1. GENERAL

1.1 System Description

.1 This performance based specification is general in nature to accommodate the various vendors of struvite recovery systems. Due to the variability in each vendor's equipment and process configuration not all components are covered. As well, some of the components listed in this specification (i.e., recycle pumps) are not necessarily required.

.2 The struvite recovery system is based on the chemical precipitation of the mineral struvite ($MgNH_4PO_4.6H_2O$) in the form of a crystalline product with sufficient purity that it is acceptable for the Contractor's proposed recycling program. The system will be an integrated package of equipment components including:

.1 fluidized bed reactor(s),

.2 chemical storage and dosing system,

.3 instrumentation and control, and

.4 product processing storage and loading

.3 The objectives of the struvite recovery system is to form struvite from a pre-digestion phosphorus release process and from digester recycle streams (e.g. centrate) under controlled conditions and produce a crystallized product with sufficient purity and physical characteristics that it qualifies for reuse as required under the Water Protection Act, Manitoba C.C.S.M. c W65.

.4 The Contractor will be responsible for entering into a long term sales agreement with the City for the fertilizer produced from the process.

.5 The City of Winnipeg will employ biological nutrient removal at all three wastewater treatment facilities (i.e., NEWPCC, SEWPCC, and WEWPCC). The WAS derived from the three facilities will be enriched in polyphosphate.

.6 Fermented primary sludge and waste activated sludge (WAS) from the WEWPCC will be trucked to the NEWPCC and discharged into the pre-digestion release tank at the NEWPCC.

.7 Fermented primary sludge and waste activated sludge (WAS) from the SEWPCC will be dewatered to 15% solids concentration and trucked to the NEWPCC where it will be discharged into the thermal hydrolysis feed tank.

.8 Waste activated sludge from the NEWPCC will be discharged into the into the pre-digestion release tank at the NEWPCC. A portion of the fementate at the NEWPCC may be available to enhance P release from the WAS.

.9 NEWPCC fermented primary sludge will be dewatered to 15% solids concentration and discharged into the thermal hydrolysis feed tank at the NEWPCC.

1.2 Submittals

.1 Product Data:

.1 Motors: Submit Product Data in accordance with Section 43 22 05 – Process Motors.

.2 Shop Drawings:

.1 Include Struvite Recovery System layout and cross-sections.

.2 Show equipment, piping, valves, and devices on P&ID and Layout Drawings.

.3 Wiring diagrams.

.4 Control equipment.

.1 Control system network architecture diagram.

.2 Process Control Narratives fully describing the system operating modes, monitoring, alarms, and plant SCADA interface requirements.

.3 Panel fabrication and dimension drawings, nameplate legends, Engineer's tag numbers, and wiring and piping schematic diagrams.

.4 Equipment dimension drawings.

.5 Component specification sheets for all panel mounted devices, field instruments, and final control elements.

.6 Equipment terminal and piping connections.

.7 Loop-by-loop system electrical schematics including terminal-to-terminal interconnections between panel and field equipment.

.3 Submit in accordance with Section 01 33 00 – Submittals.

.4 Operating and Maintenance (O&M) Data: Provide for incorporation in O&M Manual as specified in Section 01 78 00. Include the following:

.1 Complete description of operation including detailed operating sequence descriptions, and maintenance.

.2 General arrangement and detailed Drawings.

.3 Wiring diagrams for power and control schematics.

.4 Parts catalog with complete list of repair and replacement parts with Section Drawings, illustrating the connections and the part Manufacturer's identifying numbers.

.5 Complete spare parts list.

1.3 Quality Assurance

.1 Standardization and System Responsibility:

.1 For specific purposes of standardization and total system responsibility, equipment included in this section shall be furnished by single manufacturer.

.2 To ensure proper operating systems, the manufacturer of the Struvite Recovery System equipment shall also be responsible for providing following:

.1 All control valves, isolation valves, equipment and instrumentation required for a complete and operational system.

.2 Electrical system design including distribution, MCC, Starters, load panels, transformers, wiring systems, and related ancillaries shall comply with the City of Winnipeg Water & Waste Department Electrical Design Guide.

.3 Automation and control system design including control panels, PLC equipment, HMI equipment, software, UPS, process measurement instruments, control valve actuators and related ancillaries shall comply with the City of Winnipeg Water & Waste Department Automation Design Guide.

1.4 Delivery, Storage, and Handling

.1 The Contractor shall be responsible for equipment delivery to the Site. When the Installation Contractor accepts the equipment delivery, he shall certify the delivery by completing Form 100 – Certificate of Equipment Delivery as illustrated in Section 01 43 33 – Equipment Installation.

.2 Following completion of Form 100, the Installation Contractor shall be responsible for all equipment at the Site or any alternative storage location.

.3 The Contractor shall ensure that the Installation Contract is fully informed of precautions to be taken in the unloading of equipment and its subsequent storage including any required maintenance.

.4 If equipment off-site storage is required, then the second move of the equipment to the Site will be at the Installation Contractor's cost.

2. PRODUCTS

2.1 General Design Requirements:

.1 Design a Struvite Recovery System for removal of phosphate from wastewater with following characteristics

.2 The feed to the Pre-digestion phosphorus release process is listed in Table 1. The Contractor will be responsible to provide all process design information to allow the Contract Administrator to design and tender the work for this unit process under a separate contract. The Contractor will be responsible for all design calculations and performance of the pre-digestion release process.

Table 1: Design Feed Characteristics to Pre-Digestion Release of Phosphorus Unit

Parameter	Unit	2020 Average	2037 Average
Flow	ML/d	3.34	4.0
TSS	kg/d	32,000	38,500
VSS	kg/d	24,000	29,000
Nitrogen	kg/d	2,000	2,400
Phosphorus (assimilated)[1]	kgP/d	430	510
Phosphorus (PAOs)[2]	kgP/d	600	725
Concentration	Percent	0.96	0.97
Minimum Temperature	Celsius	7	7

[1] Phosphorus associated with uptake due to the requirements for bacterial growth

[2] Phosphorus associated with the uptake by phosphorus accumulating organisms (i.e., phosphorus available to be released in the pre-digestion release tank)

.3 The discharge from the pre-digestion release process will be thickened in dissolved air flotation to approximately 3 percent solids. The subnatant from the thickening process will be combined with the centrate from digestion dewatering (thermal hydrolysis followed by mesophilic anaerobic digestion). The estimated characteristics of the combined waste stream are as shown in Table 2. The Contractor shall design a struvite recovery system for the 2020 Average Conditions, and list the requirements to expand to the 2037 average conditions.

Table 2: Design Feed Characteristics to the Struvite Crystallization Process (i.e, Subnatant from Pre-digestion Release of Phosphorus + Centrate Dewatering)

Parameter	Unit	2020 Average	2037 Average
Flow	ML/d	3.31	3.95
TSS	kgTSS/d	3,100	3,713
VSS	kgVSS/d	2,200	2,600
Nitrogen	kgN/d	2,000	2,400
Phosphorus	kgPO_4-P/d	1,100	1,400

.1 The struvite recovery system shall be designed for the 2020 Average conditions listed in Table 2, with the ability to be expanded to the 2037 Average condition.

.4 The struvite recovery system will reduce the mass of soluble phosphorus and ammonia in the feed stream. The system will be capable of treating the feed stream within the following parameters:

1. Flow rate of 3.31 million litres per day as a monthly average (2020 average month). The feed stream will be equalized in an appropriate storage tank provided by others prior to being delivered to the system.
2. Ortho-phosphorus (PO_4 as P) loading to the system of 1,100 kg per day (2020 average month) or less (based on an average design flow rate of 3.31 million litres per day).

.5 The system will produce treated effluent with an average ortho-phosphorus (PO_4 as P) concentration of 30 mg/L. This will be based on a continuous twenty-eight (28) Calendar Day period by the Contractor and will be based on the average concentration over the period. When the effluent quality has been proven over a continuous twenty-eight (28) Calendar Day period the process requirements of Form 104 will be satisfied. Additional requirements of Form 104 can be found in Division 01 91 31.

.6 Materials and coatings for the system shall be selected based on the commodity being treated, stored, and conveyed. The quality and selection of materials should ensure a service life of a minimum of 20 years.

.7 At a minimum, the main equipment and services to be included with the struvite recovery system package are listed briefly as follows:

.1 Skid mounted chemical feed systems (magnesium chloride and sodium hydroxide), with each skid containing a duty/standby arrangement (refer to Section 46 33 00).

.2 A sufficient number of fluidized bed reactors to meet design conditions and treatment objectives for an uninterrupted operation of 365 days per year.

.3 System valves for isolation, diversion, control and sampling

.4 Instrumentation & Controls (HMI, PLC)

.5 Product drying, classifying, handling, storage and bagging system

.6 Control panel for equipment integral with the system

.7 Equipment General Arrangement and Layout Drawings

.8 Operating & Maintenance (O&M) Manuals

.9 Site visits and personnel training as specified

.10 Equipment delivery to site

.11 Field service assistance

.12 Start-up assistance

.13 Provide recommended spare parts for one (1) year of operation.

.14 Post-Commissioning Support

.15 O&M training including copies of all training materials in electronic format

2.2 Fluidized Bed Reactors and Effluent Recycle System

.1 The Contractor shall indicate the number of fluidized bed reactor vessels required, and list the nominal design capacity (flow and phosphorus removal capacity) of each. The Contractor will also list minimum and maximum flows and loads which can be accommodated by the proposed design.

.2 The feed stream to the vessels will include a basket-type auto-strainer and modulating flow control valve(s).

.3 The vessels shall be fabricated from welded 304 stainless steel include nozzles/flanges/ports/lugs for product slurry outlet, vessel support legs, and instrumentation.

.4 The reactor vessels will be supported on a bolted structural steel frame designed to meet the applicable loading and seismic conditions. All ladders, support structures, stairways, and walkways will be the responsibility of the Contractor.

.5 The top of each vessel will be covered with a fiber-reinforced plastic cover, complete with flange connection for venting and odour control.

.6 The treated effluent will overflow a weir at the top of the reactor vessel and be collected in a trough for discharge. Where applicable, a recycle loop will be included to control upflow velocity and feed chemical concentrations utilizing treated fluid from the top reactor section.

2.3 Chemical Dosing System

.1 The struvite recovery system will include storage and dosing systems for magnesium chloride ($MgCl_2$) and 50 percent sodium hydroxide (NaOH).

.2 Magnesium chloride and sodium hydroxide chemicals will be delivered by road tanker in solution and will be transferred to the Contractor supplied bulk storage tanks.

.3 All chemical tanks shall be provided and designed so that a chemical tank can be taken out of service for maintenance and inspection. Each tank must be supplied with duty and standby tank level sensors.

.4 Sodium hydroxide tank shall be FRP with using premium epoxy vinyl ester resin designed to provide a service life of a minimum of 20 years.

.5 Chemicals transferred to the reactor vessels will be metered in a package chemical dosing system, comprising dosing pumps, calibration measurement and valves. Provide a duty standby arrangement for each chemical feed pump.

2.4 Effluent Recycle System

.1 If required, a recycle loop will be included to control upflow velocity and feed chemical concentrations utilizing treated fluid from the top reactor section. The design of the effluent recycle system shall follow the American National Standard for Rotodynamic Pumps for Design and Application, Hydraulic Institute, ANSI\HI 1.3-2009.

.2 Provide a duty/standby arrangement for the effluent pump recycle system.

.3 Supply gauges for measuring inlet and outlet pressure with each pump,

.4 For each pump, provide for one spare mechanical seal or packing kit (as applicable) and one (1) set of pump bearings.

2.5 Product Handling

.1 The struvite recovery system will include a complete product handling system, encompassing:

.1 A product slurry removal offtake from the fluidized bed reactors, including a non-potable water product washing and segregation system,

.2 A slurry dewatering sieve or alternative

.3 A moving bed hot air dryer, including electric heating and air blowing system, and exhaust air cyclone particle filter (if required for product handling)

.4 A conveyor system to lift the product,

.5 Product storage silos holding classified struvite product

.6 A bagging system

2.6 Instrumentation and Control

.1 The struvite recovery system shall be designed and constructed using components selected in accordance with the City of Winnipeg Water & Waste Department Automation Design Guide. The guide is currently under development.

.2 As part of the Automation Design Guide, the City of Winnipeg has plans to enter purchasing agreements with preferred vendors for various components including PLCs, HMIs, MCC panels, VFDs, soft-starters and intelligent full voltage non-reversing starters.

.3 The Tender Price submitted by each Bidder shall be based on using any preferred vendor selected by the City. As such, the City reserves the right to make the final vendor and product selections following tender close without altering the Tender Price or Conditions.

.4 This City is in the process of standardising the following items for inclusion in the Automation Design Guide. Next to each item is the award status and corresponding RFP number. For informational purposes, all RFPs are available for review by Bidders on the City of Winnipeg website.

.1 UPS Systems – awarded to EECOL Electric, RFP #341-2013

.2 Control System and MCC – pending award, RFP #756-2013

.3 Electric Actuators – pending award, RFP #331-2014

.4 Instrumentation – pending award, RFP #449-2014

i. Level systems of Ultrasonic and Radar Type

ii. Temperature Sensors and Transmitters

iii. Pressure Transducers

iv. Magnetic Flowmeters

.5 Fixed Toxic Gas Detection – pending award, RFP #123-2014

.5 A complete control and automation system for operation of the Struvite Recovery System shall be provided, including all control panels, PLC equipment, HMI equipment, process measurement instrumentation, and final control devices necessary for the struvite recovery system including struvite recovery, drying, classifying, bagging, and all devices associated with the pre-digestion phosphorus release process.

.6 The struvite recovery system control system shall provide full process monitoring, manual control modes, automatic control modes and alarming of abnormal process conditions and equipment failures. A graphical operator interface panel shall be provided to facilitate monitoring, control, and management of the struvite recovery system. The graphical user interface system shall be developed using a “shades of grey” design philosophy.

.7 The PLC based control system shall include primary and hot-standby processors located in a main system control panel together with a panel mounted industrial computer based HMI system. Local control and marshalling panel(s) shall be provided at unit process areas to facilitate maintenance and manual control operations.

.8 The PLC control system shall communicate with the Main Plant Control system via Ethernet network. A PLC data table shall be provided for full integration of the struvite recovery system controls with the main plant control system. Field device communication network(s) within the struvite recovery system package if used shall be Profibus.

.9 Field instruments and final control elements shall be supplied with primarily the Profibus PA communication protocol, however, Profibus DP V2 or HART with enhanced diagnostic capability maybe utilised at the approval of the Contract Administrator.

.10 Electric valve actuators will be using the Profibus DP V2 protocol.

2.7 Coating

.1 Surface preparation, priming, and finish coating of exterior of vessels and piping, valves, and appurtenances shall comply with Section 43 09 01 – Factory Applied Protective Coatings.

3. EXECUTION

3.1 Delivery

.1 Equipment Delivery

.1 Coordinate the delivery with the Installation Contractor and give notice to the Contract Administrator ten (10) Calendar Days before delivery to allow arrangements for receipt and inspection. Arrange for delivery during normal working hours.

.2 When the Contractor and Installation Contractor are satisfied that the equipment has been delivered in its entirety without damage, complete the "Certificate of Equipment Delivery".

.3 Complete Form 100.

3.2 Contractor's Technical Service Representative

.1 Arrange for a technically qualified Technical Service Representatives to attend the installation work, certify correct installation, train operation and maintenance staff, and undertake the testing of the equipment for sufficient periods to ensure the equipment is installed, operated, and maintained in accordance with recommended procedures.

.2 The minimum periods of Site attendance are identified in the following table along with the form to be completed on each of these trips. A "day" is defined as eight (8) working hours on-site, excluding travel time to and from the Site.

.3 Allow for ten (10) trips to Site for the duration indicated in the following table. The total number of trips will depend on the Installation Contractor's schedule and may be reduced if the Installation Contractor's schedule allows combining more than one task in one visit.

Table 1 :Travel Requirement Schedule

Item	Description	No. of Days On Site	Form
1	Equipment Delivery	2	100
2	Readiness to Install	2	101
3	Satisfactory Installation	2	102
4	Commissioning and Equipment Satisfactory Performance Testing	10	103
5	Satisfactory Process Performance Testing	21	104
6	Initial Operator and Maintenance Training	4	T1
7	Final Operator and Maintenance Training	4	T2

.4 The Contractor shall include travel time to and from the Site when making an allowance for the trips to Site.

3.3 Installation Training

.1 Conform to the requirements of Section 01 43 33.

.2 Provide installation training to the Installation Contractor in the methods and precautions to be followed in the installation of the equipment. Certify by completing Form 101, illustrated in Section 01 43 33.

3.4 Equipment Satisfactory Performance Acceptance Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.1 Functional tests shall be carried out by the Contractor and witnessed by the Contract Administrator under full-scale plant operating conditions.

.2 Demonstrate satisfaction of requirements specified herein.

.3 Conform to the requirements of Section 01 43 33, as documented by Form 103.

3.5 Satisfactory Process Performance Acceptance Test

.1 Operational testing for the process system specified in this system to ensure that it functions as intended over a twenty-eight (28) Calendar Day period.

3.6 Operator Training

.1 Conform to the requirements of Section 01 91 41.

.2 Provide as a minimum the following periods of training during the Initial Training Period:

.1 Operator class room training: Two (2) hours

.2 Operator hands on training: Four (4) hours

.3 Maintenance class room: One (1) hour

.4 Maintenance hands on training: Four (4) hours

.5 Test on material covered: One (1) hour

.6 Conduct this complete program two (2) times to cover different operator shifts.

.3 Provide as a minimum the following periods of training during the Final Training Period:

.1 Operator class room training: One (1) hour

.2 Operator hands on training: Four (4) hours

.3 Maintenance class room: One (1) hour

.4 Maintenance hands on training: Four (4) hours

.5 Test on material covered: One (1) hour

.4 Conduct this complete program two (2) times to cover different operator shifts.

3.7 Equipment Manufacturer Post Commissioning Services

.1 24/7 Phone support for a period of 2 years

.2 Two (2) 2-day visits to site during first year of operation.

END OF SECTION