency.

B. The SuperOxygenation System should run continuously with a minimum amount of maintenance to guarantee reliable D.O. control. Therefore, the system shall contain no internal nozzles, mixers or inner baffles that are prone to clogging, and all openings shall be a minimum of 4 inches to avoid scaling and clogging. Additionally, no device such as a venturi, nozzle, mixer or diffuser shall be installed within the force main.

C. The SuperOxygenation System shall be operated at or near the existing pressure in the force main line to prevent the potential for oversaturation of dissolved oxygen and pure oxygen off-gassing. The SuperOxygenation System shall not be pressurized above the operating discharge pressure of 100 ft of head. The side stream pump shall not be used to maintain a pressure differential across nozzles or venturis.

2.03 INJECTION CONE

A. The SuperOxygenation Injection cone shall be constructed of Type 304 stainless steel and fabricated to ASME standards for 100 psig pressure rated vessels.

B. Features:
1. Self-cleaning bottom discharge design.
2. Sight glasses.
3. Manway.
4. 6-inch ANSI 150-pound flanged inlet and discharge ports.
5. 1 inch female NPT threaded oxygen port.
6. System discharge instrumentation ports.
7. Stripped welds and passivated interior & exterior finish.
8. Free standing vessel with lower mounting flange for anchoring.

C. SuperOxygenation System Dimensions and Parameters:
1. Model Number: ECO2-4-6-PC
2. Cone Diameter: 4 feet.
3. Cone Nominal Height: 12 feet.
4. System Operating Head: 40 feet.
5. Total head loss shall not exceed 75 feet through the SuperOxygenation System at design conditions.
6. Side Stream Flow Rate: 1,400 gpm.
7. Side Stream Pump Duty Head: 35 feet.

2.04 PIPING, VALVES, AND ACCESSORIES

A. A singular air release valve will be provided with the ECO2 SuperOxygenation System. This valve shall be placed on top the inlet piping to the cone. The model must be designed in accordance with the CCFM of air displaced from the cone during hydraulic fill, as well as accumulation of gas from raw wastewater.
1. The sewage air release valve shall be manufactured by Vent-O-Mat or equal as specified in Section 400530 - Miscellaneous Valves.
2. Intake and discharge piping shall be ductile iron as specified in Section 9 of the City of Topeka Standar Technical Specifications.
3. Plug valves shall be electric operated as specified in Section 400529 - Eccentric Plug Valves.

B. All other items to be supplied by others.

2.05 INSTRUMENTATION AND CONTROL

A. General:
1. Provide control panels, electrical components and wiring for a complete, functional system.
2. Provide all items not specifically specified which are required to implement the specified functions and the functions required for proper system operation.
3. Coordinate controls with existing SCADA system.

B. Process Control Panel: PLC driven automatic system control with sensing features. The system shall be designed for automatic flow control with full manual backup control of oxygen

flow and side stream pump control. The oxygen feed rate shall be continuously adjusted to the actual process water flow rate. The control panel shall be rated for use on a 120 volt power supply and shall be housed in a NEMA 12 painted steel enclosure. The control panel shall contain an Allen-Bradley Programmable Logic Control (PLC), operator interface screen and have the capability to monitor system parameters for alarm indication and data logging and trending.

1. Instrumentation included with the system and controlled/monitored by the Process Control Panel:
   a. Oxygen mass flow controller.
   b. One (1) solenoid valve.
   c. One (1) Swagelok actuated ball valve.
   d. One (1) 6" Rosemount magnetic flow meter.
   e. One (1) Dwyer pressure sensor.
   f. One (1) Pyromation temperature sensor.
2. PLC and I/O:
   a. Allen-Bradley Compact Logix Model L306.
   b. Ethernet switch.
   c. MicroLogix fixed racks, power supplies, expansion analog and digital I/O.
   d. Trend recording: The PLC shall record the following data as a minimum:
      1) Oxygen addition, current day's total.
      2) Oxygen addition, previous day's total.
      3) Force main flow.
      4) Side stream flow.
      5) Side stream pressure.
      6) Side stream temperature.
3. Operator Interface:
   a. Allen Bradley PanelView Plus 7, 1000
      1) Trending and logging.
      2) Ethernet communication capable (for remote connection).
4. Main Control Enclosure:
   a. Preassemble and wired, NEMA 4X 304 stainless steel construction.
   b. System Hand-Off-Auto switch.
   c. Interposing I/O relays as necessary.
   d. Disconnects and fusing for AC power distribution.
   e. DC power supply and fusing for DC power distribution.
   f. All necessary wireways, wiring, labels, and miscellaneous hardware for a complete control panel.

C. Oxygen Control Panel: NEMA 12 painted steel panel to allow for both Auto and Manual Oxygen flow control. This system is complete with an oxygen mass flow controller, rotameter, solenoid valve, check valves, isolation valves and stainless steel tubing and fittings as required. Panel may be powered, monitored, and controlled by the Process Control Panel or manual controlled by the bypass needle valve and rotameter.

1. Oxygen Control Components:
   a. Oxygen Control Panel
      1) Force main treatment selector switch
      2) NEMA 4X 304 stainless steel construction
      3) One (1) Oxygen Mass Flow Controller
      4) One (1) Solenoid Valve
      5) Stainless Steel Ball valves for system component isolation
      6) Stainless Steel needle valve and rotameter for manual flow control regulation
      7) Stainless Steel miscellaneous fitting (i.e. Bulkhead, "T")
      8) Stainless Steel Tubing
   b. Gaseous Oxygen Line Valving at Injection Cone
      1) One (1) Swagelock Actuated Ball Valve

2) One (1) Hand Ball Valve
3) One (1) Check Valve

D. Side Stream Pump Starter Panel: NEMA 4X 304 stainless steel panel complete with one (1) disconnect switch, circuit breaker, control transformer and fuses, relays and pilot devices as required to control the specified side stream pump.

E. Inputs to Process Control Panel:
1. Force main flow rate.
2. Side stream pump signal(s).
3. System enable/permission to run.

F. Description of Operation:
1. The force main to be treated by the SuperOxygenation System shall be both manually selectable locally through a selector switch mounted on the Oxygen Control Panel and remotely selectable through the City's existing SCADA system. Either the 16-inch or the 24-inch force main shall be cable of being treated but not both silmutaneously.
2. The SuperOxygenation System process control panel shall recieve the pump station flow rate read by the existing flowmeters at the station. The flowmeter signal read by the system shall be determined by the force main selected to be treated as described in paragraph 1 above.
3. Upon a call for one of the pump station's lead pump to run, an adjustable timer (adjustable from 0 to 5 minutes and initially set at 1 minute) shall be started. When the timer completes the intake automatic plug valve shall be called to open. The plug vavle that opens shall be based upon the operators selection of which force main is to be treated. Upon a signal from the plug valves full open limit switch, the side stream pump shall be called to run simultaneously with the call to open of the appropriate SuperOxygenation System discharge plug valve. If the discharge plug valve fails to open as indicated by its open limit switch, the pump shall be shut down and the intake plug vavle called to close. An alarm condition shall then be initiated.
4. The SuperOxygenation System shall operate by redirecting a side stream of raw, unscreened wastewater from the force main and pumping it through the Injection Cone. Gaseous oxygen is fed into the Injection Cone by the Oxygen Control Panel as controlled by the Process Control Panel. The Injection Cone shall provide a large oxygen/water interface as generated by an intense bubble swarm to achieve rapid oxygen dissolution such that the gaseous oxygen is completely dissolved before being blended back into the force main. The SuperOxygenation System shall not have a pure oxygen headspace inside of the vessel.
5. The Process Control Panel PLC shall monitor the force main flow rate, side stream water flow rate, and water temperature and system pressure. Based on this data, the PLC shall calculate the amount of oxygen required to meet the oxygen demand of the wastewater. The PLC shall be capable of adjusting the oxygen feed rate into the Injection Cone by means of the mass flow controller to match the calculated oxygen demand.
6. The SuperOxygenation System shall be capable of automatically adding variable amounts of oxygen as required by varying force main flow rates.
7. The PLC shall also monitor the side stream pump operation, side stream water flow rate, oxygen flow rate, and water temperature and system pressure. These parameters shall be checked against design inputs to ensure optimal system performance and provide for system shutdown and/or alarm notification if the operation is out of tolerance.
8. Upon a call by the pump station to stop the lead pump, the side stream pump shall be called to stop simultaneously along with both of the SuperOxygenation System discharge plug valves. Should either of the valves fail to close as indicated by their respective limit switches, an alarm shall be initiated.

G. Alarms shall be capable of being transmitted to the pump station's main control panel. The alarms shall be capable of remote evaluation via the control panels existing communications system.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Manufacturer shall provide written instructions for installation of equipment by Contractor.

B. Anchor Bolts: Contractor will provide and field install after receipt of equipment. Anchor bolts are as determined by local codes and regulations and Engineer's specification and adhering to local codes and regulations.

3.02 PUMP INSTALLATION

A. Provide pump manufacturer's written instructions for pump installation by Contractor.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom as designated by Owner, for minimum person-days listed below, travel time excluded:
   1. Function Testing, Performance Testing, Training of Owner's Staff, and Completion of Manufacturer's Certificate of Proper Installation: 3 days and one trip.

B. Schedule with Owner's manufacturer's services/Contractor to avoid conflict with other onsite testing or other onsite activities.

C. Furnish trained, articulate personnel to perform manufacturer's services.

3.04 FIELD TESTING

A. Prior to acceptance by Owner, an operational test of the SuperOxygenation system shall be conducted to determine if the installed equipment meets the purpose and intent of the Specifications. Tests shall demonstrate that all equipment is electrically, mechanically, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

B. All equipment shall be tested to check for proper operation, proper alignment, faulty equipment, and for excessive vibration.

C. Any and all alterations, modifications, additions and/or work necessary to rectify defects or nonconformance with the Section of the Specifications shall be in such a manner as to provide for the satisfactory operation of the system, all at no additional cost to the Owner.

D. Upon completion of Field Testing, the Manufacturer shall provide a summary report documenting the results of the required field testing.

E. All labor, instruments, equipment, apparatus, fuel, temporary piping and valving, water and electrical power required for testing shall be provided by the Contractor at no additional cost to the Owner.

3.05 PERFORMANCE

A. The manufacturer shall demonstrate system performance over a period of one year, with site visits conducted monthly or quarterly, to verify that the system is operating as intended.

3.06 WARRANTY

A. The manufacturer shall provide a warranty of not less than one (1) year, with preference given to warranties extending up to two (2) years.

END OF SECTION