THE CITY OF WINNIPEG

REQUEST FOR PROPOSAL

RFP NO. 640-2014

REQUEST FOR PROPOSAL FOR PROFESSIONAL CONSULTING SERVICES FOR NEWPCC SBR OPTIMIZATION

Proposals shall be submitted to:

The City of Winnipeg
Corporate Finance Department
Materials Management Division
185 King Street, Main Floor
Winnipeg MB R3B 1J1

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PART B - BIDDING PROCEDURES

B1. CONTRACT TITLE

B1.1 REQUEST FOR PROPOSAL FOR PROFESSIONAL CONSULTING SERVICES FOR NEWPCC SBR OPTIMIZATION

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 4:00 p.m. Winnipeg time, August 22, 2014.

B2.2 Proposals determined by the Manager of Materials to have been received later than the Submission Deadline will not be accepted and will be returned upon request.

B2.3 The Project Manager or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

B3. SITE INVESTIGATION

B3.1 The Project Manager or an authorized representative will conduct a Site Investigation tour of the SBR facility on:

(a) August 8, 2014, 9:00am at the NEWPCC Administration Building, 2230 Main Street.

B3.1.1 Proponents are requested to register for the Site Investigation by sending an email to the Project Manager identified in D2.

B3.1.2 Proponents are required to have their own PPE as required.

B3.2 Although attendance at the Site Investigations is not mandatory, the City strongly suggests that Proponents attend.

B3.3 The Proponent shall not be entitled to rely on any information or interpretation received at the Site Investigation unless that information or interpretation is the Proponent's direct observation, or is provided by the Project Manager in writing.

B4. ENQUIRIES

B4.1 All enquiries shall be directed to the Project Manager identified in D2.

B4.2 If the Proponent finds errors, discrepancies or omissions in the Request for Proposal (RFP), or is unsure of the meaning or intent of any provision therein, the Proponent shall promptly notify the Project Manager of the error, discrepancy or omission at least five (5) Business Days prior to the Submission Deadline.

B4.3 If the Proponent is unsure of the meaning or intent of any provision therein, the Proponent should request clarification as to the meaning or intent prior to the Submission Deadline.

B4.4 Responses to enquiries which, in the sole judgment of the Project Manager, require a correction to or a clarification of the RFP will be provided by the Project Manager to all Proponents by issuing an addendum.

B4.5 Responses to enquiries which, in the sole judgment of the Project Manager, do not require a correction to or a clarification of the RFP will be provided by the Project Manager only to the Proponent who made the enquiry.

B4.6 All correspondence or contact by Proponents with the City in respect of this RFP must be directly and only with the City's Project Manager. Failure to restrict correspondence and contact to the Project Manager may result in the rejection of the Proponents Proposal Submission.

B4.7 The Proponent shall not be entitled to rely on any response or interpretation received pursuant to B4 unless that response or interpretation is provided by the Project Manager in writing.

B5. CONFIDENTIALITY

B5.1 Information provided to a Proponent by the City or acquired by a Proponent by way of further enquiries or through investigation is confidential. Such information shall not be used or disclosed in any way without the prior written authorization of the Project Manager. The use and disclosure of the confidential information shall not apply to information which:

(a) was known to the Proponent before receipt hereof; or

(b) becomes publicly known other than through the Proponent; or

(c) is disclosed pursuant to the requirements of a governmental authority or judicial order.

B5.2 The Proponent shall not make any statement of fact or opinion regarding any aspect of the Request for Proposals to the media or any member of the public without the prior written authorization of the Project Manager.

B6. ADDENDA

B6.1 The Project Manager may, at any time prior to the Submission Deadline, issue Addenda correcting errors, discrepancies or omissions in the Request for Proposal, or clarifying the meaning or intent of any provision therein.

B6.2 The Project Manager will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B6.2.3 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/bidopp.asp

B6.2.4 The Bidder is responsible for ensuring that it has received all Addenda and is advised to check the Materials Management Division website for Addenda regularly and shortly before the Submission Deadline, as may be amended by addendum.

B6.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 9 of Form A: Proposal. Failure to acknowledge receipt of an addendum may render a Proposal non-responsive.

B7. PROPOSAL SUBMISSION

B7.1 The Proposal shall consist of the following components:

(a) Form A: Proposal (Section A) in accordance with B8;

(b) Fees (Section B) in accordance with B9;

B7.2 The Proposal should also consist of the following components:

(a) Experience of Proponent and Subconsultants (Section C) in accordance with B10;

(b) Experience of Key Personnel Assigned to the Project (Section D), in accordance with B11;

(c) Project Understanding and Methodology (Section E) in accordance with B12; and

(d) Project Schedule (Section F) in accordance with B13.

B7.3 Further to B7.1, all components of the Proposal shall be fully completed or provided in the order indicated, and submitted by the Proponent no later than the Submission Deadline, with all required entries made clearly and completely, to constitute a responsive Proposal.

B7.4 Further to B7.2, all components of the Proposal should be fully completed or provided in the order indicated, and submitted by the Proponent no later than the Submission Deadline, with all required entries made clearly and completely, to constitute a responsive Proposal.

B7.5 Proponents should submit one (1) 8.5" x 11" original (marked "original") and four (4) copies for sections identified in B7.1 and B7.2 along with one (1) electronic PDF copy.

B7.6 Proposal format, including type of binding, number of pages, size of pages and, font, etc., will not be regulated, except that the Proposal should be presented in the Sections identified above. Proponents are encouraged to use their creativity to submit a Proposal which provides the requested information for evaluation and other information which illustrates the strength of their team.

B7.7 Proponents are advised that inclusion of terms and conditions inconsistent with the Request for Proposal, will be evaluated in accordance with B20.1(a).

B7.8 The Proposal shall be submitted enclosed and sealed in an envelope/package clearly marked with the RFP number and the Proponent's name and address.

B7.9 Proposals submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.

B7.10 Proposals shall be submitted to:

The City of Winnipeg
Corporate Finance Department
Materials Management Division
185 King Street, Main Floor
Winnipeg MB R3B 1J1

B7.11 Any cost or expense incurred by the Proponent that is associated with the preparation of the Proposal shall be borne solely by the Proponent.

B8. PROPOSAL (SECTION A)

B8.1 The Proponent shall complete Form A: Proposal, making all required entries.

B8.2 Paragraph 2 of Form A: Proposal shall be completed in accordance with the following requirements:

(a) if the Proponent is a sole proprietor carrying on business in his/her own name, his/her name shall be inserted;

(b) if the Proponent is a partnership, the full name of the partnership shall be inserted;

(c) if the Proponent is a corporation, the full name of the corporation shall be inserted;

(d) if the Proponent is carrying on business under a name other than his/her own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.

B8.2.5 If a Proposal is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B8.2.

B8.3 In Paragraph 3 of Form A: Proposal, the Proponent shall identify a contact person who is authorized to represent the Proponent for purposes of the Proposal.

B8.4 Paragraph 11 of Form A: Proposal shall be signed in accordance with the following requirements:

(a) if the Proponent is a sole proprietor carrying on business in his/her own name, it shall be signed by the Proponent;

(b) if the Proponent is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;

(c) if the Proponent is a corporation, it shall be signed by its duly authorized officer or officers and the corporate seal, if the corporation has one, should be affixed;

(d) if the Proponent is carrying on business under a name other than its own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

B8.4.6 The name and official capacity of all individuals signing Form A: Proposal should be printed below such signatures.

B8.5 If a Proposal is submitted jointly by two or more persons, the word "Proponent" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Proponents in the Proposal and the Contract, when awarded, shall be both joint and several.

B9. FEES (SECTION B)

B9.1 The Proposal shall include a Time Based Fee schedule, calculated on a time basis that includes all Consultant team members, Subconsultants, phases, and Optional Services section identified in D4 Scope of Services. Include totals and sub-totals for all entries.

B9.2 Adjustments to Fees will only be considered based on increases to the Scope of Services.

B9.2.7 The City will not consider an adjustment to the Fees based on changes in the Project budget or the Final Total Construction Cost.

B9.3 Notwithstanding C1.1(b), Fees shall include costs for out of town travel, related meals and accommodations for the duration of the Project and shall not be considered an Allowable Disbursement.

B9.4 The Fee Proposal shall also include an allowance for Allowable Disbursements as defined in C1.1(b), but shall exclude the costs of any materials testing, soils and hazardous materials investigation during construction.

B9.5 Notwithstanding C10.1, Fees submitted shall not include the Goods and Services Tax (GST) or Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable.

B9.6 Payments to Non-Resident Consultants are subject to Non-Resident Withholding Tax pursuant to the Income Tax Act (Canada).

B10. EXPERIENCE OF PROPONENT AND SUBCONSULTANTS (SECTION C)

B10.1 Proposals should include:

(a) details demonstrating the history and experience of the Proponent and Subconsultants in providing programming; design, management of construction and contract administration services on up to three projects of similar size and complexity.

B10.2 For each project listed in B10.1(a), the Proponent should submit:

(a) description of the project;

(b) role of the consultant;

(c) project’s original contracted construction cost and final construction cost;

(d) anticipated Project schedule and actual project delivery schedule, showing design and construction separately;

(e) project owner;

(f) reference information (two current names with telephone numbers per project).

B10.2.8 Where applicable, information should be separated into Proponent and Subconsultant project listings.

B10.3 The Proposal should include general firm profile information, including years in business, average volume of work, number of employees and other pertinent information for the Proponent and all Subconsultants.

B11. EXPERIENCE OF KEY PERSONNEL ASSIGNED TO THE PROJECT (SECTION D)

B11.1 Describe your approach to overall team formation and coordination of team members.

B11.1.9 Include an organizational chart for the Project.

B11.2 Submit the experience and qualifications of the Key Personnel assigned to the Project for projects of similar complexity, scope and value, including the principals-in-charge, the Consultants Representative, managers of the key disciplines and lead designers. Include educational background and degrees, professional recognition, job title, years of experience in current position, years of experience in design and construction, and years of experience with existing employer. Roles of each of the Key Personnel in the Project should be identified in the organizational chart referred to in B11.1.9.

B12. PROJECT UNDERSTANDING AND METHODOLOGY (SECTION E)

B12.1 Describe your firm's project management approach and team organization during the performance of Services, so that the evaluation committee has a clear understanding of the methods the Proponent will use in the delivery of this Project.

B12.2 Methodology should be presented in accordance with the Scope of Services identified in D4.

B12.3 Describe the collaborative process/method to be used by the Key Personnel of the team in the various phases of the Project.

B12.4 Proposals should address:

(a) the team's understanding of the broad functional and technical requirements;

(b) the City's Project methodology with respect to the information provided within this RFP; and

(c) any other issue that conveys your team's understanding of the Project requirements.

B12.5 For each person identified in B11.2, list the percent of time to be dedicated to the Project in accordance with the Scope of Services identified in D4.

B13. PROJECT SCHEDULE (SECTION F)

B13.1 Proponents should present a schedule, using Microsoft Project or similar software, representing their understanding of the project scope and major deliverables under the Scope of Services.

B13.2 The following milestone dates are to be included in the schedule:

(a) Consultant Pre-Design Site Investigation: week of October 6th, 2014

(b) Construction Kick-Off: spring 2015 at the earliest

B14. QUALIFICATION

B14.1 The Proponent shall:

(a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Proponent does not carry on business in Manitoba, in the jurisdiction where the Proponent does carry on business; and

(b) be financially capable of carrying out the terms of the Contract;

(c) have all the necessary experience, capital, organization, and equipment to perform the Services in strict accordance with the terms and provisions of the Contract;

(d) have or establish and staff an office in Winnipeg for the duration of the Project.

B14.2 The Proponent and any proposed Subconsultant (for the portion of the Services proposed to be subcontracted to them) shall:

(a) be responsible and not be suspended, debarred or in default of any obligations to the City. A list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/debar.stm

B14.3 The Proponent and/or any proposed Subconsultant (for the portion of the Services proposed to be subcontracted to them) shall:

(a) have successfully carried out services for the programming; design, management of construction and contract administration for architectural and/or engineering projects of similar complexity, scope and value; and to those required for this Project; and

(b) be fully capable of performing the Services required to be in strict accordance with the terms and provisions of the Contract; and

(c) have a written workplace safety and health program, if required, pursuant to The Workplace Safety and Health Act (Manitoba);

(d) have the knowledge and resources to administer the requirements of The Workplace Safety and Health Act (Manitoba) during the construction works associated with this Contract; and

(e) undertake to meet all licensing and regulatory requirements of the appropriate governing authorities and associations in the Province of Manitoba.

B14.4 The Proponent shall submit, within three (3) Business Days of a request by the Project Manager, further proof satisfactory to the Project Manager of the qualifications of the Proponent and of any proposed Subconsultant.

B14.5 The Proponent shall provide, on the request of the Project Manager, full access to any of the Proponent's equipment and facilities to confirm, to the Project Manager's satisfaction, that the Proponent's equipment and facilities are adequate to perform the Services.

B15. OPENING OF PROPOSALS AND RELEASE OF INFORMATION

B15.1 Proposals will not be opened publicly.

B15.2 After award of Contract, the names of the Bidders and the Contract amount of the successful Bidder will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/ .

B15.3 To the extent permitted, the City shall treat all Proposal Submissions as confidential. However, the Proponent is advised that any information contained in any Proposal may be released if required by City policy or procedures, by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law.

B15.4 Following the award of Contract, a Proponent will be provided with information related to the evaluation of its submission upon written request to the Project Manager.

B16. IRREVOCABLE OFFER

B16.1 The Proposal(s) submitted by the Proponent shall be irrevocable for the time period specified in Paragraph 10 of Form A: Proposal.

B16.2 The acceptance by the City of any Proposal shall not release the Proposals of the other responsive Proponents and these Proponents shall be bound by their offers on such Services until a Contract for the Services has been duly executed as herein provided, but any offer shall be deemed to have lapsed unless accepted within the time period specified in Paragraph 10 of Form A: Proposal.

B17. WITHDRAWAL OF OFFERS

B17.1 A Proponent may withdraw its Proposal without penalty by giving written notice to the Manager of Materials at any time prior to the Submission Deadline.

B17.1.10 The time and date of receipt of any notice withdrawing a Proposal shall be the time and date of receipt as determined by the Manager of Materials.

B17.1.11 The City will assume that any one of the contact persons named in Paragraph 3 of Form A: Proposal or the Proponent's authorized representatives named in Paragraph 11 of Form A: Proposal, and only such person, has authority to give notice of withdrawal.

B17.1.12 If a Proponent gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials will:

(a) retain the Proposal until after the Submission Deadline has elapsed;

(b) open the Proposal to identify the contact person named in Paragraph 3 of Form A: Proposal and the Proponent's authorized representatives named in Paragraph 11 of Form A: Proposal; and

(c) if the notice has been given by any one of the persons specified in B17.1.12(b), declare the Proposal withdrawn.

B17.2 A Proponent who withdraws its Proposal after the Submission Deadline but before its offer has been released or has lapsed as provided for in B16.2 shall be liable for such damages as are imposed upon the Proponent by law and subject to such sanctions as the Chief Administrative Officer considers appropriate in the circumstances. The City, in such event, shall be entitled to all rights and remedies available to it at law.

B18. INTERVIEWS

B18.1 The Project Manager may, in his/her sole discretion, interview Proponents during the evaluation process.

B19. NEGOTIATIONS

B19.1 The City reserves the right to negotiate details of the Contract with any Proponent. Proponents are advised to present their best offer, not a starting point for negotiations in their Proposal Submission.

B19.2 The City may negotiate with the Proponents submitting, in the City's opinion, the most advantageous Proposals. The City may enter into negotiations with one or more Proponents without being obligated to offer the same opportunity to any other Proponents. Negotiations may be concurrent and will involve each Proponent individually. The City shall incur no liability to any Proponent as a result of such negotiations.

B19.3 If, in the course of negotiations pursuant to B19.2 or otherwise, the Proponent amends or modifies a Proposal after the Submission Deadline, the City may consider the amended Proposal as an alternative to the Proposal already submitted without releasing the Proponent from the Proposal as originally submitted.

B20. EVALUATION OF PROPOSALS

B20.1 Award of the Contract shall be based on the following evaluation criteria:

(a)	compliance by the Proponent with the requirements of the Request for Proposal or acceptable deviation therefrom:	(pass/fail)
(b)	qualifications of the Proponent and the Subconsultants, if any, pursuant to B14:	(pass/fail)
(c)	Fees; (Section B)	40%
(d)	Experience of Proponent and Subconsultants; (Section C)	10%

(e)	Experience of Key Personnel Assigned to the Project; (Section D)	20%
(f)	Project Understanding and Methodology (Section E)	20%
(g)	Project Schedule. (Section F)	10%

B20.2 Further to B20.1(a), the Award Authority may reject a Proposal as being non-responsive if the Proposal Submission is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Proposal, or waive technical requirements or minor informalities or irregularities if the interests of the City so require.

B20.3 Further to B20.1(b), the Award Authority shall reject any Proposal submitted by a Proponent who does not demonstrate, in its Proposal or in other information required to be submitted, that it is responsible and qualified.

B20.4 Further to B20.1(c), Fees will be evaluated based on Fees submitted in accordance with B9.

B20.5 Further to B20.1(d), Experience of Proponent and Subconsultants will be evaluated considering the experience of the organization on projects of similar size and complexity as well as other information requested.

B20.6 Further to B20.1(e), Experience of Key Personnel Assigned to the Project will be evaluated considering the experience and qualifications of the Key Personnel and Subconsultant personnel on Projects of comparable size and complexity.

B20.7 Further to B20.1(f), Project Understanding and Methodology will be evaluated considering your firm's understanding of the City's Project, project management approach and team organization.

B20.8 Further to B20.1(g), Project Schedule will be evaluated considering the Proponent's ability to comply with the requirements of the Project.

B20.9 Notwithstanding B20.1(d) to B20.1(g), where Proponents fail to provide a response to B7.2(a) to B7.2(d), the score of zero may be assigned to the incomplete part of the response.

B21. AWARD OF CONTRACT

B21.1 The City will give notice of the award of the Contract, or will give notice that no award will be made.

B21.2 The City will have no obligation to award a Contract to a Proponent, even though one or all of the Proponents are determined to be responsible and qualified, and the Proposals are determined to be responsive.

B21.2.13 Without limiting the generality of B21.2, the City will have no obligation to award a Contract where:

(a) the prices exceed the available City funds for the Services;

(b) the prices are materially in excess of the prices received for similar services in the past;

(c) the prices are materially in excess of the City's cost to perform the Services, or a significant portion thereof, with its own forces;

(d) only one Proposal is received; or

(e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B21.3 Where an award of Contract is made by the City, the award shall be made to the responsible and qualified Proponent submitting the most advantageous offer.

B21.4 The City may, at its discretion, award the Contract in phases, and limit the number of phases awarded to the Consultant.

B21.5 Notwithstanding Paragraph 6 of Form A: Proposal and C4, the City will issue a Letter of Intent to the successful Bidder in lieu of execution of a Contract.

B21.5.14 The Contract documents as defined in C1.1(n)(ii) in their entirety shall be deemed to be incorporated in and to form a part of the Letter of Intent notwithstanding that they are not necessarily attached to or accompany said Letter of Intent.

B21.6 The form of Contract with the City of Winnipeg will be based on the Contract as defined in C1.1(n).

B21.7 Following the award of Contract, a Proponent will be provided with information related to the evaluation of its Proposal upon written request to the Project Manager.

B21.8 If, after the award of Contract, the Project is cancelled, the City reserves the right to terminate the Contract. The Consultant will be paid for all Services rendered up to time of termination.

PART C - GENERAL CONDITIONS

C0. GENERAL CONDITIONS

C0.1 The *General Conditions for Consultant Services* (Revision 2010-10-01) are applicable to the Services of the Contract.

C0.1.15 The *General Conditions for Consultant Services* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division website at http://www.winnipeg.ca/matmgt/gen_cond.stm.

C0.2 A reference in the Request for Proposal to a section, clause or subclause with the prefix "**C**" designates a section, clause or subclause in the *General Conditions for Consultant Services*.

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

D1.1 In addition to the *General Conditions for Consultant Services*, these Supplemental Conditions are applicable to the Services of the Contract.

D2. PROJECT MANAGER

D2.1 The Project Manager is:

Chris Sauvé, P.Eng., PMP

Email: csauve@winnipeg.ca

Telephone No. 204 986-2077

D2.2 At the pre-commencement meeting, the Project Manager will identify additional personnel representing the Project Manager and their respective roles and responsibilities for the Services.

D2.3 Proposal Submissions must be submitted to the address in B7.10.

D3. BACKGROUND

D3.1 In 2008, the City commissioned a Sequence Batch Reactor (SBR) nitrogen removal facility at the NEWPCC. The SBR's nitrogen removal performance has been satisfactory, but compared to newer SBR processes with advanced processes, operating costs are significantly higher.

In 2012, the City retained AECOM to evaluate options for the SBR process. Based on AECOM's report in Appendix B 'NEWPCC SBR Optimization Study Technical Memorandum', the City selected the Long SRT Nitrification-Denitrification upgrade. This modification is expected to reduce energy requirements and the dependency on hazardous chemicals. The result will be a safer work environment, significant operational savings, and a short investment payback period.

The City has also identified an opportunity to use treated centrate in place of potable water for the mixing and conveyance of soda ash, eliminating the cost and environmental impact of potable water use.

D3.2 In 2014, the City agreed to move forward with the following scope of work for the SBR facility:

(a) Implement the Long SRT Nitrification-Denitrification modifications.

(b) Consider replacing potable water with treated centrate for the conveyance of soda ash.

(c) Address SBR process concerns and opportunities for improvement, detailed in D4.

D4. SCOPE OF SERVICES

D4.1 Provide consulting engineering and design services for the NEWPCC SBR optimization and ancillary works. In addition, the City has the option to award either D4.2(e) 'Contract Administration, Phase 4' services, or D4.2(g) 'Optional Services'.

D4.2 The Scope of Services required under this contract shall consist of the following:

(a) General Services

(i) Prepare an agenda for all project team meetings (excluding the construction kick-off meeting, which will be supplied by the City). Forward a copy to the meeting attendees at least 24 hours in advance of meeting.

(ii) Schedule and chair all meetings. Record minutes including action items and corresponding due dates, and distribute electronically within 3 working days of the meetings.

(iii) Keep a record of all project-related documents and submit copies to the Project Manager electronically for review and comment. Amend as requested.

(iv) Use an email format provided by the Project Manager.

(v) Plan, organize, secure and manage resources to bring about the successful completion of specific project goals and objectives.

(vi) The Project Manager may request up to 5 hardcopies of draft and final documents generated by the Consultant along with an electronic copy.

(vii) Develop a project schedule identifying project activities, milestones, and deliverables. Include award dates, phases, report and design submissions, substantial performance, and proposed total performance. Allow the following:

- Up to 10 working days for the City to review submissions,
- 15 working days for construction tender submissions,
- 40 working days for tender evaluation and award.

(viii) Develop a risk register with input from the project team using City supplied templates. Re-evaluate with the City at least once within each phase of the project, or more frequently if deemed necessary by the Project Manager.

(ix) Identify to the Project Manager the impact (time, quality, cost) of proposed changes, so that the Project Manager may make well-informed decisions whether or not to proceed with the proposed changes.

(x) Use City supplied templates and forms for all services identified unless requested otherwise. The Consultant is to review these requirements with the City's Project Manager identified in D2.

(xi) When applicable, the Consultant shall have a confined entry permit system and safe work plan in place. If City equipment is to be used, the Consultant shall sign an applicable liability waiver.

(b) Pre-Design, Phase 1

(i) Conduct a pre-design kick-off meeting with City personnel.

(ii) Task 1 - SBR Optimization to Long SRT Nitrification-De-nitrification

- Review the Report entitled 'NEWPCC SBR Optimization Study Technical Memorandum'.
  - Confirm that the recommendations and expected results for the Long SRT Nitrification-Denitrification alternative are valid. Note that SBR Tank 2 will be available for inspection from September 2014 into mid-October 2014 to coincide with scheduled maintenance, and that SBR Tank 1 will not be available for inspection. Assume the Tanks share similar characteristics.
  - If discrepancies are found between the Report and expected results or scope of work, provide details and recommendations to the City for review and discussion, and possible revision.
- Assume responsibility for successful implementation of the Long SRT Nitrification-Denitrification process. A Performance Review, as described in D4.2(f), will be conducted after the commissioning period.
- Complete an assessment of NEWPCC equipment and processes that may be impacted by the selected scope of work. The assessment should include, but not be limited to, the following:
  - SBR blower including capacity, efficiency, and level of redundancy
  - SBR seeding process
  - Dilution pumps and ChemScan sampling process
  - SBR sampling system improvements
  - Condition and function of diffusers to meet design requirements

(iii) Task 2 - Process Enhancements

- Review and provide recommendations on the following:
  - ♦ SBR soda ash feed system process improvements and maintenance requirements.
  - ♦ Feasibility of locating the SBR wasting stream ahead of the Primary Clarifiers,
  - ♦ A new plumbing system for SBR cleaning operations (a section of pipe with a header)
  - ♦ Mass flow meter installation
  - ♦ Wear and performance review of all pumping, piping, and mixers associated with the SBR process.
  - ♦ Influent gate alignment and functionality.

(iv) Task 3 - Soda Ash Conveyance

- Review and provide recommendations on the use of treated centrate in place of potable water for soda ash conveyance. Include an evaluation of the treated centrate to confirm functionality.

(v) Prepare a Pre-Design Report for Tasks 1, 2, and 3 documenting investigations performed, findings, recommendations, sketches (if applicable), and project schedules for review and approval by the City.

- Provide a breakdown of cost estimates for each Task, and within each Task as applicable.
- Include site constraints and installation strategies.

(vi) Arrange a meeting with the City to present the Pre-Design Report and obtain input and approval from City personnel.

(vii) Finalize the scope of work for the project and obtain approval from the City.

(viii) Additional meetings can be accommodated to suit the Consultant's requirements.

(c) Preliminary Design, Phase 2

(i) Prepare preliminary design drawings, specifications, and tender package for review by the City. Meet with the City steering committee to discuss progress and obtain input. Incorporate requested changes into document.

(ii) Organize and lead a HAZOP/CHAIR workshop at the NEWPCC.

(iii) Identify all permits necessary for construction.

(iv) Include the following as part of the design scope:

- Additional DO and pH instrumentation to meet design requirements
- Development and installation of SBR control algorithms.
- All works to tie-in to the existing DCS system.
- Blanking off diffusers to reduce flow
- Blower air flow monitoring installation

(v) Create a construction sequence plan, and include site constraints identified in the Pre-Design Phase.

(vi) Prepare a preliminary cost estimate (Class 3) and revised project schedule.

(vii) Develop a preliminary commissioning plan.

(d) Detailed Design, Phase 3

(i) Make application to public agencies for necessary authorizations such as permits, prepare and submit reports and drawings thereto, and appear before the same in support of all applications.

(ii) Prepare tender ready detailed design drawings, specifications, and final tender package for review by the City. If required, meet with the City steering committee to obtain input and incorporate requested changes into document.

(iii) Prepare a detailed level cost estimate (Class 1).

(iv) Submit approved tender package to Materials Management for public bidding.

(v) Provide appropriate response to bidders and advice to the City during tender period and issue addenda to the contract documents as necessary.

(vi) Arrange for and attend bidder's site visit(s).

(vii) Evaluate submissions and make a recommendation for award of contract.

(viii) Conduct a pre-award meeting with the proposed contractor.

(e) Contract Administration, Phase 4

(i) Appendix D 'Contract Administration Manual' shall be applicable to the provision of Contract Administration services for this project with the following exceptions:

- Any conflict between the RFP and Appendix D 'Contract Administration Manual' or Appendix A 'Definition of Professional Consulting Services (Consulting Engineering Services)' shall be governed by this RFP Document.

(ii) Conduct a construction kick-off meeting using the agenda supplied by the City.

- At this meeting, establish a communication plan that includes the protocol for change management and distribution of documents.

(iii) Prior to construction, prepare and submit a written and photographic record of the physical condition of the work area, existing facilities, and structures sufficient to equip the City to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the project.

(iv) Review contractor's safe work plan for content and relevance to project.

(v) Review and accept shop drawings supplied by the contractor or supplier to ensure the drawings are in conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof.

- Submit two (2) hardcopies and one (1) electronic PDF copy of all final shop drawings.

(vi) Arrange for, review and report laboratory, field, shop and other tests conducted upon materials and/or equipment placed or installed by the contractor to ensure conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof.

(vii) Review and provide recommendations for requests for alternate materials and methods. No alternates shall be approved without written authorization from the City.

(viii) Review contractor schedule for acceptance. Monitor and advise City on construction progress and slippage mitigation measures during the course of construction.

(ix) Furnish the City with an electronic copy (paper where applicable) of all correspondence relating to the project.

(x) Prepare and track all FIN (field instruction notices), CCN (contemplated change notices), approved contract changes, RFI (request for information), submittals, and progress estimates and review same with City prior to issuance to contractor.

(xi) Arrange and chair weekly on-site meetings, which meetings shall include representatives of the contractor and the City.

(xii) Provide inspection services when the contractor is on-site to ensure that the construction is carried out in conformance with the drawings and specifications.

(xiii) Visit and inspect work at fabrication shops, staging areas, and manufacturing facilities as necessary.

(xiv) Keep records of project activities including a photographic record of construction work, working days, teleconferences, emails, inspections, and observations sufficient to equip the City to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the project.

(xv) Prepare and submit monthly progress reports to the Project Manager. At a minimum include the following; safety and security, cost reporting, construction progress, scheduling updates, and quality assurance activities (testing/inspections).

(xvi) Co-ordinate all work by third parties including, but not limited to hydro, gas, and City personnel, as applicable. Prepare and submit applications, reports, drawings, and other information as required in support of work by third parties.

(xvii) As required, provide a reference line and elevation to the contractor and check the contractor's adherence thereto.

(xviii) Prepare, certify and submit progress estimates to the City for payment to the contractor for construction performed in accordance with the drawings and specifications.

(xix) Co-ordinate and manage training sessions for City personnel for the operation and maintenance of new facilities and equipment. This includes planning and scheduling of training sessions, and review of training procedures and training documents prepared by the contractor. Accommodate employees on shift work.

(xx) Co-ordinate and manage start-up and commissioning of new equipment and facilities. This includes preparing a detailed commissioning plan, planning and scheduling of commissioning work for City personnel, full time site inspection during commissioning work, review of contractor submissions, and record keeping.

(xxi) Perform a detailed inspection of the project with the contractor and the City prior to completing Substantial Performance and Total Performance reviews. Ensure Total Performance is achieved within a reasonable time period.

(xxii) Prepare project closeout documents following City requirements.

(xxiii) Prepare and submit record drawings using the instructions provided in Appendix C.

(xxiv) Operations and Maintenance Manuals

- The City will issue a current SBR Operations and Maintenance manual to the Consultant.
- Manage, co-ordinate, and review Operations and Maintenance manual submissions from the contractor, and update the existing SBR Operation and Maintenance manuals accordingly. Submit draft copies to the City for review.
- Include updated descriptions, photographs, sketches and diagrams to reflect the new construction and equipment.
- Provide six (6) final hardcopies and one (1) electronic copy of the final O&M manuals. Ensure final copies are submitted within 1 month of the final draft review.

(f) Performance Review, Phase 5

(i) In addition to commissioning requirements, the Consultant, in cooperation with the City, will complete a performance review of the SBR process.

(ii) Process performance will be assessed by calculating average methanol consumption per removed nitrogen (kg methanol/kg N), and comparing to baseline values provided by the City and expected results defined in D4.2(b)(ii) ‘Pre-Design, Phase 1’.

(iii) The review period will last for 30 consecutive days, and will be initiated after the commissioning period has ended and SBR function has stabilized.

(iv) During the review period, centrate flow is to be uninterrupted by NEWPCC process changes. If interrupted, the review will be suspended until centrate flow is back to normal.

(v) The City will provide daily values for total nitrogen removed, methanol consumption, and centrate flow, and will measure general process performance using ChemScan equipment.

(vi) At the end of the review period, the Consultant shall submit a performance review report to the City. At a minimum, the report shall include an analysis of methanol consumed, total nitrogen removed, ChemScan results, and actual savings compared

to the 2013 Project Business Case found in the 'NEWPCC SBR Optimization Study Technical Memorandum'.

(vii) If the expected results for methanol consumption per removed nitrogen are not achieved, the Consultant will continue to provide suitable resources, and in a timely manner, until the expected results are achieved. During this time, additional funding will not be provided for consulting services, expenses related to the delivery of consulting services, or modifications to the SBR process due to Consultant error or omissions.

(g) Optional Services

The City may, in lieu of awarding D4.2(e) 'Contract Administration, Phase 4', award the proponent the following items of work.

(i) Prior to construction, prepare and submit a written and photographic record of the physical condition of the work area, existing facilities, and structures sufficient to equip the City to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the project.

(ii) Provide inspection services when the contractor is on-site complete with progress photographs to ensure that the construction is carried out in conformance with the drawings and specifications. Submit inspection reports/photo's to the city on a weekly basis

(iii) Visit and inspect work at fabrication shops, staging areas, and manufacturing facilities as necessary and approved by the city

(iv) As required, provide a reference line and elevation to the contractor and check the contractor's adherence thereto.

(v) Prepare, certify and submit progress estimates to the City for payment to the contractor for construction performed in accordance with the drawings and specifications.

(vi) Provide response to the city regarding contractor generated RFI (request for Information)

(vii) Provide engineering documentation to the City in regard to contemplated changes in the work

(viii) Attend and contribute as required at all contractor progress meetings

(ix) Provide contractor submittal review recommendations to the City

(x) Co-ordinate and manage training sessions for City personnel for the operation and maintenance of new facilities and equipment. This includes planning and scheduling of training sessions, and review of training procedures and training documents prepared by the contractor. Accommodate employees on shift work

(xi) Co-ordinate and manage start-up and commissioning of new equipment and facilities. This includes preparing a commissioning plan, planning and scheduling of commissioning work for City personnel, full time site inspection during commissioning work, review of contractor submissions, and record keeping.

(xii) Perform a detailed inspection of the project with the contractor and the City prior to completing Substantial Performance and Total Performance reviews

(xiii) Prepare and submit record drawings using the instructions provided in Appendix C.

(xiv) Operations and Maintenance Manuals

- The City will issue a copy of the current SBR Operations and Maintenance manual to the Consultant.
- Manage, co-ordinate, and review Operations and Maintenance manual submissions from the contractor, and update the existing SBR Operation and Maintenance manuals accordingly. Submit draft copies to the City for review.
- Include updated descriptions, photographs, sketches and diagrams to reflect the new construction and equipment.

- Provide six (6) final hardcopies and one (1) electronic copy. Ensure final copies are submitted within 1 month of the final draft review.

(h) Warranty Review

(i) Prior to expiration of the Warranty Period, make arrangements for a warranty acceptance inspection. Include representatives from the City, contractor, and each sub-contractor.

(ii) Provide a summary of warranty requirements to the City.

(iii) Make all necessary arrangements to ensure warranty work is completed. Provide written acceptance of the work to the City.

D4.3 Unless otherwise stated, Appendix A 'Definition of Professional Consultant Services (Consulting Engineering Services)' shall be applicable to the provision of Professional Engineering services for this project.

D5. DEFINITIONS

D5.1 When used in this Request for Proposal:

(a) "SBR" means Sequential Batch Reactor

(b) "SRT" means Sludge Retention Time

(c) "NEWPCC" means North End Water Pollution Control Center

(d) Report refers to the 'NEWPCC SBR Optimization Study Technical Memorandum' located in Appendix B

D6. OWNERSHIP OF INFORMATION, CONFIDENTIALITY AND NON DISCLOSURE

D6.1 The Contract, all deliverables produced or developed, and information provided to or acquired by the Consultant are the property of the City and shall not be appropriated for the Consultants own use, or for the use of any third party.

D6.2 The Consultant shall not make any public announcements or press releases regarding the Contract, without the prior written authorization of the Project Manager.

D6.3 The following shall be confidential and shall not be disclosed by the Consultant to the media or any member of the public without the prior written authorization of the Project Manager;

(a) information provided to the Consultant by the City or acquired by the Consultant during the course of the Work;

(b) the Contract, all deliverables produced or developed; and

(c) any statement of fact or opinion regarding any aspect of the Contract.

D6.4 A Consultant who violates any provision of D6 may be determined to be in breach of Contract.

SUBMISSIONS PRIOR TO START OF SERVICES

D7. AUTHORITY TO CARRY ON BUSINESS

D7.1 The Consultant shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Consultant does not carry on business in Manitoba, in the jurisdiction where the Consultant does carry on business, throughout the term of the Contract, and shall provide the Project Manager with evidence thereof upon request.

D8. INSURANCE

D8.1 The Consultant shall procure and maintain, at its own expense and cost, insurance policies with limits no less than those shown below.

D8.2 As a minimum, the Consultant shall, without limiting its obligations or liabilities under any other contract with the City, procure and maintain, at its own expense and cost, the following insurance policies:

(a) Comprehensive or Commercial General Liability Insurance including:

(i) an inclusive limit of not less than $2,000,000 for each occurrence or accident with a minimum $2,000,000 Products and Completed Operations aggregate and $5,000,000 general aggregate;

(ii) all sums which the Consultant shall become legally obligated to pay for damages because of bodily injury (including death at any time resulting therefrom) sustained by any person or persons or because of damage to or destruction of property caused by an occurrence or accident arising out of or related to the Services or any operations carried on in connection with this Contract;

(iii) coverage for Products/Completed Operations, Blanket Contractual, Consultant's Protective, Personal Injury, Contingent Employer's Liability, Broad Form Property Damage, Employees as Additional Insureds, and Non-Owned Automobile Liability;

(iv) a Cross Liability clause and/or Severability of Interest Clause providing that the inclusion of more than one Insured shall not in any way affect the rights of any other Insured hereunder in respect to any claim, demand, suit or judgment made against any other Insured;

(b) if applicable, Automobile Liability Insurance covering all motor vehicles, owned and operated and used or to be used by the Consultant directly or indirectly in the performance of the Service. The Limit of Liability shall not be less than $2,000,000 inclusive for loss or damage including personal injuries and death resulting from any one accident or occurrence.

(c) Professional Errors and Omissions Liability Insurance including:

(i) An amount not less than $5,000,000 per claim and $5,000,000 in the aggregate.

D8.2.16 The Consultant's Professional Errors and Omissions Liability Insurance shall remain in force for the duration of the Project and for twelve (12) months after Total Performance.

D8.3 The policies required in D8.2(a) shall provide that the City is named as an Additional Insured thereunder and that said policies are primary without any right of contribution from any insurance otherwise maintained by the City.

D8.4 The Consultant shall require each of its Subconsultants to provide comparable insurance to that set forth under D8.2(a).

D8.5 The Consultant shall provide the Project Manager with a certificate(s) of insurance for itself and for all of its Subconsultants, in a form satisfactory to the City Solicitor, at least two (2) Business Days prior to the commencement of any Services, but in no event later than the date specified in C4.1 for the return of the executed Contract. Such Certificates shall state the exact description of the Services and provide for written notice in accordance with D8.10.

D8.6 The Consultant may take out such additional insurance as it may consider necessary and desirable. All such additional insurance shall be at no expense to the City.

D8.7 All insurance, which the Consultant is required to obtain with respect to this Contract, shall be with insurance companies registered in and licensed to underwrite such insurance in the Province of Manitoba.

D8.8 If the Consultant fails to do all or anything which is required of it with regard to insurance, the City may do all that is necessary to affect and maintain such insurance, and any monies expended by the City shall be repayable by and recovered from the Consultant.

D8.9 The failure or refusal to pay losses by any insurance company providing insurance on behalf of the Consultant or any Subconsultants shall not be held to waive or release the Consultant or Subconsultants from any of the provisions of the insurance requirements or this Contract. Any insurance deductible maintained by the Consultant or any Subconsultants under any of the insurance policies is solely for their account and any such amount incurred by the City will be recovered from the Consultant as stated in D8.8.

D8.10 The Consultant shall not cancel, materially alter, or cause any policy to lapse without providing at least thirty (30) Calendar Days prior written notice to the City.

SCHEDULE OF SERVICES

D9. COMMENCEMENT

D9.1 The Consultant shall not commence any Services until it is in receipt of a notice of award from the City authorizing the commencement of the Services.

D9.2 The Consultant shall not commence any Services until:

(a) the Project Manager has confirmed receipt and approval of:

(i) evidence of authority to carry on business specified in D7;

(ii) evidence of the insurance specified in D8;

(b) the Consultant has attended a meeting with the Project Manager, or the Project Manager has waived the requirement for a meeting.

D9.3 The City intends to award this Contract by October 3, 2014.

APPENDIX A – DEFINITION OF PROFESSIONAL CONSULTANT SERVICES (CONSULTING ENGINEERING SERVICES)

1. INTRODUCTION

1.1 It is the intent of the City of Winnipeg, in defining Professional Consultant Services (Consulting Engineering Services), to clarify the role required of consulting Engineers; to more fully identify the services to be rendered by consulting Engineers to the City and to other parties on behalf of the City; and to provide a more clearly determined basis of obligation in respect thereof by consulting Engineers to the City and to third parties in the provision of such services.

1.2 The services shall be performed in the City of Winnipeg, unless otherwise authorized by the City, under direct supervision of a professional Engineer. All drawings, reports, recommendations and other documents, originating there from involving the practice of professional engineering, shall bear the stamp or seal and signature of a qualified Engineer as required by the Engineering and Geoscientific Professions Act of the Province of Manitoba and By-laws of the Association of Professional Engineers and Geoscientists of the Province of Manitoba. Other reports and documents not involving the "practice of professional engineering", such as letters of information, minutes of meetings, construction progress reports, may be originated and signed by other responsible personnel engaged by the consulting Engineer and accepted by the City. Progress estimates, completion certificates and other reports related to the technical aspects of a project, must be endorsed by the Engineer in a manner acceptable to the City.

2. ADVISORY SERVICES

2.1 Advisory services are normally not associated with or followed by preliminary design and/or design services, and include, but are not limited to:

(a) Expert Testimony;

(b) Appraisals;

(c) Valuations;

(d) Rate structure and tariff studies;

(e) Management services other than construction management;

(f) Feasibility studies;

(g) Planning studies;

(h) Surveying and mapping;

(i) Soil mechanics and foundation engineering;

(j) Inspection, testing, research, studies, or reports concerning the collection, analysis, evaluation; and

(k) Interpretation of data and information leading to conclusions and recommendations based upon specialized engineering experience and knowledge.

3. PRELIMINARY DESIGN

3.1 Preliminary design services are normally a prelude to the detailed design of a project and include, but are not limited to:

(a) Preliminary engineering studies;

(b) Engineering investigation;

(c) Surface and subsurface site explorations, measurements, investigations, and surveys;

(d) Operations studies including drainage studies, traffic studies, etc.;

(e) Functional planning;

(f) Physical, economical (capital and operating) and environmental studies including evaluation, comparison, and recommendation regarding alternative preliminary designs;

(g) Preparation and submission of a report and appropriate drawings to the City, fully documenting data gathered, explaining adequately the assessment made, stating with clarity the resulting conclusions, and containing all recommendations which are relevant to this stage of project implementation;

(h) Special applications to public agencies for necessary authorizations, preparation and submission of reports and drawings thereto and appearance before same in support of the application.

4. DETAILED DESIGN

4.1 Detailed design services normally involve preparation of detailed designs, tender specifications and drawings, and analysis of bids and recommendations for contract award, and include, but are not limited to:

(a) Addressing alternative methods of accommodating; relocating; avoiding, and/or avoiding injury to Utilities and railways; proposing alternative methods of solution, reviewing same with the appropriate Regulatory approval agencies and stakeholders;

(b) Application to public agencies for necessary authorizations, preparation and submission of reports and drawings thereto, and appearance before same in support of the application;

(c) Preparation and submission of detailed engineering calculations, drawings, and criteria employed in the design(s), securing review of and an acceptance by the City;

(d) Preparation of detailed engineering drawings, specifications and tender documents consistent with the standards and guidelines of the City, securing review of acceptance by the City;

(e) Preparation and provision to the City in written form, a fully detailed formal construction contract estimate;

(f) Provision of appropriate response to bidders and advice to the City during the bid period and, subject to acceptance by the City, issuing addenda to the tender documents;

(g) Submission of a review, analysis, comparison, tabulation, calculation, and evaluation of the bids received, to the City;

(h) Preparation of a report including revised contract estimate, identifying and explaining variations from the earlier formal estimate, and containing recommendation regarding contract award identifying the reasons therefore.

5. CONTRACT ADMINSTRATION SERVICES

5.1 Contract administration services are associated with the construction of a project and include the office and field services required to ensure the conduct of the project in accordance with the intent of the City and in conformance with the particulars of the drawings and specifications; and include but are not limited to:

NON-RESIDENT SERVICES

(a) Consultation with and advice to the City during the course of construction;

(b) Review and acceptance of shop drawings supplied by the contractor or supplier to ensure that the drawings are in conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(c) Review and report to the City upon laboratory, shop and other tests conducted upon materials and/or equipment placed or installed by the contractor to ensure to the City conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(d) Acceptance of alternate materials and methods, subject to prior acceptance by the City, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(e) Provision to the City of a complete current report on the project status on a monthly basis;

(f) Provision to the City a current update of revised contract-end cost estimate on a monthly basis, or more frequently if found necessary, with explanation and justification of any significant variation from the preceding contract-end cost estimate;

(g) Definition and justification of and estimate of cost for additions to or deletions from the contract for authorization by the City;

(h) Furnishing the City with a copy of all significant correspondence relating directly or indirectly to the project, originating from or distributed to, parties external to the consulting Engineer, immediately following receipt or dispatch of same by the consulting Engineer;

(i) Provision of adequate and timely direction of field personnel by senior officers of the Consultant;

(j) Establishment prior to construction and submission to the City of written and photographic records of, and assessment of the physical condition of adjacent buildings, facilities, and structures sufficient to equip the consulting Engineer to provide valid evidence and relevant testimony in settlement of any claim involving the City by any court of law, or by any other party for damages thereto arising from the project;

(k) Arranging and attending pre-construction meetings and on-site or off-site review meetings, which meetings shall include representatives of the contractor and the City;

(l) The preparation and submission of:

  (i) a detailed design notes package including items such as structural, geotechnical, hydraulic and heating, air-conditioning and ventilation design calculations; mechanical and electrical design calculations related to process equipment and building services; process design calculations; and instrumentation and process control design calculations;

  (ii) approved related shop drawings and equipment process manuals all within one (1) month of completion of each separate installation contract required to complete the Works.

RESIDENT SERVICES

(m) Provision of qualified resident personnel acceptable to the City present at the project site to carry out the services as specified immediately below, without relieving the contractor of his contractual and other legal obligations in respect thereof:

  (i) inspection of all pipe prior to installation;

  (ii) inspection and acceptance of excavation for, and full time inspection at the time of bedding placement, pipe laying and backfilling in respect of installation of watermains, land drainage sewers, and wastewater sewers;

  (iii) inspection of installation of all connections to watermains, sewers, manholes, valves, hydrants or house services, and excavation and/or exposing of all underground services, structures, or facilities;

  (iv) "full time inspection" and/or testing of watermains and sewers;

  (v) inspection of all excavations to determine soil adequacy prior to installation of base and subbase courses for sidewalks, public back lanes, and street pavements.

  It is to be understood that "full time inspection" will require assignment of a qualified person to each specific location when the referenced work is being undertaken by the contractor.

(n) Without relieving the contractor of his contractual and other legal obligations in respect thereof, conduct detailed inspection of construction sufficient to ensure that the construction carried out by the contractor is in conformance with the drawings and specifications;

(o) Co-ordination and staging of all other works on the project site including traffic signal installations, hydro, telephone, and gas utility work, railway work forces and City or developer work;

(p) In conjunction with the City, provision of notice to adjacent residents and businesses of those stages of construction of the project that will interrupt public services or access thereto, sufficiently in advance of same to permit preparation therefore;

(q) Enforcement of contractor conformance with the City of Winnipeg Manual of Temporary Traffic Control in Work Areas on City Streets and with reasonable standards of safety for motorists and pedestrians, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(r) Provision of reference line and elevation to the contractor and checking upon the contractor's adherence thereto, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(s) Responsible, sensitive, and prompt reaction to the reasonable requests and complaints of citizens regarding the conduct of the project, acting in the interest of the City;

(t) Arranging for and carrying out of testing of materials utilized by the contractor to ensure conformance with the drawings and specifications, without relieving the contractor of his contractual and other legal obligations in respect thereof;

(u) Preparation, certification, and prompt submission of progress estimates to the City for payment to the contractor for construction performed in accordance with the drawings and specifications;

(v) Arrange, attend and prepare and distribute records of and minutes for, regularly held on-site or offsite project review meetings including representatives of the contractor and the City;

(w) Promptly reporting to the City upon any significant and unusual circumstances;

(x) Promptly arranging for and taking part in a detailed final inspection of the project with the contractor and the City prior to commencement of the period of contractor maintenance guarantee specified in the contract for the project and providing to the City in written form an appropriate recommendation of acceptance of the constructed or partially constructed project;

(y) Act as Payment Certifier and administer all contracts as required under the Builder's Liens Act of Manitoba;

(z) Prepare a Certificate of Substantial Performance;

(aa) Preparation and submission to the City of "as-constructed" drawings for the project within 1 month of project completion;

(bb) Prepare a Certificate of Total Performance;

(cc) Provision of inspection services during the maintenance guarantee period of the contract;

(dd) Undertake a detailed inspection of the project with the contractor and the City prior to the end of the period of contractor maintenance guarantee specified in the contract for the project;

(ee) Keep a continuous record of working days and days lost due to inclement weather during the course of contract works;

(ff) Prepare a Certificate of Acceptance.

6. ADDITIONAL SERVICES

6.1 Additional services are in addition to those specified in other Types of Services and may or may not be associated with a construction project, but are not in place of or in substitution for those services elsewhere specified in the Definition of Standard Consulting Engineering Services in respect of other Types or Categories of Services.

(a) Revision of completed, or substantially completed, drawings and/or specifications that were in conformance with the original intent of the City or had been accepted by the City;

(b) Preparation of operating manuals and/or training of operating personnel;

(c) Start-up and/or operation of operating plants;

(d) Procurement of materials and equipment for the City;

(e) Preparation for and appearance in litigation on behalf of the City; and

(f) Preparation of environmental studies and reports and presentation thereof in public hearings

APPENDIX B – NEWPCC SBR OPTIMIZATION STUDY TECHNICAL MEMORANDUM

City of Winnipeg

NEWPCC SBR Optimization Study
Technical Memorandum

Prepared by:

AECOM
99 Commerce Drive
Winnipeg, MB, Canada R3P 0Y7
www.aecom.com

204 477 5381 tel
204 284 2040 fax

Project Number:

60278572.400

Date:

April, 2013

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to Consultant which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by Consultant represent Consultant's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since Consultant has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, Consultant, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by Consultant and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

Consultant accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of Consultant to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM: 2012-01-06

AECOM
99 Commerce Drive
Winnipeg, MB, Canada R3P 0Y7
www.aecom.com

204 477 5381 tel
204 284 2040 fax

April 17, 2013

Dr. Jong Hyuk Hwang, Ph.D., P.Eng.
Project Engineer - Wastewater Planning & Projects Delivery
City of Winnipeg, Water and Waste Dept., Engineering Division
110-1199 Pacific Avenue
Winnipeg, MB R3E 3S8, Canada

Dear Dr. Hwang:

Project No: **60278572.400**

Regarding: **NEWPCC SBR Optimization Study**
Technical Memorandum

AECOM is pleased to submit the final technical memorandum on the SBR Optimization Study. The document includes information from different vendors that should be considered confidential.

We thank you for the opportunity to undertake this study.

Sincerely,
AECOM Canada Ltd.

Simon Baker, M.Sc., P.Eng.
Project Manager
SB:td

Encl.

Distribution List

# of Hard Copies	PDF Required	Association / Company Name
5	1	City of Winnipeg

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	RT	April 17, 2013	Final TM

AECOM Signatures

Report Prepared By:

Ryujiro Tsuchihashi, Ph.D.
Senior Process Engineer

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1. Project Background

The centrate treatment plant at the NEWPCC, which uses sequencing batch reactors (SBRs), was commissioned in 2008. Since then the SBRs have been operating in their as-designed mode of operation, namely nitrification and denitrification, which was the best available and proven technology at the time the design was carried out. This approach to treatment uses costly and hazardous chemicals, predominantly methanol, and consumes significant electrical energy. The City of Winnipeg therefore wishes to explore options for reducing these costs, with a focus on some of the more recent developments in centrate treatment technology that have occurred since the NEWPCC centrate treatment plant was designed.

1.1 Objective of the Study

The objective of the study is to evaluate alternatives for modification or upgrade of the existing centrate treatment SBRs to:

1. Reduce energy and chemical consumption
2. Improve operability and safety by reducing the use of hazardous chemicals
3. Maintain, or improve on the nitrogen removal efficiency

1.2 Scope of Work

The scope of the study is divided into five tasks:

1. Establish reference case
   As advised by the City, calendar year 2011 is used to establish a reference case. Influent characteristics, treatment process performance, and chemical and energy consumption are summarized.
2. Identify and describe alternatives
   Alternatives will include optimized existing process, short- and long-SRT nitritation and denitritation, and the processes with partial nitritation-anaerobic ammonium oxidation (deammonification). A general description of each process, typical design parameters, and existing installations for each of the identified alternatives are provided.
3. Review alternatives
   Based on the information collected in the second task, each of the identified alternatives is reviewed for the process modification requirements, energy and chemical consumption, operational issues during the transition to new configurations, and the cost. Life cycle cost for each alternative is reported for 7 and 25 years. Design solutions, cost and other operational conditions for the alternatives are compared against the reference case.
4. Recommend alternatives
   Based on the analysis in the third task, recommendations are made.
5. Issue a technical memorandum (this report).

2. Reference Case

In this section, the reference case is defined. Treatment alternatives will subsequently be compared against the reference case. As mentioned in the scope of work, the definition of the reference case in this study is the conditions observed in calendar year 2011.

2.1 Design Flows and Loading of Existing Treatment Process

The existing treatment process was designed for the flows and loadings summarized in **Table 1**.

Table 1: Design Flows and Loadings

Parameter	Unit	Average	Maximum/ Design value
Centrate flow	MLD	2.05	3.00
Flushing water flow	MLD	2.25	3.4
Total flow to SBRs	MLD	4.3	6.4
Total Kjeldahl nitrogen (TKN)	kg/d	1779	2770
Total suspended solids (TSS)	kg/d	957	2538
COD	kg/d	2341	3787
$CBOD_5$	kg/d	252	411
Centrate temperature	°C		36
SBR influent temperature	°C		25
Total nitrogen (TN) in the effluent	kg/d		174[a]

[a] *30-day rolling average, minimum requirement.*

Note: The plant was originally designed for a TN removal of 838 kg/d (53 percent removal on average), with one SBR operating in nitrogen removal mode, and one in nitrification mode. However, subsequent discussions with the Province resulted in a change to an effluent of 174 kg/d (90 percent removal, on average). This change required both SBRs to operate in the nitrogen removal mode.

2.2 Description of Current Treatment Process

The existing centrate treatment process consists of:

- centrate feed system
- sequencing batch reactors
- flow equalization tank
- sodium carbonate feed system
- methanol feed system

2.2.1 General Description

A simplified schematic of the treatment process is shown in **Figure 1** and a summary of major structures and equipment is shown in **Table 2**. The main treatment process consists of two SBR units operating in parallel. Both SBRs are currently operating in the nitrification-denitrification mode. However, based on the functional design, the SBRs could be operated with one SBR in the nitrification mode for ammonia removal only and the other SBR in the nitrification-denitrification mode.

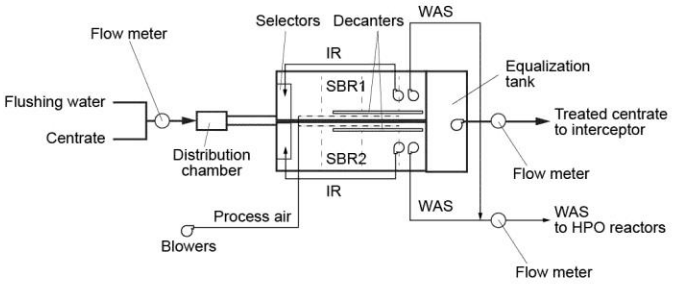


Figure 1: Schematic of Current Centrate Treatment Process

Table 2: Major Structures and Equipment for Centrate Treatment

Item	Description
Selector	95 m^3 (9 m long x 1.5 m wide x 7 m depth) each. Coarse bubble diffuser with a 50mm pipe for intermittent mixing
SBR tanks	SBR-1, SBR-2: 2 tanks in parallel, 5800 m^3 each, covered Reactor length: 48.0 m Reactor width: 17.8 m Maximum water depth = 7.0 m Freeboard = 1.5 m Bottom water level = 5.1 m (water volume at BWL = 4200 m^3)
Mixed liquor pumps	One pump in each SBR (C140, C240), MLSS to selector via 100ø pipe Flow: 3.9 L/s TDH: 2.5 m Power: 0.8 kW each
WAS pumps	One pump in each SBR (C150, C250) Flow: 81 L/s TDH: 11 m Power: 17.9 kW each
Aeration grid	Diffuser type: EPDM 9" membrane No. of diffuser grids per tank: 3 No. of diffusers per tank: 4610 (1537/grid) Total air flow (max): 15120 m^3/hr Air flow rate per diffuser (Max): 3.28 m^3/hr
Mixers	Three mixers in each SBR (C110, 120, 130, C210, 220, 230) Speed: 580 rpm Power: 6.2 kW each Mixing intensity: 3.2 W/m^3, 18.6 kW per reactor
Decanters	One in each SBR (C160, C260). Design weir loading rate = 70 m^3/m/hr. Design sludge blanket level = 1.0 m below the water level
Equalization tank	One tank accepting effluent from both SBRs, 1600 m^3 Reactor length: 36.0 m Reactor width: 12.7 m Depth between TWL and BWL: 3.5 m Two 3 kW submersible mixers (mixing energy = 5.6 W/m^3)

Item	Description
Equalization tank pumps	2 (1 duty, 1 standby) Flow: 81 L/s TDH: 11 m Power: 17.9 kW
Instrumentation	On sampling pipeline: pH, temperature, DO Online monitoring system (vendor package): NH_3, NO_2, NO_3, PO_4
Blowers	4 total (all duty), positive displacement, VFD Pressure: 73.5 kPa Flow: 115 m^3/min Power: 186 kW each
Soda ash feed	Package by vendor, sized for maximum of 850 kg/hr bulk soda. Includes potable water supply, soda ash silo (108 m^3 capacity), and a solution tank with a mixer.

The centrate feed system includes pipelines for centrate and flushing water, and a distribution chamber. Flushing water and centrate are mixed upstream of the distribution chamber and the influent flow is distributed through weir gates. The flushing water is added to lower the influent centrate temperature from nominal 36ºC to around 25ºC. Flowrate and temperature are monitored along the 350ø line between the junction of the two streams and the distribution chamber. A daily influent sample is taken downstream of the flow meter before the distribution chamber for influent quality analysis. Influent flows from the distribution chamber to the SBR by gravity. There is a line to feed RAS from the main treatment process (high purity oxygen activated sludge) but in 2011 no RAS from the main process was fed to the SBRs.

Each SBR tank has a 5800 m^3 capacity with a maximum water depth of 7.0 m. Each SBR is equipped with an anoxic selector, where influent and internal recycling (IR) flows are mixed to improve solids settlement. The SBRs are designed to operate on a 12 hour cycle time, with 10 hours of reaction and 2 hours of settlement and decanting. The SBRs are designed for a SRT of 10 days but are reported to operate at greater than 10 days. During the *react* phase in each SBR, intermittent aeration is applied based on a defined time schedule to provide aerobic and anoxic periods for nitrification and denitrification, respectively. For process monitoring, mixed liquor is pumped from the SBR tanks and the stream analyzed at a ChemScan unit for NH_3, NO_2^-, NO_3^-, and PO_4^{3-}. Temperature, DO, and pH are measured along the sampling pipeline before the ChemScan unit.

The air supply system has four positive displacement blowers (4 duty, no standby), each rated at 186 kW (250 hp) and equipped with variable speed drives. Two blowers are dedicated to each SBR. Fine bubble diffusers are used to distribute the air within the SBRs. The diffuser setup is illustrated in **Figure 2**. Three submersible mixers, one mixed liquor recycle pump and a WAS pump are placed in each SBR tank.

Treated effluent from the SBRs is decanted into a 1600 m^3 equalization tank, from which the effluent is pumped to the head of the mainstream plant. There are two mixers in the equalization tank.

Waste activated sludge (WAS) from the SBRs is directed to the existing high purity oxygen (HPO) reactors.

2.2.2 Flushing Water Addition

Flushing water is added to control the temperature of the SBRs. A flushing water to centrate flow ratio of approximately 50:50 to 60:40 was planned for the cold and warm seasons, respectively. The target mixed liquor temperature in the SBRs was between 22.5 and 27.5°C. The purpose of flushing water addition was to maintain the treatment temperature closer to that of the HPO process in anticipation of providing bioaugmentation (i.e., providing

nitrifying biomass to the mainstream bioreactor) for the mainstream process. However, the NEWPCC is currently not implementing bioaugmentation due to foaming encountered by the change in the operating conditions of the HPO system, and there is no plan to resume the operation of the HPO system in a bioaugmentation mode. Flushing water is still added as originally planned, and when the total flow exceeds the hydraulic capacity, excess centrate is bypassed to the interceptor sewer.

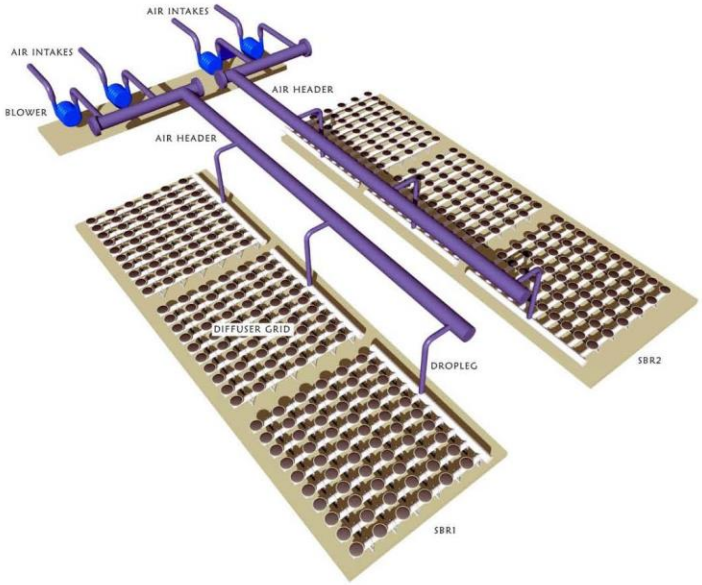


Figure 2: Aeration System Arrangement

2.2.3 Chemical Addition

Alkalinity, in the form of soda ash (sodium carbonate) is supplied to the SBRs for pH and alkalinity control. Soda ash is transferred from trucks to a 108 m^3 silo using a positive displacement blower. From the silo, soda ash is directed to a make-up system where it is mixed with potable water to a 3 percent solution and transferred to the SBRs.

Methanol is supplied to the nitrification-denitrification reactors as an external carbon source for denitrification. There are two 50 m^3 methanol storage tanks, and methanol is pumped to the nitrification-denitrification reactor during the anoxic (denitrification) phase of the *react* cycle.

2.2.4 Centrate Treatment Process Overflow

According to the plant staff, flows that exceeded the centrate treatment plant's hydraulic capacity are diverted to the interceptor sewer. When one of the two SBRs is shut down for maintenance, such as the replacement of diffusers, the other reactor would operate at the capacity of one SBR, and any excess flow diverted to the interceptor sewer.

2.3 Influent and Effluent Characteristics

Flows and influent characteristics for 2011 are summarized in **Table 3**. As indicated in **Figure 1**, the flow meter is placed for the combined centrate and flushing water flow. The centrate flowrates shown in **Table 3** are estimated based on the design flow ratio between centrate and flushing water. The average TKN concentration in the combined influent flow was 341 mg-N/L. Based on the design flow ratio of the centrate and flushing water, the average TKN concentration in the centrate before flushing water is added was estimated to be 713 mg-N/L.

Table 3: Flows and Influent Characteristics, 2011

Parameter	Unit	Average	5th percentile	95th percentile
Flowrate to SBRs including flushing water	MLD	3.7	2.4	4.9
Centrate feed rate (assumed 47.7% centrate)	MLD	1.8	1.1	2.3
Flushing water feed (assumed 52.3% flushing water)	MLD	1.9	1.2	2.6
SBR influent temperature	°C	27.0	25.2	29.8
Total suspended solids	mg/L	150	44	399
Total organic carbon	mg/L	75	44	128
Total Kjeldahl nitrogen	mg-N/L	341	268	440
Nitrate/nitrite	mg-N/L	10.7	2.5	21.7
Total phosphorus	mg-P/L	16.6	5.8	28.6
Ortho phosphorus	mg-P/L	10.2	0.6	20.8
Alkalinity	mg/L as $CaCO_3$	1065	857	1310

Effluent characteristics during calendar year 2011 are summarized in **Table 4**.

Table 4: Treated Effluent Characteristics, 2011

Parameter	Unit	Average	5th Percentile	95th Percentile
SBR effluent flow	MLD	2.6	1.3	4.0
WAS flow (SBR-1 and SBR-2 combined)	MLD	0.4	0.2	0.6
SBR-1 temperature	°C	30.9	27.4	32.8
SBR-2 temperature	°C	29.6	22.7	32.0
Total suspended solids	mg/L	16.8	4.0	45.6
Total organic carbon	mg/L	36.8	22.0	54.0
TKN	mg-N/L	10.1	3.0	36.0
Ammonium nitrogen	mg-N/L	5.0	0.1	26.8
Nitrate/nitrite	mg-N/L	6.5	1.2	18.4
Total phosphorus	mg-P/L	11.1	0.9	22.3
Ortho phosphorus	mg-P/L	10.3	0.6	21.2
Alkalinity	mg/L as $CaCO_3$	189	106	336

2.4 Current Process Performance

The treatment performance in 2011, which constitutes the reference case, is summarized in **Table 5**. Average flow rate to the SBRs in 2011 was 3.7 MLD. The design goal for the SBR system was 838 kg/d minimum removal as a

30-day rolling average. The Licence also refers to 838 kg/d removal. However, the current treatment goal based on an agreement with Manitoba Conservation is to achieve 174 kg/d effluent loading as a 30-day rolling average.

Table 5: SBR Performance, 2011

Parameter	Unit	Average	5th Percentile	95th Percentile
Flowrate to SBR including flushing water	MLD	3.7	2.4	4.9
Influent TKN loading	kg/d	1282	792	1857
Influent nitrate/nitrite loading	kg/d	40.6	7.8	89.5
Effluent TKN loading	kg/d	41.3	8.2	155.8
Effluent nitrate/nitrite loading	kg/d	25.4	4.4	81.9
Effluent TN loading	kg/d	66.7	12.6	237.7
TKN removed	kg/d	1235	798	1760
TN removed (% removal)	kg/d	1249 (95%)	811 (86%)	1811 (98%)
Total methanol use	kg/d	3144	1692	4839
Total methanol use as COD	kg-COD/d	4716	2538	7259
COD/N ratio for denitrification	-	4.02	2.81	5.48
Nitrogen loading rate	kg-N/m^3•d	0.12	0.08	0.18
Alkalinity consumed (calc)	kg/d as $CaCO_3$	4362	2778	6296
Soda ash solution use (calc)	kg/d	324	2.3	767
SBR-1 temperature	°C	30.9	27.4	32.8
SBR-2 temperature	°C	29.6	22.7	32.0

2.4.1 Nitrogen Removal

The average TN removal was approximately 1250 kg/d. The Licence level of 838 kg/d removal (as a 30-day rolling average) was met consistently during 2011. The annual average effluent TN loading was about 67 kg/d and the 30-day rolling average ranged from 23 to 199 kg/d. There was about one month when the effluent data were not available, and the 30-day rolling average effluent TN load exceeded 174 kg/d for 3.6 percent of the time.

The average TKN loading rate to two SBRs was 1282 kg-N/d and the average water volume in each SBR is 5130 m^3 (lower water level 4200 m^3 plus the volume received by one SBR in one cycle, 3700 m^3/d/4 cycles/d). The specific loading rate for the process was therefore 0.12 kg-N/m^3/d, which is lower than typical sidestream treatment processes. By design, the specific loading rate for the SBR system is lower since the initial intent was to bioaugment the HPO plant with nitrifier-enriched biomass. Bioaugmentation would be optimized through the addition of flushing water to reduce and control the SBR temperature and the addition of a portion of RAS to integrate the HPO and SBR mixed liquor solids. The 2011 specific loading rate was lower than design since the annual average daily TKN load was 28% lower than the average TKN design load of 1779 kg-N/d.

2.4.2 Chemical use

Methanol: In 2011, 1,235,476 kg of methanol was received and the average daily methanol consumption rate was 3100 kg/d (4700 kg-COD/d). With average influent and effluent TN loads of 1302 kg/d and 65 kg/d, respectively, the average daily nitrogen removal rate was 1237 kg-N/d. Using the average TN removal rate and average methanol

addition rate, this results in an average COD-to-N ratio of 4.02 g-COD/g-N-removed, which is close to a typical ratio for denitrification with methanol when considering that there is some biodegradable carbon in the influent. The total expenditure for methanol in 2011 was $692,435 ($740,941 with PST).

Soda Ash: Soda ash was delivered three times in 2011 (January, March and September). Each bulk delivery was about 30 m^3 at a total cost of $39,190 ($41,933 with PST). The average soda ash usage was 10.5 m^3/d, which is 324 kg/d of soda ash assuming the concentration of the feed solution as 3 percent. Soda ash is mixed with potable water in the soda ash solution tank (C645) and transferred to each SBR.

2.4.3 Energy Use

Energy consumption for the centrate treatment facility is not recorded separately. Therefore energy consumption was estimated based on the equipment usage. The summary of energy use and the costs is shown in **Table 6**.

The electrical power cost was estimated based on the fee structure for non-residential, customer-owned transformation. The rate includes 2.85 cents per kWh of energy charge, and $6.06 per kVA of demand charge.

Table 6: Energy Use Summary

Item	Unit	Value
Aeration system power consumption	kWh/mo	112,320
Mixing power consumption	kWh/mo	7,279
Other electrical power consumption	kWh/mo	17,881
Monthly power consumption	kWh/mo	137,480
Monthly electrical power charge	$/mo	6,853
Electrical power cost per year	$/yr	82,236

2.5 Current SBR Operations

Current operating conditions presented in this section represent the reference case operation. Possible modifications to the current operating conditions and treatment processes are described in the subsequent sections, and expected performance and costs in each option are compared against the reference case.

2.5.1 SBR Operation Mode

Currently, both SBRs are operated in nitrification/denitrification mode. Each operation cycle is 12 hours consisting of the following sequence:

- Aerobic fill: 2 hours
- Anoxic fill: 1 hour
- Aerobic fill: 2 hours
- Anoxic fill: 1 hour
- Aerobic fill: 2 hours
- Anoxic fill: 1 hour
- Aerobic fill: 1 hour
- Settling: 1 hour

- Decant: 1 hour

Typical DO and pH readings in response to the aerobic and anoxic cycles are shown in **Figure 3**.

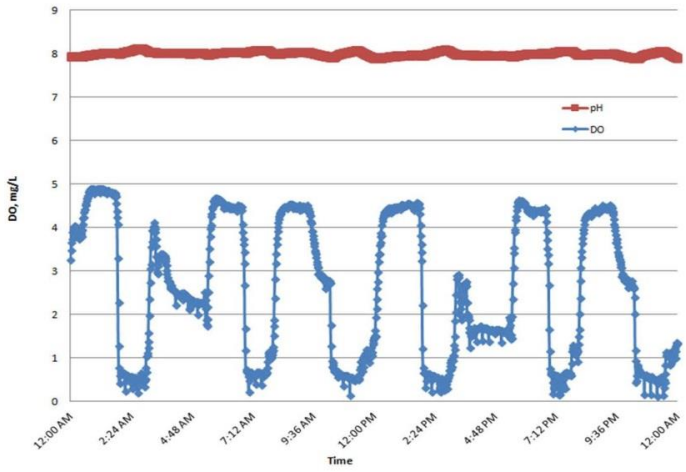


Figure 3: DO and pH Readings In Response to Aerobic and Anoxic Cycles (SBR-1, January 15, 2011)

2.5.2 Dilution of Centrate

Flushing water flow to the centrifuges was designed for a 60/40 split (flushing water to centrate) in the summer and a 50/50 split (flushing water to centrate) in the winter. The TKN concentration in the influent flow was 341 mg-N/L. Based on the flow contribution of the flushing water, the average TKN concentration in the centrate without flushing water was approximately 713 mg-N/L. In 2011, the average HPO plant effluent ammonium level was 22.8 mg-N/L, which is expected to correlate with the flushing water ammonium concentration. As mentioned previously, excess flow to the centrate treatment process is diverted to the interceptor sewer. However, no records were available to quantify the flows and nitrogen loads of any diverted flows.

2.5.3 Aeration and DO Control

As reported in **Table 1**, there are 4 variable-speed blowers. Currently, however, only one duty blower is used for each reactor and operated on an on/off basis based on the SBR sequence controller. According to the sequencer chart, the blower operates a total of 14.4 hours per day based on two SBRs with three 2.4-hour aeration cycles. The blower operates at approx. 75% speed (1200 rpm). Typical DO during the aerobic cycle appears to be in the range of 3 to 5 mg/L. The original intent was to control the blower with the DO concentration. However, the readings of the DO meter, which is located on the sampling pipeline, have not been reliable and the operator prefers not to use the data for process control.

It was reported that holes were cored in the SBR covers recently to immerse the DO and pH probes into the SBRs directly, instead of measuring DO and pH from the sample pipelines. SBR-1 has been operating for approximately two months in this configuration and DO readings were reported to be more responsive and higher for a given blower speed, which indicates that previous DO readings may have been artificially low due to sample transit time. The DO probes for SBR-2 have just been moved, and no data are available yet.

2.5.4 Soda Ash Dosing

Limited data are available on soda ash dosing. The soda ash feeding system is a packaged system and produces 3 percent solution to feed to each SBR. The pH of each SBR has been maintained mostly around 8 during both aerobic and anoxic phases.

2.6 Operating Cost

As shown in **Table 6**, the estimated cost of power consumption at the centrate treatment facility is approximately $82,000/yr. In 2011 and 2012, the unit price for soda ash was $417/m^3 and in 2011 $41,933 was spent on purchasing soda ash. Methanol was by far the largest expenditure, at $740,941.

3. Alternatives Identification

As per the scope of work, the following options were considered:

- Reference Case (NEWPCC SBR)
- Optimized Reference Case. This alternative involves modifications, where possible, to the Reference Case for optimized performance using the current nitrification-denitrification mode of operation.
- Long SRT nitritation-denitritation. This alternative is based on running the existing SBRs at a relatively long solids retention time (SRT) while inhibiting the formation of nitrate.
- Short SRT nitritation-denitritation (e.g. SHARON®). This system uses a short SRT for inhibition of nitrification
- Deammonification in a single stage reactor with suspended growth biomass (e.g. DEMON® and Cleargreen™). This alternative involves nitritation and deammonification using the ANAMMOX bacteria.
- Deammonification with a fixed film biomass (e.g. ANITA™Mox).

Each of the alternatives is described briefly in this section.

3.1 Reference Case

The reference case is exactly the same SBR operating mode as in Year 2011. The flow contribution from the flushing water will be 50 to 60 percent, depending on the temperature of the flushing water, and operating temperature will be between 24 and 33°C. The aeration rate is fixed and one blower is used for each reactor at 75 percent speed continuously during the aeration period. Each operation cycle is 12 hours (two cycles per day per reactor), and two SBRs operate in parallel. Soda ash is dosed to maintain pH at the 2011 average of 8.0 – 8.3, and methanol is dosed during the anoxic phases for denitrification. A summary of operating conditions for the Reference Case is shown in **Table 7**.

Table 7: Reference Case Summary

Item	Description
Reactor configuration	SBR
Nitrogen removal pathways	Nitrification/denitrification
Solids retention time	10 – 20 d
Operating temperature	24-33°C
Operating pH	~8
Operating DO	4-5 mg/L during aerobic phase
TKN loading rate	Average loading = 1282 kg/d
Volumetric TKN loading rate	0.12 kg-N/m^3•d at 2011 average 0.24 kg-N/m^3•d at design capacity
Aeration system	Fine-bubble 9" EPDM membrane disk
Mixing	3 x 6.2 kW per reactor
Control philosophy	On/off base aeration based on SBR sequencing controller, blowers operate at a constant 75% speed
Full-scale installation	City of Winnipeg

3.2 Optimized Reference Case

In the optimized reference case, no modifications involving capital cost are made to the existing treatment process except for the installation of online analyzers, but the operating conditions are modified to reduce the operating costs while maintaining the process performance. The pathways of nitrogen removal will be nitrification and denitrification (i.e., oxidizing ammonium to nitrate, NO_3^-, and denitrifying nitrate to nitrogen gas, N_2). The optimization will include:

- Improved DO control
- Reduction in the use of soda ash
- Reduction in flushing water flow which will result in a higher operating temperature

A summary of operating conditions for the Optimized Reference Case is shown in **Table 8**.

Table 8: Optimized Reference Case Summary

Item	Description
Reactor configuration	SBR
Nitrogen removal pathways	Nitrification/denitrification
Solids retention time	10 - 20 d
Operating temperature	30-38°C
Operating pH (expected range)	7-7.5
Typical operating DO	1.5-2 mg/L
TKN loading rate, average	1282 kg/d
Aeration system	Fine-bubble 9" EPDM membrane disk
Mixing	3 x 6.2 kW per reactor
Control philosophy	DO-based aeration control
Full-scale installation	N/A

Two major potential savings from process optimization are reduced electrical cost associated with aeration, and reduced soda ash consumption.

Currently, DO is measured at the online sample analysis system which draws mixed liquor from the SBR by sampling pump. Recognizing that the DO readings appeared to be unreliable, a DO meter was installed directly to the SBR reactor through holes drilled in the SBR cover. In the Optimized Reference Case, readings from the DO meters in the SBR tanks will be used to control the aeration rate.

Soda ash has been added at a constant rate to the SBRs, maintaining the reactor pH level at around 8. While this pH level is best for the growth of nitrifying bacteria, with an aerobic SRT above 5 days and an operating temperature near or above 30°C, similar nitrification performance is expected even at a pH near 7. Therefore, the soda ash dosing rate could be lowered to reduce this operating cost.

As described in the Reference Case, flushing water has been used to dilute centrate, resulted in a lower temperature and higher SBR influent flow rates. The primary purpose of flushing water addition was to lower the operating temperature closer to the main HPO process to grow nitrifying biomass to allow bioaugmentation. Because bioaugmentation is not currently being considered for the NEWPCC, flushing water flow will be reduced to raise the SBR operating temperature. The dilution water flow rate is determined based on a heat balance, and the expected flow rate is presented in the analysis of alternatives (Section 4). The modified flow rate will marginally reduce the nitrogen loading rate and the associated electrical cost for aeration.

3.3 Long SRT Nitritation-Denitritation

Long sludge retention time (SRT) nitritation-denitritation is defined as an operational mode when the DO concentration during each aerobic phase is reduced so that nitrogen is oxidized only to nitrite (NO_2^-) instead of nitrate (NO_3^-), and nitrite is reduced to nitrogen gas during the anoxic phase. Even though a single mechanism may not be solely responsible for restricting the nitrite oxidizing bacteria (NOB) growth, NOBs have a higher sensitivity to a low DO concentration than the ammonium oxidizing bacteria (AOB), reflected as a higher value of the DO half-saturation coefficient (Hanaki, et al., 1990). A low DO concentration has also been shown to induce the accumulation of hydroxylamine (Yang and Alleman, 1992) which has been shown to inhibit NOB growth (Noophan et al., 2004). As a consequence of this change in operating condition, the existing NOB population in the SBRs will gradually "wash out" of the system and nitrite accumulation during the aerobic phases will increase.

By preventing oxidation of nitrite to nitrate, approximately 25 percent reduction in oxygen requirement and 40 percent reduction in external carbon requirement will be achieved. Alkalinity consumption, however, will not change, as all alkalinity consumption occurs during ammonium oxidation, and all alkalinity recovery occurs during reduction of nitrite (no alkalinity recovery by reduction of nitrate to nitrite).

The SBR reactors will be operated without major modifications, except that DO and pH meters and a new process control algorithm must be introduced. The target DO concentration will be in the range of 0.5 to 1.0 mg/L, which will marginally reduce the air requirement. The blowers will be controlled by the DO concentration setpoint and the aeration cycle will be based on pH. The use of pH in turning on and off blowers has been shown to be effective in maintaining process stability. In this control method, high and low pH setpoints are established, typically creating a pH interval of 0.3 units, e.g. high and low setpoints of 7.5 and 7.2. At the high pH setpoint, the blower turns on to begin the aerobic phase. During nitrification, alkalinity is destroyed and the pH decreases. When the pH reaches the lower setpoint, the blower is turned off to initiate the anoxic phase. With the addition of methanol during each anoxic phase to enhance denitritation, alkalinity is created and the pH increases. Once at the higher pH setpoint, the next aeration cycle begins. Once stable operation is achieved and the duration of the aerobic and anoxic phases become evident, the operating mode could be switched to a timed intermittent aeration control scheme with defined aerobic and anoxic periods. However, if the duration of the aerobic and anoxic periods varies with centrate nitrogen load, the pH-based control scheme may provide a more robust process and stable effluent quality.

Similar to the optimized reference case, flushing water flow rate will be reduced to achieve the operating temperature between 30 and 38°C (typically 35°C on average). The target pH range will be fine-tuned during the transition to this operating mode, but is expected to be 7.2 to 7.5. In this pH range, soda ash consumption will decrease. Operating conditions for the long SRT nitritation-denitritation SBR are summarized in **Table 9**.

The long SRT nitritation-denitritation mode in a SBR where pH is used for blower control was demonstrated and documented at the Strass WWTP (Austria) in the late 1990s. This process mode was used until the sidestream system was converted to partial nitritation – anaerobic ammonium oxidation (deammonification) in 2004 (the first DEMON® process). The use of the long SRT nitritation-denitritation process continues to be used at other facilities such as the Salzburg WWTP (Austria). Based on the operating data from these plants, the nitrogen loading rate is in the range of 0.4 to 0.6 kg-N/m^3•d and primarily limited by the aeration system.

Table 9: Long SRT Nitritation-Denitritation Summary

Item	Description
Reactor configuration	SBR
Nitrogen removal pathways	Nitritation/denitritation
Solids retention time	5-10d (total)
Operating temperature	30ºC-38ºC
Operating pH (expected range)	7-7.5
Typical operating DO	0.5-1.0 mg/L
TKN loading rate	Average loading = 1282 kg/d
Typical volumetric nitrogen loading rate	0.4-0.6 kg-N/m^3•d
Aeration system	Fine-bubble 9" EPDM membrane disk
Mixing	3 x 6.2 kW per reactor
Control philosophy	pH controlled, DO-controlled, or time-based intermittent aeration.
Full-scale installation	Strass, Austria; Salzburg, Austria

3.4 Short SRT Nitritation-Denitritation

Short SRT nitritation-denitritation is defined as an operational mode in which the aerobic SRT is controlled at a lower setpoint and the temperature is maintained within a narrow range so that ammonium oxidizing bacteria can be retained but nitrite oxidizing bacteria are washed out and thus ammonium is oxidized only to nitrite. The SHARON® (Stable reactor system for High Ammonia Removal Over Nitrite) process is the only well-established proprietary technology with full-scale installations in this category.

The SHARON® process is designed usually as a flow-through configuration without solids retention (i.e. no settling or clarification step), and all recent installations are designed in a two-stage configuration: the first stage for denitritation, and the second stage for nitritation with a recycle flow to feed nitrite to the denitritation stage (typically 10 to 12 times the influent flow). An external carbon such as methanol is used for denitritation, and alkalinity is added to the nitritation tank as needed. The process provides stable nitritation-denitritation by exploiting the difference in the specific growth rates of the AOB and NOB at operating temperatures above 30˚C. At these elevated temperatures, an aerobic SRT of 1.5 days provides sufficient time for AOB growth, but the NOB cannot grow fast enough to sustain themselves in the reactor. Therefore, the operating temperature must be controlled within the desired range, typically around 35˚C, by dilution water or a heat exchanger. In the absence of solids retention, the SRT will be the same as the hydraulic retention time (HRT), and the aerobic volume is based on the maximum centrate flow rate or diluted centrate flow rate if dilution water is used for temperature control. At flow rates less than design, the blower is cycled on and off to control the aerobic time in the nitritation stage precisely at 1.5 days, using influent flow measurements for control. A simplified process flow diagram is shown in **Figure 4** and design and operating conditions are summarized in **Table 10**.

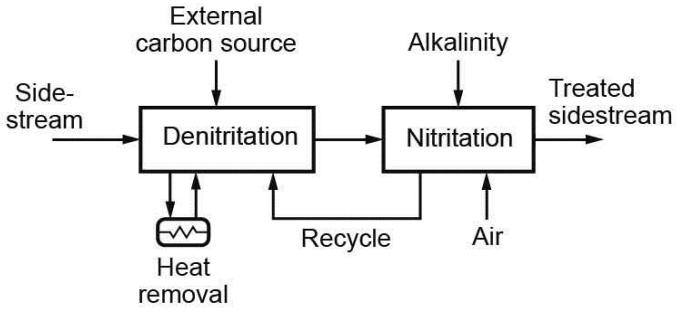


Figure 4: SHARON® Process

Table 10: Short SRT Nitritation-Denitritation Summary

Item	Description
Reactor configuration	Chemostat (flow-through)
Nitrogen removal pathways	Nitritation/denitritation
Solids retention time	1.5 d (aerobic), 0.75 d (anoxic)
Operating temperature	35-38°C
Operating pH	7.0
Typical operating DO	1.5 mg/L
TKN loading rate, average	1282 kg/d
Typical volumetric nitrogen loading rate	<0.7 kg-N/m^3/d
Feed points	Multiple (2 minimum)
Aeration equipment	EDI tube diffuser preferred
Control philosophy	Temperature, hydraulic retention time
Full-scale installation	Wards Island WPCP, New York

The largest installation of the SHARON® process is at the Wards Island WPCP in New York, and a number of processes have been installed and in operation in Europe. A list of full-scale installations is included in **Appendix A**.

3.5 Deammonification in a Single Stage Reactor with Suspended Growth Biomass

In this alternative, ammonium is converted to nitrogen gas and a small amount of nitrate in a cyclical two-step process within a single suspended growth biomass. In the first step, part of the ammonium is oxidized by AOB to nitrite under aerobic conditions ("partial" nitritation). In the second step, nitrite produced from the first step is combined with the residual ammonium under oxygen-free conditions to produce nitrogen gas and nitrate ("anaerobic ammonium oxidation" or anammox). Collectively, the two-step process is commonly referred to as "deammonification". In the second reaction, which is catalyzed by slow-growing autotrophic organisms commonly referred to as anammox bacteria, inorganic carbon is used for biomass growth, nitrite serves as the electron acceptor and no organic carbon source is required. The product of the anammox reaction, however, includes a small amount of nitrate (approximately 11 percent of the ammonium-N removed in the two-step process), and thus a small amount of an organic carbon source is required to reduce nitrate to nitrogen if more than 90 percent nitrogen removal is required.

To date, the DEMON® process is the only suspended growth SBR deammonification process installed and operated at full scale. The process was first developed at the Strass WWTP in Austria by Dr. Bernhard Wett, formerly of the University of Innsbruck, and has been implemented in several facilities in Europe and in North America. The process is currently offered in North America by World Water Works (Oklahoma City, OK) through a joint marketing agreement with Cyklar Stulz (Switzerland). Infilco-Degremont is marketing a similar suspended growth SBR process, Cleargreen™; however, there is no full-scale installation yet.

The operating principle for the DEMON® process is similar to the long SRT nitritation-denitration SBR except no external carbon is strictly required for nitrogen removal (only carbon requirement is for removal of the nitrate product, if desired). As the SBR is continuously filled during the react phase of the SBR cycle, the blower is turned on and off based on high and low pH setpoints. During the aerobic phase, alkalinity is consumed as nitrite is produced causing a decrease in pH. When the pH reaches the low setpoint, the blower is turned off and the pH increases due to the consumption of acidity by the anammox bacteria. In contrast to the nitritation-denitration process, the pH interval that is used to control the DEMON® SBR is only 0.01 or 0.02 units, resulting in aerobic and anoxic period durations of 10-15 minutes and 5-10 minutes, respectively. The narrow pH interval is believed to be required for process stability since a relatively short aeration period limits the concentration of nitrite, which is known to have irreversible toxic effects on the anammox bacteria (to be more accurate, the reported toxicity is believed to be a function of nitrite concentration and exposure time).

Since the anammox bacteria grow slowly, having a maximum specific growth rate that is one-tenth of the AOB growth rate, a long SRT (e.g. greater than 20 days) is required to sustain them in the reactor. Maintaining the reactor temperature above 30˚C is therefore preferred to maximize their growth rate. As the DEMON® biomass matures, anammox bacteria accumulate as reddish-colored granules, which serve as a visual indicator of their presence in the sludge at a high concentration. The AOB and other solids (inert solids, other types of bacteria) grow or remain in a flocculated form. To further stabilize the process and limit the risk of aerobic nitrite oxidizing bacteria re-establishing themselves in the reactor, the granulated anammox bacteria are separated from the flocculated solids in the DEMON® waste sludge stream and returned to the reactor, thereby achieving a very long SRT for the anammox bacteria (e.g. 40-50 days) and a shorter SRT for the remaining solids (e.g. 10 days) that will restrict NOB growth. Taking advantage of the higher specific gravity of the anammox granulates, relative to the flocculated solids, the waste sludge is processed through a hydrocyclone where greater than 90% of the anammox granules are separated, recovered and returned to the reactor. The overflow from the hydrocyclone is sent to the desired location as the waste sludge. A summary of the DEMON® process is shown in **Table 11** and a list of full scale installations is shown in **Appendix A**.

Table 11: Deammonification in a Single Stage Reactor with Suspended Growth (DEMON®) Summary

Item	Description
Reactor configuration	SBR
Nitrogen removal pathways	Partial nitritation/deammonification
Solids retention time	40-50 d (Anammox), 10 d (other biomass)
Operating temperature	20-38 (30-38 preferred)
Operating pH (expected range)	7-7.5 with pH interval of 0.01 or 0.02 s.u.
Typical operating DO	0.3 mg/L
TKN loading rate, average	1282 kg/d
Typical volumetric nitrogen loading rate	0.7-1.2 kg-N/m^3•d
Aeration	Fine bubble disk sufficient
Mixing	Typically 10 W/m^3
Feed	Multi-point, 2 minimum
Control philosophy	pH-controlled or time-based intermittent aeration.
Full-scale installations	See **Appendix A**

3.6 Deammonification with Fixed Film Biomass

The principle reactions and bacteria involved in nitrogen removal in this alternative are the same as the DEMON® SBR process, but a fixed film biomass is employed, thus requiring a support medium for biofilm growth. Three proprietary deammonification biofilm processes have been implemented in full scale: DeAmmon®, ANITA™Mox, and Terra-N®.

DeAmmon® was developed in 2001-2002 by Purac AB (Sweden) in collaboration with the University of Hannover and the Ruhr River Association (Ruhrverband). The process consists of a continuously-fed single or dual train moving bed biofilm reactor (MBBR) system with three stages per reactor. AnoxKaldnes polypropylene media is used for biofilm support at a fill volume of approximately 40 to 50% (K1 media; effective specific surface area for biofilm growth of 500 m^2/m^3). The stages are intermittently aerated to provide aerobic and anoxic phases for the nitritation and anammox reactions. Screens are provided between stages and in the effluent-end of the last stage to prevent movement of media from one stage to another or loss of the media with the treated effluent. Although two systems have been implemented at full-scale in Germany and Sweden, DeAmmon® is not actively being offered by Purac AB.

In an advancement of the technology, Veolia/AnoxKaldnes developed the ANITA™Mox process, which is a continuously-fed single-stage deammonification MBBR system that is continuously aerated with a variable DO setpoint in the range of 0.5 to 1.5 mg/L. By controlled the DO concentration, both the nitritation and anammox reactions can occur simultaneously within the biofilm. Polypropylene media from AnoxKaldnes is also used for biofilm support, but the K5 media with an effective specific surface area of 800 m^2/m^3 is used to increase the mass of active solids in the reactor. Similar to DeAmmon®, screens are required to prevent the loss of the media with the effluent. ANITA™Mox is marketed in North America by Veolia/Krüger/John Meunier and there is currently one full-scale system and one large four-reactor demonstration or pilot system in Sweden where Veolia developed the process.

In the Terra-N® process, developed by SÜD-Chemie/Clariant GmbH (Munich, Germany), bentonite is used as the support media for biofilm growth. The Terra-N® process can be configured in a single-stage SBR where the nitritation and anammox reactions occur within the biofilm. Similar to the DEMON® reactor, aeration is applied intermittently. Alternatively, Terra-N® can be configured as a two-stage continuous flow system where each stage

has its own clarifier. In this reactor arrangement, the partial nitritation and anammox reactions are performed in separate stages, where the first stage is continuously aerated and the second stage is only mechanically mixed. There are currently four full-scale Terra-N® deammonification systems, all in Germany. Typical design and operating parameters for fixed film processes are shown in **Table 12** and full-scale installations are listed in **Appendix A**.

Table 12: Deammonification with Fixed Film Summary

Item	Description
Reactor configuration	SBR/chemostat
Nitrogen removal pathways	Partial nitritation/deammonification
Solids retention time	Greater than 20 days due to moving bed support media (plastic; bentonite)
Operating temperature	25-38
Operating pH (expected range)	7-7.5
Typical operating DO	0.5-3.0 mg/L
TKN loading rate, average	1282 kg/d
Typical volumetric nitrogen loading rate	0.7-1.2 kg-N/m^3•d
Feed	More than 2 points preferred
Aeration system	Medium bubble, stainless for ANITA™Mox and DeAmmon Fine bubble for Terra-N®
Mixing	Intermittent mixing – DeAmmon® and Terra-N® SBR Continuous mixing during startup period only – ANITA™Mox. Intermittent mixing after start-up.
Control philosophy	DO setpoint 0.5-1.5 mg/L, based on the online ammonium-N and nitrate-N measurements – ANITA™Mox; Intermittent aeration with variable aerobic and anoxic periods based on nitrogen load – DeAmmon; Intermittent aeration at defined DO concentration – Terra-N®
Full-scale installation	See **Appendix A**

3.7 Alternative Deammonification Technologies

One of the first deammonification processes was developed by Paques BV (The Netherlands) in Rotterdam in 2002. Using the process name ANAMMOX®, the first system that was developed consisted of partial nitritation in a SHARON® reactor (no addition of methanol or another carbon source) followed by the anammox reaction in a high rate, upflow granulated sludge bed reactor, the design of which is based on the Paques high rate Internal Circulation (IC) anaerobic reactor design for high strength industrial wastewaters. After the successful startup of the Rotterdam process and a smaller two-stage deammonification system at another facility, Paques developed a single-stage ANAMMOX reactor, which is based on an air-lift design that induces the granulation of the entire biomass (AOB, anammox and other solids). A proprietary solids-liquid-air separation device is employed within the reactor to ensure the granulated biomass is retained. Paques has primarily implemented the ANAMMOX® technology for treatment of high ammonium wastewater in industrial facilities, although the single-stage technology could be applied to municipal sidestreams such as centrate.

Due to the unique design characteristics of the two-stage and single-stage ANAMMOX processes and the reactor geometries that are specific to the type of wastewater being treated, the Paques technologies are not considered

further in this report. In addition, Paques has not been actively marketing the ANAMMOX technology in North America, thus presenting a potential impediment even if the SBR dimensions at the NEWPCC would be acceptable for retrofit to a single-stage ANAMMOX configuration.

4. Review of Alternatives

Based on the information presented in Section 3, an initial screening was made to eliminate alternatives unsuitable for the NEWPCC centrate treatment upgrade. Specific proprietary processes were identified and budget price quotes were requested from the vendors to determine expected capital costs.

In this section, selected technologies identified and described in Section 3 are reviewed. The flow and loading data from the reference case (calendar year 2011) were used to estimate air and chemical consumption. The review also includes the following items for each alternative:

- A conceptual-level description of the modifications to the existing plant that would be required.
- A conceptual-level description of how the modifications could be implemented, if possible, while maintaining existing operation. This requirement includes a discussion on startup and acclimation.
- A conceptual-level description of the sensitivity of the alternative to changes in centrate quality and quantity, sensitivity to accidents/upset conditions, recovery time, and biomass retention.
- A conceptual-level capital cost estimate. For the capital cost estimate, a 35 percent contingency and a 15 percent engineering fee were added to the raw cost of equipment and installation.
- A conceptual-level O&M cost estimate, with the primary focus being on chemicals and energy.
- A whole life cost estimate for a 7 year and a 25 year project duration using a discount rate of 6 % and a CPI of 2%.
- An estimated payback period.

The lowest sustained flow and loading used in this review is the lower 5th percentile of the 2011 (reference case) operational data. Energy and chemical consumptions were estimated based on the 2011 average flow and loads. The highest flow considered in this assessment is the design maximum flow and loads.

4.1 Pre-screening

Based on the preliminary estimate of the capital cost and expected O&M cost savings for each of the alternatives identified, the alternatives were pre-screened during discussion with the City. First, the short-SRT nitritation-denitritation process, i.e., SHARON®, was not considered further because it is a flow-through system which will require major structural modifications to the existing SBR reactors whereas the long-SRT nitritation-denitritation process can be operated in a SBR with only minor modifications to the process control. Next, among the fixed film deammonification processes, DeAmmon® was eliminated because ANITA™Mox is a similar and simpler process with successful installations, and DeAmmon® is apparently not being marketed by Purac AB.

In the following sections, five (5) options are reviewed:

1. Optimized reference case
2. Long SRT nitritation-denitritation
3. DEMON® (suspended growth deammonification, SBR)
4. Anita™MOX (attached growth deammonification, flow-through)
5. Terra-N® (attached growth deammonification, SBR)

4.2 Optimized Reference Case

4.2.1 Description of the Modifications

Based on the 2011 data, the existing treatment process (reference case) consistently achieved the permit limit of 838 kg/d removal on a 30-day rolling average and 174 kg/d effluent discharge about 96 percent of the time. Based on the observation of the operating data, improvements in process operation to reduce energy and chemical consumption were identified. The opportunities for process optimization that could lead to energy and chemical savings are listed in **Table 13**.

Table 13: Optimized Reference Case Process Modification Summary

Modification	Description
Reactor structure	No change
Aeration blowers	No change
Aeration diffusers	No change
Reactor configuration	2 SBRs in parallel operation
Operating temperature	30-38ºC – operating temperature could be higher than 30ºC (less flushing water)
Operating pH	7.0-7.5 – operating pH could be lower than current condition which is around 8
Flushing water addition	0.7-1.7 MLD
Instrumentation	New DO sensors have been placed directly into the reactors. The use of new DO meters for online DO control could trim DO concentration in the reactor, which could save power cost and reduce the fraction of the methanol consumed by aerobic degradation. New nitrate meters will be installed in each reactor and methanol dosing would be determined based on the nitrate concentration at the end of the aeration cycle.
Control philosophy	Use the existing DO control algorithm with the new DO probes. Recommended DO setpoint = 1.5-2.0 mg/L

The modifications will be made to the process control, namely DO control and methanol dosing rate control. DO meters, recently placed directly into the SBR reactors, will be used for DO monitoring and aeration control. New nitrate meters will be used to determine the methanol dose for each anoxic cycle.

At the lower 5th percentile loading, the required air flow is less than half of one blower's capacity, and with existing diffusers the required air flow rate is lower than the recommended minimum flux rate. To allow DO control over the full range of loadings, a smaller blower could be installed and some diffusers blanked off to provide the required minimum air flow. If low loadings are infrequent, then the additional capital cost may not be justified and the DO level will increase above2 mg/L at the minimum air flow rate during the low loading periods. The following discussion will assume no modifications to blowers and diffusers, and the existing system would be operated at the lowest possible rate during the low loading period.

4.2.2 Implementation

Optimization of the existing operating conditions could be implemented without interrupting the current operation. As summarized in **Table 13**, optimization of the existing process will include:

- Reducing flushing water to raise operating temperature
- Improving DO control to reduce aeration energy consumption
- Reducing soda ash dosing

The reduction in the flushing water flow rate can be implemented first to raise the operating temperature. Once the flushing water flow rate target is met, the DO setpoints can be adjusted based on the DO meters installed in the SBR reactors, using the existing DO control algorithm. Finally the operating pH could be lowered by gradually lowering the soda ash flow rate. If the reduction of soda ash dosing is proven to negatively impact the process, the dosing rate could be brought back to the level required to meet the nitrogen discharge limit. For this evaluation, approximately half of the current soda ash use was assumed.

4.2.3 Expected Performance

The optimized reference case will not change the treatment process, therefore the expected performance in terms of effluent quality will be the same as the existing condition. However, a slight decrease in power consumption and chemical consumption can be expected.

During the Reference Case period, one blower was operated for each reactor at a constant 75 percent speed during the aeration period. The estimated power usage by aeration blowers was 112,320 kWh/month. By controlling the DO concentration to 2 mg/L, the power consumption for aeration could be lowered by about 22 percent to 81,900 kWh/month.

4.2.4 Preliminary Cost Estimates, Advantages and Drawbacks

Based on the expected performance described above, the annual O&M cost associated with the operation of SBRs will be reduced about 4 percent from $813,000/yr to $784,000/yr primarily due to the reduced energy cost and reduced soda ash use. No change in methanol demand is expected with the operational changes described above.

For the optimized reference case, a capital cost of $86,000 was assumed to include the cost to install two nitrate meters and controls programming. With the expected O&M cost reduction, the payback period is approximately 3 years.

The drawback of this alternative is that the improvements in energy and chemical usage and associated cost savings depend primarily on the operation of the process. For example, if the DO-based aeration control proves to be unreliable even with the new DO meter locations, the operators will be forced to operate the SBR on the conservative side, thus using more air and chemical. Because of the relatively insignificant reduction in aeration energy use and the chemical consumption, the operation of the SBR may end up returning to the reference case to make sure the SBRs are operated consistently.

4.3 Long SRT Nitritation-Denitritation

4.3.1 Description of the Modifications

Upgrade of the existing SBRs to long SRT nitritation-denitritation would not require a structural modification to the reactors. The modifications will be made to the instrumentation and the control algorithm. Conceptual-level descriptions of the modifications are summarized in **Table 14**. If two SBRs are in operation the air requirement during average loading (2011 data) is 48 m^3/min and 30 m^3/min at the 5th percentile loading condition, which are less than half of the capacity of the existing blower's 115 m^3/min. The air requirement is 104 m^3/min for each reactor at the design centrate loading rate. If two SBRs will be used continuously, a smaller blower will need to be installed in place of one of the existing blowers for each reactor to deliver lower air flow during the period of average or lower loading, as the existing blowers could only be turned down to 50 percent of the 115 m^3/min capacity (57.5 m^3/min). It is recommended that 2430 diffusers per tank be blanked off to maintain the recommended minimum flow rate through the membrane diffusers in two tanks during low loading periods while allowing sufficient air during the peak loading period.

The flow rate including the flushing water will be approximately 2.6 MLD at the average loading and 3.5 MLD at the 95th percentile loading. Under these hydraulic and TKN loading conditions, it may be possible to operate only one

SBR in nitritation-denitritation mode and use the second SBR as a standby, which would be operated only when a higher than the 95th percentile loading is sustained for an extended period, or when the average loading is increased to necessitate the operation of two reactors continuously. If only one reactor is used, the air requirement will be 97 and 60 m^3/min for the average and the 5th percentile loadings, respectively. These air flow rates could be achieved using the existing blowers. However, operating two reactors is considered beneficial to minimize the potential degradation of diffusers due to an extended period of drying and also to minimize the flow of influent to the reactor during settling and decant periods, or diversion of untreated centrate to the interceptor sewer. In the economic analysis, a two-SBR operation was assumed.

The operating temperature will be between 30 and 38°C, which will reduce the flushing water flow rate to between 0.5 and 1.8 MLD, and 0.8 MLD at an average loading condition, which is less than half of the current flushing water flow rate. Similar to the optimized reference case, it was assumed that the soda ash consumption could be reduced to a half of the current usage. Methanol demand under the nitritation-denitritation mode is 2.4 m^3/d at 2011 average, and 5.2 m^3/d at the design maximum loading. A summary of the modifications is listed in **Table 14**.

Table 14: Long SRT Nitritation-Denitritation Process Modification Summary

Modification	Description
Reactor structure	No change
Aeration blowers	Need to install one small blower for each SBR
Aeration diffusers	Partially blank off diffusers (up to 2430 per reactor) for 2 SBRs in operation; no changes required if only 1 SBR is operated
Reactor configuration	2 SBRs in parallel operation, or 1 SBR in operation,1 standby/overflow
Operating temperature	30-38ºC
Operating pH	7.1-7.4 (expected range)
Expected volumetric loading rate	0.2-0.4 kg-N/m^3•d (1 SBR in operation) 0.1-0.3 kg-N/m^3•d (2 SBRs in operation)
Flushing water addition	0.5-1.8 MLD
Instrumentation	New DO and pH analyzers directly in the reactor, 2 each per tank
Control philosophy	New control algorithm to be developed. DO target 0.5-1.0 mg/L, based on the online DO measurement and aeration cycle controlled by pH measurement

4.3.2 Implementation

Assuming two SBRs will continue to operate, the first phase of implementation will consist of replacing the existing spare blowers with lower capacity blowers (one per SBR). The new control algorithms will also be installed. The SBRs will continue to operate under the reference case condition with one existing 115 m^3/min blower per reactor during this period. Once the first phase is completed, one SBR (SBR-2) will begin operation in the nitritation-denitritation mode using the existing DO and pH probes to control DO and the aeration cycle. Centrate loading to SBR-2 will be gradually increased and the flushing water flow will be adjusted for temperature control during this transition period. Once the SBR is capable of treating the entire centrate load in the nitritation-denitritation operating mode at the target temperature, SBR-1 will be taken off-line to blank off the diffusers in consultation with the diffuser supplier for the new air flow range. Additional instrumentation (DO, pH) will also be installed to enhance monitoring and control. Upon completion of these modifications, SBR-1 is put back online by transferring mixed liquor to it from SBR-2. Once SBR-1 is stabilized in long-SRT nitritation-denitritation mode, SBR-2 will be removed from service and will receive the same modifications. During the modifications to SBR-2, excess loading that cannot be treated by SBR-1 will be diverted to the interceptor sewer. A preliminary projection of the implementation schedule is presented in **Figure 5**.

ID	Task Name	Duration
1	**Longe SRT Nitritation-Denitritation**	**385 days**
2	Predesign	2 mons
3	Predesign review and approval	1 mon
4	**Contractor Selection**	**80 days**
5	Tender document development	2 mons
6	Contractor tender document issuing	0 days
7	Contractor bid closing	0 days
8	Contractor signing/approval	1 mon
9	**Construction - SBR1**	**140 days**
10	Equipment order-delivery	16 wks
11	SBR 1 equipment installation	2 mons
12	SBR 1 equipment testing	1 mon
13	**Process commissioning**	**245 days**
14	SBR2 process control to restrict NOB (incl. reduction of dilution)	2 mons
15	Optimization of SBR2	2 mons
16	Transition to SBR1	1 wk
17	Optimization of SBR1	2 mons
18	SBR2 equipment installation	2 mons
19	SBR2 equipment testing	1 mon
20	Transition to 2 SBR operation	2 mons

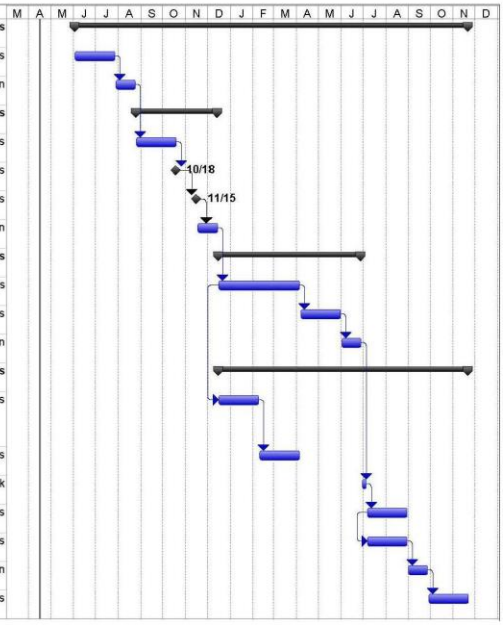


Figure 5: Implementation Schedule for Long SRT Nitritation-Denitritation

4.3.3 Expected Performance

With the long-SRT nitritation-denitritation mode, the process is expected to achieve 90 percent removal of nitrogen to meet the 174 kg/d effluent TN load. Based on the average loading, methanol consumption will be 2.4 m^3/d, or 694,500 kg/yr, which is 44 percent lower than the Reference Case.

During the Reference Case period, one blower was operated for each reactor at a constant 75 percent speed during the aeration period. The estimated power usage by aeration blowers was 112,320 kWh/mo under the reference case. By controlling the DO concentration to 0.5 mg/L to inhibit nitrite oxidation, the power consumption for aeration could be lowered to 50,700 kWh/mo, which is approximately a 55 percent reduction from the Reference Case and 38 percent reduction from the Optimized Reference Case.

4.3.4 Preliminary Cost Estimates, Advantages and Drawbacks

The estimated O&M cost is approximately $471,000, which is about a 42 percent reduction from the reference case. The capital cost will include installation of DO and pH probes into the SBR reactors, development and installation of new process control programming, diffuser modifications, and a new blower if two SBRs will be operated in parallel in normal operation. An allowance for nitrite probes in both SBRs was also included in the cost estimate to provide monitoring capability; however, this cost is considered optional.

The estimated capital cost for long-SRT nitritation-denitritation upgrade include 1 DO probe (in addition to the recently installed DO probes), 1 pH probe (in addition to the existing pH probe) and 1 nitrite probes in each SBR, control programming, diffuser modifications, and two new blowers to provide air during lower air demand. The estimated total is $589,000. At the new O&M cost of $471,000 per year, the payback period is 1.7 years.

The advantage of the long SRT nitritation-denitritation option is it requires minimal modifications to the reactor configuration. The modification to the diffusers could be made when one of the two SBRs is taken off-line while the other SBR continues to operate. The primary concern with the long SRT nitritation-denitritation process is the control of NOB growth. DO control at a low concentration will suppress NOB growth, but the plant operators must be diligent in applying this control since extended periods of time at a higher DO operating setpoint will re-introduce NOB growth into the SBRs.

If only one SBR will be in operation under normal conditions, the existing blower can provide the range of the required air flow rate. However, if two SBRs must be operated in parallel, a smaller blower would need to be installed to provide air during the normal operating conditions. The cost analysis assumed that two SBRs will be in operation in parallel.

4.4 DEMON®

4.4.1 Description of the Modifications

Upgrade of the existing SBRs to the DEMON® process will not require a structural modification to the reactors. The modifications will be made to the mixers in the tank, addition of a hydrocyclone for separating granulated anammox biomass from the flocculated waste solids, new instrumentation and control algorithm. Conceptual-level descriptions of the modifications are summarized in **Table 15**. According to the information provided by the World Water Works, the air requirement during average loading is 3370 m^3/h (56 m^3/min), and it was recommended that smaller blowers be installed in place of the existing blowers for each reactor to deliver lower air flow during the period of average or lower loading. Based on anadditional assessment, one smaller size blower could provide the required air at the low loading condition and the existing blower could be used when the loading is above the Reference Case average condition. The meet the air requirement while maintaining the recommended range of air flow rate per diffuser during the low loading condition, about 3490 diffusers per reactor would need to be blanked off if both reactors are assumed to be in operation. If it is assumed that only one SBR would operate, approximately 2370 diffusers would

need to be blanked off to maintain the air flow rate from the diffusers. There are three mixers in place in the existing SBR, and three additional mixers will be added to each tank to provide sufficient mixing.

Table 15: DEMON® Process Modification Summary

Modification	Description
Reactor structure	No change
Aeration blowers	Need to install a small blower for each SBR
Aeration diffusers	Partially blank off diffusers (up to 3490 diffusers per reactor)
Mixers	3 additional mixers required
Other equipment	Hydrocyclones for anammox separation
Reactor configuration	1 SBR in operation, 1 standby
Operating temperature	30-38°C
Operating pH	7.0-7.5 with pH interval of 0.01 or 0.02 s.u.
Expected volumetric loading rate	0.2-0.5 kg-N/m^3•d (1 SBR in operation) 0.1-0.3 kg-N/m^3•d (2 SBRs in operation)
Flushing water addition	0.2-0.9 MLD
Instrumentation	Online analyzers and control to be provided by the vendor
Control philosophy	Control algorithm to be provided by the vendor
Process start up	To be specified by the vendor. Seed sludge will be required to shorten the start-up period

4.4.2 Implementation

The upgrade will be implemented in phases. First, one of the two SBRs will be taken out of service to install the hydrocyclone, online instrumentation and additional mixers, and blank off diffusers. During this work, the other SBR will operate in a long-SRT nitritation-denitritation mode, with methanol, to treat the entire load. The first SBR that is being modified will be seeded with DEMON® biomass provided by World Water Works and returned to service. The load to this DEMON® SBR will be increased gradually until the entire centrate load is being treated in this tank. When this is achieved, the other SBR will be removed from service and similarly modified with the new equipment. A portion of the diffusers will be blanked and the tank will be held in reserve as stand-by capacity. Depending on the performance guarantee requirements, this tank may have to be seeded and brought on-line to verify that this second DEMON® SBR will also provide the desired performance. In the long-term, only one SBR will be required to treat the projected loading. However, operating two reactors is considered beneficial to minimize the potential degradation of diffusers due to an extended period of drying and also to minimize the flow of influent to the reactor during settling and decant periods, or diversion of untreated centrate to the interceptor sewer.

The logistics of converting from the reference case condition to nitritation-denitritation, then to the DEMON® process would include the shipping of seed sludge. The quantity necessary to allow less than 6 months start-up period will be approximately 300 m^3 and World Water Works expects the system would treat the entire centrate load within 2 to 3 weeks after seeding, and in the absence of mechanical or process control issues.

The assumption is to operate only one SBR, which will pose a risk of non-compliance in case of a plant upset. Because the anammox biomass is slow-growing, a new batch of DEMON® seed would need to be shipped in case of an irreversible plant upset; if such an upset occurs, it would take at least a few weeks before the DEMON® process itself would be able to resume treatment of the entire load. During this period, one or both SBRs will be operated in nitritation-denitritation mode, with methanol, to ensure permit compliance. A preliminary projection of the implementation schedule is presented in **Figure 6**.

4.4.3 Expected Performance

The deammonification process can be operated with higher than 90 percent reaction efficiency, but the reaction will convert about 11 percent of reacted nitrogen into nitrate. To further trim the TN, a supplemental carbon source will

be required to denitrify the remaining nitrate. Without denitrification, the DEMON® process will not achieve the effluent loading of 174 kg-N/d (90 percent removal of TN). In this assessment, therefore, external carbon addition was assumed to achieve the effluent loading of less than 174 kg-N/d, assuming methanol as the external carbon. Based on the average loading, methanol consumption with the DEMON® process will be 0.39 m^3/d, or 114,000 kg/yr, which is over 90 percent lower than the reference case.

However, inhibition of anammox activity by methanol has been observed (for example, van der Star et al., 2007) and methanol is not recommended for denitrification with the anammox-based processes. If the City will adopt an anammox-based SBR process with denitrification (either DEMON®, or Terra-N®), alternative carbon sources should be investigated. Methanol is used for the calculation of external carbon cost only to allow direct comparison to the other operating cases. If the least expensive alternative carbon source is more expensive than methanol, this will result in an incremental increase in operating cost.

During the Reference Case period, one blower was operated for each reactor at a constant 75 percent speed during the aeration period. The estimated power usage by aeration blowers was 112,320 kWh/month under the reference case. The DEMON® reactor will require significantly reduced air flow than the reference case; the power consumption for aeration could be lowered to 27,660 kWh/month, which is approximately a 75 percent reduction from the reference case.

4.4.4 Preliminary Cost Estimates, Advantages and Drawbacks

World Water Works, the supplier of the DEMON® process, was contacted for a budget cost estimate. In addition, a preliminary cost estimate was conducted for the items not included in the pricing. The estimated total capital cost for the DEMON® upgrade is $3,775,000.

Operational cost was estimated to be approximately $138,000/yr, which is about an 83 percent reduction compared to the reference case. The estimated payback period is approximately 5.6 yrs.

The advantage of DEMON® is significant savings on methanol and power consumption. Without denitrification of the residual nitrate produced by the anammox reaction, the DEMON® process could still meet the Licence level (838 kg/d TN removal, or approximately 47 percent removal with the average loading) but supplemental carbon will be required to meet the 174 kg/d TN discharge limit. Should the City and Manitoba Conservation agree on a relaxed discharge limit while still meeting the Licence level, the DEMON® process could completely eliminate methanol consumption.

ID	Task Name	Duration
1	**DEMON**	**610 days**
2	Predesign	2 mons
3	**Process Supplier Selection**	**100 days**
4	RFP development	2 mons
5	RFP issuing	0 days
6	RFP closing	0 days
7	Proposal review and approval	2 mons
8	Completion of process selection	0 days
9	**Contractor Selection**	**140 days**
10	Equipment vendor shop drawings	3 mons
11	Tender document development	2 mons
12	Contractor tender document issuing	0 days
13	Contractor tender closing	0 days
14	Review and approval	1 mon
15	**Construction - SBR1**	**260 days**
16	Equipment delivery	20 wks
17	Equipment installation	6 mons
18	Epuipment testing	2 mons
19	**Process commissioning - SBR1**	**210 days**
20	SBR2 process control to restrict NOB (incl. reduction of flush water)	2 mons
21	SBR1 seeding	1 wk
22	SBR1 incremental increase in loading	2 mons
23	SBR1 up to full-loading	1 wk
24	**Construction - SBR2**	**410 days**
25	Equipment procurement	20 wks
26	Equipment installation	3 mons
27	Epuipment testing	2 mons

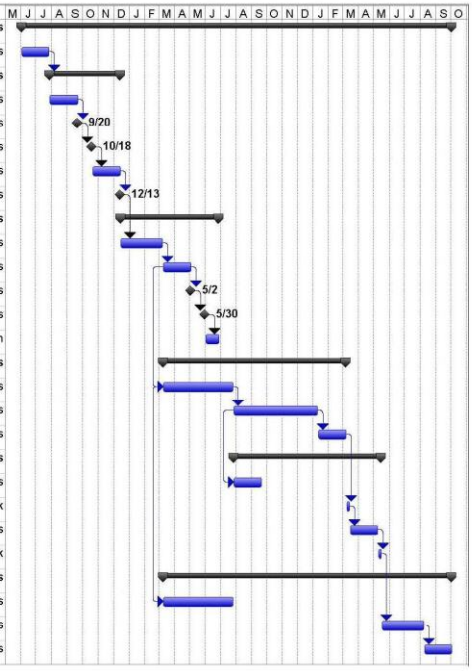


Figure 6: Implementation Schedule for DEMON®

4.5 ANITA™ Mox

4.5.1 Description of the Modifications

Upgrade of the existing SBRs to the Anita™Mox MBBR process will require a structural modification to the reactors from current SBR to a flow-through configuration. The modifications will be made according to the design by the vendor. Instrumentation and the control system will also be provided. The media will be introduced to the reactor when all necessary modifications are complete. A summary of the modifications are shown in **Table 16**, but due to confidentiality of the information provided by the vendor, technical details of the modifications are not included. Because the proposed system is a flow-through system, a solid separation process may be required to remove nitrogen associated with suspended solids. However, if the discharge of nitrogen associated with the suspended solids could be waived because the centrate treatment effluent will still flow through the mainstream treatment plant (including secondary clarifiers), the solids separation process could be eliminated.

Table 16: ANITA™Mox Process Modification Summary

Modification	Description
Reactor structure	Modification to flow-through reactor. One of the two reactors will be converted to the ANITA™Mox. Solids separation may be included. More than 2 feed points preferred.
Aeration blowers	No change (tentative, additional blower may be necessary)
Aeration diffusers	To be replaced
Mixers	Replaced with new mixers as specified by the vendor
Reactor configuration	Flow-through MBBR, with a consideration for solids separation
Operating temperature	30-38°C
Operating pH	7.0-7.5 with pH interval 0.01 to 0.02
Expected volumetric loading rate	0.3-1.0 kg-N/m^3•d
Flushing water addition	0.2-0.9 MLD
Instrumentation	Control panel to be provided by the vendor Online analyzers as specified by the vendor
Control philosophy	Proprietary control system to be provided by the vendor
Process start up	One reactor will be converted to ANITA™Mox and the other reactor will be kept in operation as a conventional SBR until ANITA™Mox conversion is complete.

4.5.2 Implementation

The upgrade will require one of the reactors to be taken off-line to make structural modifications as well as installation of mechanical equipment and online analyzers. The other SBR will operate in a conventional nitrification-denitrification mode during the reactor modification. Once the ANITA™Mox process is in operation, the other SBR could be turned off and all the loading be treated by the ANITA™Mox process. A preliminary projection of the implementation schedule is presented in **Figure 7**.

4.5.3 Expected Performance

The proposed ANITA™Mox process will achieve 174 kg-N/d or lower with solids separation.

The methanol consumption is expected to be approximately 387,000 kg/yr, which is over 69 percent lower than the reference case. Unlike DEMON® or Terra-N®, methanol would be consumed in an anoxic zone downstream of the ANITA™Mox reactor; thus, methanol is an acceptable carbon source since the anammox bacteria will not be in contact with it.

During the Reference Case period, one blower was operated for each reactor at a constant 75 percent speed during the aeration period. The ANITA^{TM}Mox reactor is expected to require a higher air flow than other anammox-based system but lower than the Reference Case power requirement (See Section 5). The estimated power consumption is approximately 90,000 kWh/month for aeration. With a solids separation process, the total is estimated to be approximately 107,000 kWh/month.

4.5.4 Preliminary Cost Estimates, Advantages and Drawbacks

Veolia, the supplier of the ANITA^{TM}Mox process, was contacted for a budget cost estimate. The estimated total cost by AECOM included the system proposed by Veolia and other modifications that were not included in the vendor's pricing. The total operational cost was estimated to be approximately $398,000/yr with solids separation, and $311,000/yr without solids separation. The O&M cost reduction will be about 51 percent for the system with solids separation and 62 percent for the system without solids separation. The estimated payback period is approximately 20 years with solids separation and 14 years without solids separation.

The perceived advantage of fixed-film deammonification reactors over a suspended growth system like DEMON® is the stability of the process due to the biofilm. However, as operating and performance data for suspended growth and biofilm systems accumulate, this apparent advantage is not readily apparent. The drawback with adopting ANITA^{TM}Mox is that the reactor must be modified from an SBR to a flow-through reactor, and because it is a flow-through process, a solids separation process will be required to meet the TN discharge limit. Due to the high air flowrate and high mixing rate, the power consumption will be higher than the two other anammox-based processes. Based on Veolia's estimate, the external carbon requirement for additional nitrogen removal will also be higher than the alternative deammonification technologies.

ID	Task Name	Duration
1	**ANITA Mox**	**850 days**
2	Predesign	4 mons
3	**Process Supplier Selection**	**100 days**
4	RFP development	2 mons
5	RFP issuing	0 days
6	RFP closing	0 days
7	Proposal review and approval	2 mons
8	Completion of process selection	0 days
9	**Contractor Selection**	**180 days**
10	Equipment vendor shop drawings	4 mons
11	Tender document development	2 mons
12	Contractor tender document issuing	0 days
13	Contractor tender closing	0 days
14	Contractor signing/approval	2 mons
15	**Construction**	**380 days**
16	Equipment delivery	20 wks
17	Tank modifications	8 mons
18	Equipment installation	3 mons
19	Epuipment testing	3 mons
20	**Process commissioning**	**430 days**
21	Transition to 1 SBR operation (reducing dilution)	2 mons
22	Seeding	1 wk
23	Incremental increase in loading	8 wks
24	Up to full-loading	1 wk
25	Construction of Standby System	8 mons

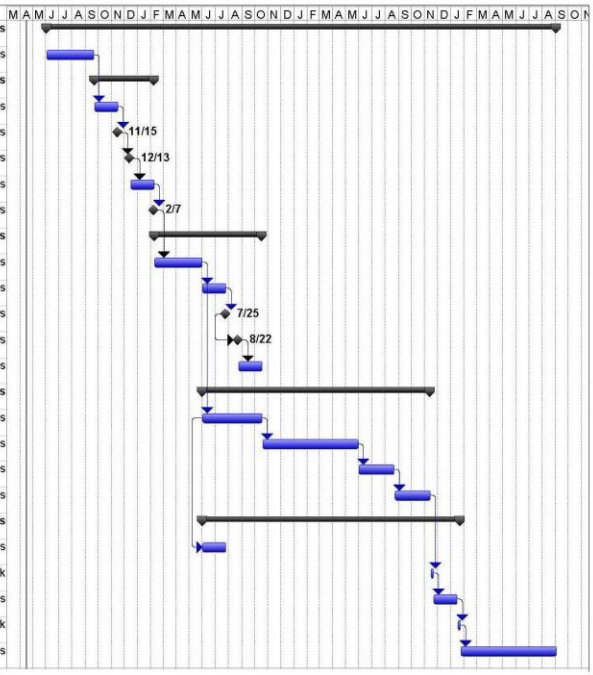


Figure 7: Implementation Schedule for ANITA™Mox

4.6 Terra-N®

4.6.1 Description of the Modifications

Two options were proposed by Clariant, both SBRs operated in a single-stage deammonification mode, and a two-stage SBR, which is a variation of the continuous-flow two-stage systems implemented in Germany.

In the single-stage system, the upgrade of the existing SBRs to the Terra-N® process, according to the proposal provided by Clariant Produkte, does not require structural modifications, or changes in blowers and aeration diffusers.

Modifications for a two-stage system will require installation of baffles to separate the SBR tank into a nitritation reactor with Terrana® as the support medium for the ammonium oxidizing bacteria. The bentonite also serves to enhance solids separation during the *settle* phase of the SBR cycle. In the second stage, the SBR will only be mixed for the anammox reaction.

Based on Clariant's assessment, they recommended that the operation of both SBRs in a single-stage deammonification mode is preferred based on their experience with both configurations. Therefore the cost estimate was conducted for the single stage SBR. The proposal by Clariant did not specify the need to use a smaller blower or to blank off diffusers, but based on the theoretical air requirement, such modifications may be necessary to control the DO concentration in the reactor within a desired range. A summary of the process modifications is shown in **Table 17**.

Table 17: Terra-N® Process Modification Summary

Modification	Description
Reactor structure	No change
Aeration blowers	No change (smaller blower may be advised)
Aeration diffusers	No change (blank off up to 3490 diffusers per reactor may be advised)
Mixers	No change
Reactor configuration	Single-stage SBR, 2 reactors in parallel operation, or 1 SBR in operation, 1 standby/overflow. Terrana (bentonite) madia in the reactor
Operating temperature	30-38ºC
Operating pH	7.0-7.5
Expected volumetric loading rate	0.2-0.5 kg-N/m^3•d (1 SBR in operation) 0.1-0.3 kg-N/m^3•d (2 SBRs in operation)
Flushing water addition	0.2-1.0 MLD
Instrumentation	Online analyzers in the reactor
Control philosophy	New control algorithm to be developed. DO setpoint 0.5-1.5 mg/L, based on the online DO measurement
Process start up	To be specified by the vendor

4.6.2 Implementation

The upgrade will be implemented in phases. First, the SBRs will be controlled to operate in a nitritation-denitritation mode. For the single-stage option, once the nitritation-denitritation SBR is established, one of the reactors will be seeded with anammox provided by Clariant to start establishing deammonification. The load to this tank will be decreased and gradually increased as performance allows. During this deammonification startup period, the other reactor will continue to operate in nitritation-denitritation mode. Once the desired performance and load are achieved, a portion of the sludge from the deammonification SBR will be transferred to the other SBR to initiate its

transition to deammonification. A preliminary projection of implementation schedule is presented in **Figure 8**. It should be noted that one SBR should be sufficient to treat the design loading. However, operating two reactors is considered beneficial to minimize the potential degradation of diffusers due to an extended period of drying and also to minimize the flow of influent to the reactor during settling and decant periods, or diversion of untreated centrate to the interceptor sewer.

4.6.3 Expected Performance

According to the Clariant proposal, the proposed system will be able to maintain the 174 kg/d effluent limit (30-d rolling average).

The deammonification process can be operated with higher than 90 percent reaction efficiency for deammonification, but the reaction will convert about 11 percent of reacted nitrogen into nitrate. To further trim the TN, a supplemental carbon source will be required to denitrify the remaining nitrate. Without denitrification, the Terra-N® process will not achieve the effluent loading of 174 kg-N/d (90 percent removal of TN). In this assessment, therefore, external carbon addition was assumed to achieve the effluent loading of less than 174 kg-N/d, assuming methanol as the external carbon. Based on the average loading, methanol consumption with the Terra-N® process will be 0.39 m^3/d, or 114,000 kg/yr, which is over 90 percent lower than the reference case.

As noted in the section on DEMON® implementation, methanol is not recommended for denitrification with the anammox-based processes, with the exception of ANITA™Mox. If the City will adopt an anammox-based SBR process with denitrification (either Terra-N® or DEMON®), alternative carbon sources should be investigated. Similar to DEMON®, the inclusion of methanol in the economic analysis is only for the purpose of comparison to the other options. If the selected alternative carbon source is more expensive than methanol, this will incrementally increase the operating cost for Terra-N®.

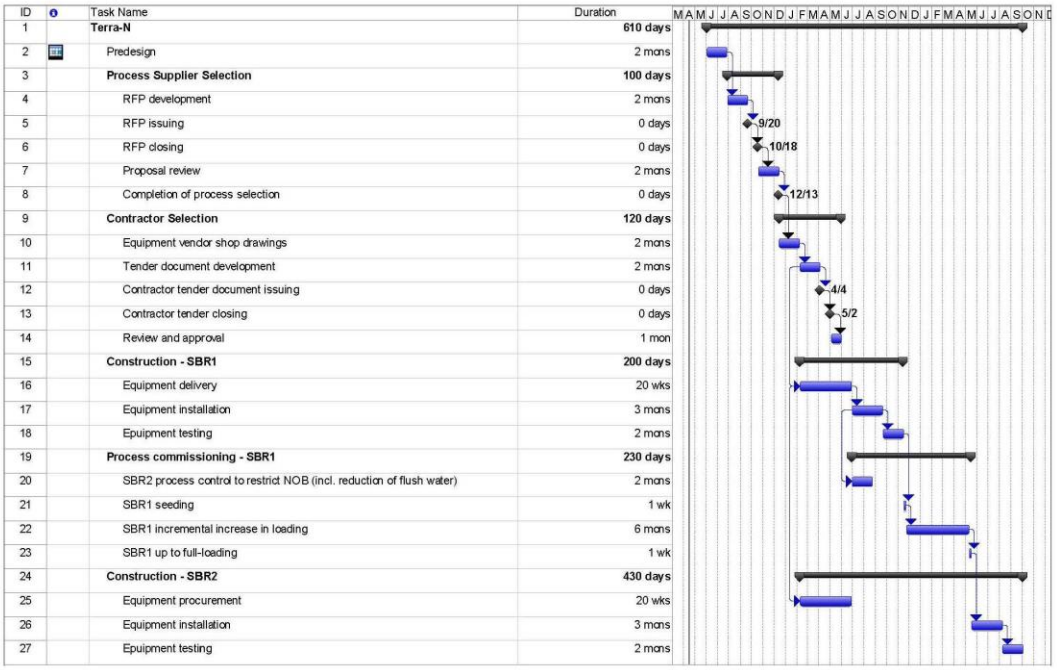
During the Reference Case period, one blower was operated for each reactor at a constant 75 percent speed during the aeration period. The estimated power usage by aeration blowers was 112,320 kWh/month under the reference case. The Terra-N® reactor will require significantly reduced air flow than the reference case; the power consumption for aeration could be lowered to 29,630 kWh/month, which is approximately 74 percent reduction from the reference case.

4.6.4 Preliminary Cost Estimates, Advantages and Drawbacks

Clariant, the supplier of the Terra-N® process, was contacted through the US representative Seepex, Inc. for a budget cost estimate. In addition, a preliminary cost estimate was conducted for the items not included in the pricing. The estimated total for the Terra-N® upgrade is $2,936,000.

Operational cost was estimated to be approximately $141,000, which is about an 83 percent reduction compared to the reference case. The estimated payback period is approximately 4.4 years.

The Terra-N® process will provide significant savings on methanol and power consumptions. Similar to the DEMON® process, the Terra-N® process could meet the Licence level (838 kg/d removal) without denitrification, but supplemental carbon will be required to achieve 174 kg/d TN discharge limit. Should the City and Manitoba Conservation agree on a relaxed discharge limit, Terra-N® will eliminate the cost associated with external carbon addition.



ID	Task Name	Duration
1	**Terra-N**	**610 days**
2	Predesign	2 mons
3	**Process Supplier Selection**	**100 days**
4	RFP development	2 mons
5	RFP issuing	0 days
6	RFP closing	0 days
7	Proposal review	2 mons
8	Completion of process selection	0 days
9	**Contractor Selection**	**120 days**
10	Equipment vendor shop drawings	2 mons
11	Tender document development	2 mons
12	Contractor tender document issuing	0 days
13	Contractor tender closing	0 days
14	Review and approval	1 mon
15	**Construction - SBR1**	**200 days**
16	Equipment delivery	20 wks
17	Equipment installation	3 mons
18	Epuipment testing	2 mons
19	**Process commissioning - SBR1**	**230 days**
20	SBR2 process control to restrict NOB (incl. reduction of flush water)	2 mons
21	SBR1 seeding	1 wk
22	SBR1 incremental increase in loading	6 mons
23	SBR1 up to full-loading	1 wk
24	**Construction - SBR2**	**430 days**
25	Equipment procurement	20 wks
26	Equipment installation	3 mons
27	Epuipment testing	2 mons

Figure 8: Implementation Schedule for Terra-N®

5. Summary of Alternative Evaluation

The preliminary estimates of the capital and O&M costs for the optimized reference case, long SRT nitritation-denitritation, DEMON®, ANITA™Mox, and Terra-N® were described in the previous section.

5.1 Power Consumption

The expected power consumption for the options considered in this study is illustrated in **Figure 9**. The air requirements were calculated based on the stoichiometric oxygen requirement and expected operational conditions for each process at the average loading condition. The actual air requirement may be slightly lower as centrate treatment processes usually do not oxidize 100 percent of the incoming TKN. The DEMON® process is expected to have the lowest power usage, and ANITA™Mox will have the highest power usage, of all of the alternatives being considered.

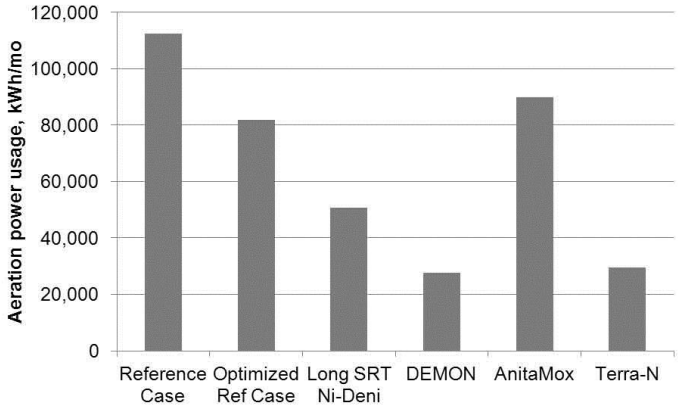


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Figure 9: Power Consumption of the Alternatives

5.2 Chemical Consumption

The three Anammox-based technologies, DEMON®, ANITA™Mox, and Terra-N® could potentially eliminate the use of methanol if the treatment requirement is relaxed to the Licence level (848 kg/d TN removal as a 30-day rolling average) and the centrate treatment plant does not have to meet a 174 kg/d discharge limit. If the 174 kg/d limit is to be met, the external carbon consumption for these three processes is theoretically about 11 percent of the optimized reference case.

As discussed above, methanol is known to inhibit the anammox reaction, and alternative carbon sources should be evaluated should DEMON® or Terra-N® be selected as a preferred option. For ANITA™Mox, however, the use of methanol may be acceptable as long as it is added downstream of the deammonification process.

The evaluation of soda ash dosing was limited in this study, as the pH level at which each of the alternative would be operated without adversely impacting the nitrogen removal performance is unknown for this particular case. However, based on published information, the operating pH for any of the considered processes could be in the range of 7 and 7.5, as compared to current pH 8, when the treatment process is operated at an elevated temperature in the range of 30 and 38°C. Without sufficient data to allow further analysis, it was assumed that the soda ash consumption could be reduced to about half of the current use for all alternatives considered in this study.

The costs for the proprietary processes were based on the information provided by the vendors, supplemented by additional estimates to allow direct comparison of the costs. The O&M cost information for the reference case was based on the actual expenditure during 2011. A summary of the options is shown in **Table 18**.

5.3 Robustness of the Deammonification Processes

The supplier of each deammonification process was contacted to address their understanding on the sensitivity of the process to changing centrate quality and plant upset. World Water Works indicated that they have not yet experienced a complete failure of the anammox biomass at any of the municipal sidestream treatment installations.

According to World Water Works and Clariant, DEMON® and Terra-N® processes are both expected to require a month or two for the process to get back to a full capacity in case of a total loss of anammox activity. However, both World Water Works and Clariant also indicated that a small tank to maintain a reserve of anammox biomass from the wasted sludge could be considered so that each treatment plant could rapidly re-seed the reactors in case of an unexpected complete failure of the anammox activity. This option would eliminate the time required to ship the seed sludge and shorten the time required for a full recovery of the process.

According to Veolia, the recovery time for ANITA^{TM}Mox in case of complete process upset is expected to be about one month. Due to the biofilm formed on the attached growth media, Veolia expects some biomass will survive and it will not have a complete loss of all anammox activity.

All suppliers indicated that the shipment of seeding sludge in case of plant upset will only include the cost for the sludge and shipping, and no licensing fee would be included in the cost.

5.4 Cost Comparison

The capital and O&M costs estimated for each alternative were described in the previous sections, and the summary of the cost comparison is shown in **Table 18**, including 7-year and 25-year life cycle cost.

The City is planning to upgrade the NEWPCC's residuals handling process. Depending on the upgrade to be adopted, the characteristics of sidestream generated for treatment may change significantly. Because of the uncertainties with the characteristics of the sidestream after the residuals handling upgrade, a phased approach was considered in the cost evaluation. In the phased approach, the long-SRT nitritation and denitritation process, which is recognized to provide significant cost savings with a short payback period (less than 2 years), is implemented first. Upon completion of the solids handling process upgrade, the sidestream treatment process is further upgraded to either one of the deammonification processes that employ an SBR configuration (i.e., DEMON or Terra-N). A 25-year life cycle cost was estimated assuming the first 10 years for the long-SRT nitritation-denitritation process and the remaining 15 years in the 25-year project life cycle for the deammonification process, as shown in **Table 18**. The phased approach is expected to result in a 25-year life cycle cost slightly lower than that of long-SRT nitritation-denitration but higher than the deammonification options.

Table 18: Cost Comparison – 7yr and 25yr Life Cycle Cost

(a) Summary of 7-year and 25-year life cycle cost for each alternative

			Alternatives						
Category	Sub-Category	Unit	Base case	Optimized base case	Long SRT Nitritation / denitritation	DEMON	AnitaMox (no solids separation)	AnitaMox (with solids separation)	Terra-N
Capital Cost		$	$ -	$ 84,000	$ 589,000	$ 3,775,000	$ 7,073,000	$ 8,228,000	$ 2,936,000
O&M: Energy									
Sub-total: Annual		$/yr	$ 82,000	$ 72,000	$ 62,000	$ 54,000	$ 74,000	$ 75,000	$ 52,000
Sub-total: PW 7yrs		$	$ 494,000	$ 433,000	$ 373,000	$ 325,000	$ 394,000	$ 451,000	$ 313,000
Sub-total: PW 25yrs		$	$ 1,292,000	$ 1,134,000	$ 977,000	$ 851,000	$ 1,153,000	$ 1,181,000	$ 819,000
O&M: Chemical									
Sub-total: Annual		$/yr	$ 731,000	$ 712,000	$ 409,000	$ 84,000	$ 237,000	$ 323,000	$ 89,000
Sub-total: PW 7yrs		$	$ 4,400,000	$ 4,286,000	$ 2,462,000	$ 506,000	$ 1,698,000	$ 1,944,000	$ 536,000
Sub-total: PW 25yrs		$	$ 11,515,000	$ 11,216,000	$ 6,443,000	$ 1,323,000	$ 4,965,000	$ 5,088,000	$ 1,402,000
Total Capital		$	$ -	$ 84,000	$ 589,000	$ 3,775,000	$ 7,073,000	$ 8,228,000	$ 2,936,000
Total O&M: Annual		$/yr	$ 813,000	$ 784,000	$ 471,000	$ 138,000	$ 311,000	$ 398,000	$ 141,000
Total O&M: 7yr Present-value		$	$ 4,894,000	$ 4,719,000	$ 2,835,000	$ 831,000	$ 2,092,000	$ 2,395,000	$ 849,000
Total O&M: 25yr Present-value		$	$ 12,807,000	$ 12,350,000	$ 7,420,000	$ 2,174,000	$ 6,118,000	$ 6,269,000	$ 2,221,000
Total Present-value: 7yr		$	$ 4,894,000	$ 4,803,000	$ 3,424,000	$ 4,606,000	$ 9,165,000	$ 10,623,000	$ 3,785,000
Total Present-value: 25yr		$	$ 12,807,000	$ 12,434,000	$ 8,009,000	$ 5,949,000	$ 13,191,000	$ 14,497,000	$ 5,157,000
Payback Period (non-discounted)		yr		2.90	1.72	5.59	14.09	19.83	4.37
Payback Period (discounted)		yr		3.28	1.87	7.02	32.04	-	5.22

(b) Summary of 7-year and 25-year life cycle cost for the phased options

			Alternatives	
Category	Sub-Category	Unit	Long SRT Nit/Denit - DEMON	Long SRT Nit/Denit - Terra N
Capital Cost		$	$ 2,903,000	$ 2,332,000
O&M: Energy				
Sub-total: Annual		$/yr		
Sub-total: PW 7yrs		$	$ 373,000	$ 373,000
Sub-total: PW 25yrs		$	$ 916,000	$ 901,000
O&M: Chemical				
Sub-total: Annual		$/yr		
Sub-total: PW 7yrs		$	$ 2,462,000	$ 2,462,000
Sub-total: PW 25yrs		$	$ 3,970,000	$ 4,008,000
Total Capital		$	$ 2,903,000	$ 2,332,000
Total O&M: Annual		$/yr		
Total O&M: 7yr Present-value		$	$ 2,835,000	$ 2,835,000
Total O&M: 25yr Present-value		$	$ 4,886,000	$ 4,909,000
Total Present-value: 7yr		$	$ 3,424,000	$ 3,424,000
Total Present-value: 25yr		$	$ 7,789,000	$ 7,241,000

6. Recommendations

Based on the preliminary cost comparison, the long SRT nitritation-denitritation alternative will have the shortest payback period (1.8 years) and it will reduce the annual O&M cost by 42 percent compared to the Reference Case. The 7-year present worth total cost is also lowest for the long SRT nitritation-denitritation option, followed by the Terra-N® and the DEMON® processes However, the 25-year life-cycle cost was the lowest for Terra-N®, followed by DEMON®, because of the significantly lower O&M costs. Even though the long SRT nitritation-denitritaion alternative would provide the shortest payback period, the 25-year life cycle cost is significantly higher than the two anammox-based alternatives.

In addition, these two anammox-based processes may be able to be operated without using methanol if the 174 kg/d TN discharge limit requirement is relaxed. The minimization or elimination of this hazardous chemical was identified as one of the objectives of the centrate treatment plant modification. Thus it is recommended that two anammox-based SBR processes, DEMON® and Terra-N® be considered for further evaluation, with long SRT nitritation-denitritation as a third option as transition to either DEMON® or Terra-N®. It should also be noted that methanol is not recommended for the DEMON® and Terra-N® processes, and if the 174 kg/d effluent limit is required, the use of alternative carbon sources should be considered.

7. References

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Yang L. and J.E. Alleman (1992) "Investigation of Batchwise Nitrite Build-up by an Enriched Nitrification Culture," *Water Sci. Technol.*, **26**, 5–6, 997–1005.

Appendix A

List of Reference Installations

Appendix A

List of installations

Installations	Country	Trade Name	N load, kg N/d	Year	Comment
Utrecht	Netherlands	SHARON®	410	1997	
Rotterdam	Netherlands	SHARON®	390	1999	Converted to two-stage deammonification in 2002
Zwolle	Netherlands	SHARON®	190	2003	
Beverwijk	Netherlands	SHARON®	540	2003	
The Hague-Houtrust	Netherlands	SHARON®	590	2005	
Groningen-Garmerwolde	Netherlands	SHARON®	1090	2004	
Geneva	Switzerland	SHARON®	860	2009	
MVPC Shell Green, Manchester	United Kingdom	SHARON®	730	2010	
Seine Grèsillion, Paris	France	SHARON®	1590	2010	
Wards Island WPCP	NY, USA	SHARON®	2590	2010	
Whitlingham	United Kingdom	SHARON®	680	2011	
Linkoping	Sweden	SHARON®	410	2011	
Hattingen WWTP	Germany	DeAmmon®	120	2001	Single (40%)
Strass	Austria	DEMON	500	2004	
Himmerfjärden WWTP Stockholm	Sweden	DeAmmon®	680	2007	Dual (32%)
Glarnerland	Switzerland	DEMON	250	2007	
Plettenberg	Germany	DEMON	80	2007	
Heidelberg	Germany	DEMON	640	2008	
Thun	Switzerland	DEMON	390	2008	
Gengenbach	Germany	DEMON	50	2008	
Apeldoorn	Netherlands	DEMON	1630	2009	
Etappi Oy	Findland	DEMON	950	2009	
Balingen	Germany	DEMON	190	2009	
Alltech	Serbia	DEMON	2400	2010	
Limmattal	Switzerland	DEMON	250	2010	
Sjölunda WWTP	Sweden	ANITA™Mox	200	2010	K3, Anox™K5; Biofilmchip™M
Zalaegerszeg	Hungry	DEMON	160	2010	
Sundet WWTP	Sweden	ANITA™Mox	320	2011	Anox™K5
Holbæk WWTP	Denmark	ANITA™Mox	120	2012	K3
Klaranlage Rheda	Germany	Terra-N®	680	2011	One step SBR; Reject Water
Fulda	Germany	Terra-N®	400	2008	Two step CSTR; Reject Water
Landshut	Germany	Terra-N®	340	2010	Two step CSTR; Reject Water
KA North Potsdam	Germany	Terra-N®	160	2012	Two step CSTR; Reject Water
KA Rinteln	Germany	Terra-N®	80	2010	One step SBR; Reject Water
Alexandria,	VA, USA	DEMON	1810	Design/Construct	Reject Water
Etappi II	Finland	DEMON	910	Design/Construct	Biogas

Installations	Country	Trade Name	N load, kg N/d	Year	Comment
Maszewo	Poland	DEMON	820	Design/Construct	Biogas
Kokkola	Findland	DEMON	590	Design/Construct	Reject Water
Helsinki	Findland	DEMON	500	Design/Construct	Reject Water
Lavis	Italy	DEMON	500	Design/Construct	Landfill
Pustertal	Italy	DEMON	500	Design/Construct	Reject Water
York River	VA, USA	DEMON	240	Design/Construct	Reject Water
Lahr	Germany	DEMON	240	Design/Construct	Reject Water
Neumarket	Germany	DEMON	190	Design/Construct	Reject Water
Erpfendorf	Austria	DEMON	120	Design/Construct	Reject Water
Bickenbach	Germany	DEMON	90	Design/Construct	Reject Water
Lavant	Austria	DEMON	50	Design/Construct	Landill

APPENDIX C – INSTRUCTIONS FOR SUBMISSION OF RECORD DRAWINGS

(a) Submit draft record drawings for review in both paper and electronic format. Use a paper size suitable for detailed review. Amend as requested.

(b) Final record drawings shall be stamped and signed by a professional engineer, and submitted in both paper and electronic format.

(c) Paper format shall be prepared using 3 mil, matte, 2 sided Polyester film (often referred to as 'Mylar').

(d) Electronic format shall be produced in AutoCAD or AutoCAD LT .dwg and saved in the version presently being used by the WWD. Approved submissions are to include an AutoCAD file and a pdf file for each individual drawing. Third party fonts, hatch patterns, custom linetypes or shapefiles, shall not be used in Final Drawing files submitted to the WWD.

(e) Drawing files shall be submitted on CD or DVD or made available on an ftp.

(f) Each individual drawing that is part of an overall project package must be submitted to the WWD as individual drawing files, using the Department assigned drawing number as the file name, e.g. D-xxxxxx.DWG.

(g) On large projects, where several drawings are needed to show continuous infrastructure, the base entities and cadastral data shall be continuous in model space. These entities shall not be "broken up," rotated or edited in order to depict the specific sections of the project on individual drawings. Instead, views, paper space and layouts shall be used to display the work.

(h) All drawing files shall have all tabs and model space zoomed to EXTENTS, prior to any submittal to the WWD, whether it is the final or a working submittal. This is to ensure there are no extraneous entities in the drawing.

(i) All drawing files shall be saved with the first layout tab active.

(j) ALL FINAL FILES SHALL BE FULLY PURGED PRIOR TO SUBMITTAL

APPENDIX D – CONTRACT ADMINISTRATION MANUAL

Winnipeg Sewage Treatment Program
Integrated Management System

Contract Administration Manual

DOCUMENT NUMBER: CD-PM-PC-01

Rev	Prepared by	Reviewed by	Date	Approved by	Date
2013-05-01	B. Willemsen			Jackie Veilleux	2013-05-01
2013-07-11	B.Willemsen			Jackie Veilleux	2013-07-31
2014-03-03	B Willemsen			Jackie Veilleux	2014-03-04

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1. INTRODUCTION

This manual has been created to aid the Contract Administrator in delivering contract administration duties.

The Contract Administrator is the city's representative throughout the duration of the contract and has the authority to act on behalf of the city to the extent expressly provided for in the contract.

The Contract Administrator will interpret or clarify the contract or any part thereof which appears indefinite, not clear or contradictory to the contractor.

Note: these procedures are modeled on the City of Winnipeg's general conditions. The Contract Administrator must also review the supplemental conditions of the respective contract. These may alter applicable clauses within the general conditions.

2. CONTRACT ADMINISTRATION SERVICES

In general, Contract Administration Services shall follow the City's definition of professional consulting services for contract administration or as may be modified by the scope of work defined in the RFP for Consulting Services.

Notwithstanding the generality of the foregoing, the Contract Administrator shall utilize, processes, procedures, forms and templates contained within this manual to deliver the duties of the Contract Administrator

3. DEFINITIONS

City	means City of Winnipeg or City designated Project Manager
Contract Administrator	means entity contracted by City of Winnipeg to deliver contract administration services
Consultant	means entity contracted by City to provide engineering services for the project
Contractor	means entity contracted by the City to provide goods and services
General Conditions	means City of Winnipeg general conditions for construction contracts dated 2000 -11- 09
RFP	means Request for Proposals Issued by the City
ITP	means Inspection and Test Plan
CCN	means Contemplated Change Notice
ACC	means Authorized Contract Change
FWA	means Field Work Authorization
PE	means Progress Estimate
FI	means Field Instruction
DCR	means Daily Construction Report
CRR	means Construction Review Record

4. RECORDS, REPORTING AND FILING

4.1 Introduction

This section identifies the process the Contract Administrator will follow for all records pertaining to the Contract, what reporting will be conducted throughout the duration of the Project and how the information will be filed. The Contract Administrator shall ensure copies of all forms and records are transmitted to the

City within 48 hours of their creation.

4.2 Forms And Records

The Contract Administrator shall generate as required the following site records throughout the course of the contract.

4.2.1 Meetings

The Contract Administrator shall record minutes of all regular and special contractor meetings, coordination meetings and conference calls.

4.2.2 Change Management

The Contract Administrator Shall Coordinate, compile and prepare Change Management Documentation including contemplated Change Notices, Authorized Contract Changes, Field Work Authorizations and Contractor Claims.

4.2.3 Clarification and Directives

The Contract Administrator shall collect and disseminate additional Information requested by or provided to the Contractor including Requests for Information and Field Instructions.

4.2.4 Quality Assurance

The Contract Administrator shall coordinate inspections, collect and file documents and monitor remedial works including Construction Review Records, Test Records and Non Conformance Reports

4.2.5 Daily Progress Reporting

The Contract Administrator shall prepare or cause to be prepared Daily Construction Reports containing, inspections completed, manpower on site, equipment on site, problems encountered, activities started, completed and planned, site conditions, work stoppages, unusual events and verbal instructions given to contractor.

4.3 Reporting

4.3.1 Monthly Construction Status Report

The Contract Administrator shall compile and submit to the City, Monthly Construction Status Reports. The reports shall contain the following:

(a) Executive Summary

A Written Summary Of The Current And Cumulative Progress Of The Contract Identifying Major Activities Completed During The Period, Major Activities Planned For Next Period And Any Areas Of Concern;

(b) Safety And Security

Provide an overview of Contractors safety performance including Record of Incidents, Investigations, Permits, Trainings, Inspections, Hazard Reviews, Notifications and Safety Committee Meetings held;

(c) Cost Reporting

A commitment based cost report reflecting costs committed to date, invoiced to date, percent complete, forecast to complete, estimate at completion and variance;

A Detailed Contract Status report listing all approved ACC's to date, all outstanding CCN's, FWA's , Detailed Progress Estimate Listing reflecting Holdbacks retained, MRST included or self-assessed, amounts paid to contractor, dates paid and holdback releases;

(d) Construction Progress

A construction schedule presenting actual vs. planned progress shall be updated to reflect performance to date. The schedule can take the form of Gantt Charts, S-curves and histograms to demonstrate the progress of the Contract against the baseline; and

(e) Quality Assurance

This section of the report will provide a listing of Inspections, Reviews and testing completed during the previous period as well as status reports of all NCR's.

4.4 Project Filing System

The Contract Administrator shall file all documentation generated from contract administration services into the following electronic project file structure. In circumstances where more than one contractor is engaged on the Project, this file structure shall be established for each Contract.

Bid Op/Contract Number #1 Project Electronic File Structure

1.0 Contractual Documents
- 1.1 Letter of Intent/PO
- 1.2 Insurance
- 1.3 Bonding
- 1.4 Permits
- 1.5 Contract Drawings and Specifications

2.0 Meeting Minutes
- 2.1 Pre-Construction
- 2.2 Weekly Contractor
- 2.3 Special Meetings/Conference Calls
- 2.4 Coordination

3.0 Contract Changes
- 3.1 Contemplated Change Notices
- 3.2 Authorized Contract Changes
- 3.3 Field Work Authorizations
- 3.4 Contractor Claims

4.0 Clarifications
- 4.1 Field instructions
- 4.2 Requests for Information

5.0 Progress
- 5.1 Work Schedules
- 5.2 Progress Estimates
- 5.3 Daily Construction Reports
- 5.4 Monthly Progress Reports
- 5.5 Progress Photographs

6.0 Quality Assurance
- 6.1 Inspection and Test Plans
- 6.2 Construction Review Records
- 6.3 Test Records
- 6.4 Non- conformance Reports
- 6.5 Deficiency Lists
- 6.6 Performance Verification Records

7.0 Submittals
- 7.1 Shop Drawings
- 7.2 O&M Manuals
- 7.3 Redline As-built Markups
- 7.4 Warranties
- 7.5 Training Plans
- 7.6 Commissioning Procedures
- 7.7 Completion Certificates

8.0 Safety Health and Environment
- 8.1 Safe Work Plans
- 8.2 Incidents and Investigations
- 8.3 Daily Safety Reports
- 8.4 Statistics

Emails

Emails shall be filed relative to their pertinence to one of the project file system subfolder categories. All Emails shall have the date entered at the beginning of the email subject line in the following format Bid Op # followed by YYMMDD and subject key words (e.g. 125-2012-120924-Boiler Training Plan).

5. MEETINGS

5.1 General

The Contract Administrator shall arrange and chair all contractor site meetings including preparation, distribution and filing of minutes within 3 business days of the meeting date.

5.2 Pre-Construction Meeting

The Contract Administrator shall convene a preconstruction meeting and include representatives of management from the various parties who have the authority to make decisions, so as to resolve any problems that may arise. The preconstruction meeting should be held in conjunction with a site inspection to verify site conditions and the need for preparatory works.

A template of a typical Preconstruction Meeting Agenda is available. and shall be utilized to record minutes of the meeting. The minutes should be distributed to all attendees and to other persons having key input into the project.

5.3 Site Meetings

Depending on the scope and nature of the project, the Contract Administrator shall convene weekly or bi-weekly meetings with the Contractor and record minutes of such meetings. Regular contractor site meetings shall address the following:

(a) To review progress to date;

(b) Review contractor site safety;

(c) To discuss expected progress;

(d) Review contractor submittals;

(e) Review outstanding RFI's and CCN's;

(f) To review contract schedule;

(g) To identify coordination needs of Contract Administrator;

(h) To identify and resolve any problems occurring during construction; and

(i) Other items pertaining to the contract.

5.4 Site Coordination Meetings

On projects were multiple contracts are awarded, to complete the work, the Contract Administrator shall arrange regular coordination meetings to facilitate logical sequencing of the work. Minutes of the meetings shall be prepared by the Contract Administrator. The minutes shall record agreed upon dates, timeframes and actions by respective parties

5.5 Special Meetings And Conference Calls

The Contract Administrator shall convene special meetings or conference calls as may be required to resolve issues with a smaller focused group or to disseminate special materials pertinent to the progress of the work. The Contract Administrator shall chair and record minutes of such meetings and or conference calls.

6. CONTRACTOR SUBMITTALS

6.1 Introduction

This section describes the duties of the Contract Administrator with regard to contractor submittals throughout the duration of the Contract. The Contract Administrator shall obtain a listing of submittals from Contractor c/w a submission schedule.

The Contract Administrator shall obtain the city's approval for any substitutions, alternates or equivalents proposed by the contractor during the course of the work.

6.2 Shop Drawings And Product Data

The Contract Administrator or designated representative will receive contractor shop drawings, log drawings into the Submittal Log Form and transmit the shop drawings to respective design disciplines, for review. Unless agreed otherwise the shop drawing review period shall be no longer than 10 working days. The

respective design disciplines shall return the reviewed shop drawings to the Contract Administrator for recording the review status in the shop drawing log and transmission of the Reviewed, Reviewed as Noted or Revise and Resubmit shop drawings to the Contractor. Only Reviewed or Reviewed as Noted shop drawings shall be used for the work. Shop drawings stamped Revised and Resubmit are to be acted upon accordingly by the Contractor. The Contract Administrator shall place copies of the reviewed or reviewed as noted shop drawings in the Project File.

On instances were multiple contracts have been awarded on the project, the Contract Administrator shall review the shop drawings with respect to work of other contracts and transmit copies of the reviewed shop drawings to the other Contractors for coordination with their works.(e.g.: anchor bolt layouts from an equipment vendor to the concrete contractor for embedment).

6.3 Samples

All samples submitted by the contractor will be logged by the Contract Administrator in the Submittal Log, identifying the Date of Submission, origin, intended use in the work and any deviation from the requirements set out in the Contract Documents. The samples shall be reviewed by the appropriate reviewer and comments recorded on the submittal log. The Contract Administrator shall advise the contractor regarding Acceptance or Rejection of the sample and record same in the submittal log.

6.4 Inspection and Test Plans (ITP)

The Contract Administrator shall obtain or prepare a detailed Inspection and Test Plan based on the design specifications for construction of the Project. The process is likely to be, a construction activity, element of work, trade work or equipment manufacturing section. An Inspection and Test Plan identifies the items of materials and work to be inspected or tested, by whom and at what stage or frequency, as well as Hold and Witness Points, references to relevant standards, acceptance criteria and the records to be maintained. Inspection and Test Plans, when properly implemented, help ensure that, and verify whether, work has been undertaken to the required standard and requirements, and that records are kept.

The Contract Administrator shall expedite and receive ITP's from City Supplied Equipment Vendors. The Contract Administrator in conjunction with the City shall determine the need for Factory Acceptance Tests witnessing and inspections. The Contract Administrator shall coordinate and arrange for appropriate inspectors to visit the manufacturing facilities at the appropriate hold points identified in the vendors' ITP.

The Contract Administrator shall place ITPs' and associated inspection reports in the Project File's designated subfolder and copies of the inspection reports shall be forwarded to the responsible design discipline for their review and acceptance.

6.5 Operations and Maintenance Manuals

Upon receipt of O&M manuals from the Contractor, the Contract Administrator shall review the manuals for compliance with the Contract documents. The Contract Administrator will send the O&M manuals to the respective design disciplines and the City for their review and approval. The Contract Administrator will compile the review comments from the reviewers and return the compiled comments to the

Contractor for incorporation into the final O&M manual submission.

The Contract Administrator shall ensure the O&M manuals (first draft) are submitted and available for Pre-commissioning prior to issuance of Certificate of Substantial Performance.

6.6 Training Materials

The Contract Administrator shall receive track and review lesson plans and other training materials. The Contract Administrator shall forward training materials to the City for review and comment. All submittals shall be recorded in the submittal log c/w their status identified.

6.7 Spare Parts

The Contract Administrator shall coordinate receipt of, inspection, tracking and storage of all spare parts in a location designated by the City. The Contract Administrator shall create a listing of spare parts including description, specification reference and relative equipment tag numbers.

7. PROGRESS MONITORING AND CONTROL

7.1 Schedule of Work

The Contractor shall submit a Detailed Construction Schedule, incorporating the schedule requirements and constraints set out in the Supplementary General Condition of the Contract, for the Contract Administrators review. The Contract Administrator shall forward the schedule along with a recommendation of agreement to the City for their approval. This Schedule becomes one of the tools by which the Contract Administrator will monitor and control the works of the project and forms the Contract Time baseline.

The Detailed Construction Schedule must be submitted prior to commencing the work. The agreed upon schedule becomes a crucial measure for any subsequent delay claims that may arise between the City and the Contractor. The Detailed Construction Schedule becomes an enforceable obligation of the Contract, like every other aspect of the contract, and thus, a party causing delay which results in increased costs is likely to be liable for additional costs resulting from the delay.

Progress reviews shall be carried out on a regular basis, typically at the regularly scheduled site meetings. Activities which are behind schedule are identified, and corrective action to bring the activity back on schedule is determined. Progress reviews may be augmented by having special/additional meetings to discuss critical activities which are behind schedule.

If the Schedule must change, it may only be revised with the prior written consent of the Contract Administrator, and only to reflect valid changes in the work or delays beyond the control of the Contractor.

Should the Contractor fail to meet the Critical Stage and Completion Dates defined in the Supplemental General Conditions, the Contract Administrator in conjunction with the City can assess liquidated damages as provided for in the Supplemental Conditions of the Contract, should Critical Stages not be achieved.

7.2 Delays in Completing Work

Construction delays fall into different categories. as follows:

(a) Compensable;

(b) Non-Excusable;

(c) Excusable.

Compensable delays are typically delays caused by the City. These types of delays are compensable in that they may be corrected by extending the Contract Time and/or by providing additional compensation or damages. Examples of these types of delay include late award of the Contract, impeded access to the site, and late delivery of City-supplied equipment or materials.

Non-Excusable delays are those caused by the Contractor, such as his own inability to complete the Work on schedule or delays caused by Sub-contractors.

Excusable delays involve delays beyond the control of the City or Contractor (Force Majeure). These may include strikes, lock-outs (including lock-outs decreed by a recognized contractor's association for its members of which the Contractor is a member), an act of God, or any other cause which the Contractor satisfies the Contract Administrator to be totally beyond his control or any cause within the Contractor's control which the Contract Administrator has determined is an excusable delay. In these cases, the Contract Time shall be extended for a period of time equal to the time lost due to such delays. Extensions in Contract Time shall be recorded via Authorized Contract Change Form.

7.3 Critical Stages

Critical Stages are typically used on multiple contract projects and provide a means of identifying the dates, for which the logical sequence of works for one contract is complete to facilitate aspects of another contract tie-in or start point. The Critical Stage dates often have liquidated damages associated with them, to set off delay claims that may appear if the work of another contract is delayed.

7.4 Progress Monitoring/Recording

The Contract Administrator shall issue or cause to be issued Daily Construction Reports (DCR) and forward to the City by 9:00am the following day. The DCR provides a chronological record of Contractors progress including manpower and equipment being utilized, safety records, activity reporting/ forecasting, inspections and tests taken. Recording of daily construction issues raised and verbal directions given to the contractor should also be recorded in the DCR. The Contract Administrator shall place DCR's in the Project File's appropriate subfolder.

7.5 Request for Information (RFI)

A RFI is the form established by the City for the contractor to request information and/or clarification related to the plans, specifications or contract requirements. RFI's are also issued to request minor deviations from the contract requirements that do not have cost or schedule impacts and to obtain direction on how to proceed when there are conflicting contract requirement. The Contractor shall use the City's standard Request for Information Form to submit questions.

The Contract Administrator shall receive the RFI from the contractor, log the receipt and forward the RFI to the applicable design discipline for response. The Contract Administrator shall log the response date and return the RFI to the Contractor for his action. If the RFI will have cost or schedule implications the Contract Administrator shall obtain a Project Record Index PRI number from the

City and undertake the Change Management processes in Section 10.

7.6 Substantial Performance

The Contract Administrator shall determine if and when Substantial Performance is achieved and shall certify the date thereof.

When the Contractor is of the opinion the work of his Contract has been substantially performed, he shall notify the Contract Administrator requesting arrangement of an inspection of the work. The Contract Administrator shall arrange an inspection with the applicable engineering discipline inspectors, City representative and Contractor. The Contract Administrator shall review the outcome of the inspection in context with the Builders' Liens Act and certify whether Substantial Performance of the contract has been achieved.

In cases where correction of deficiencies is restricted by climatic/seasonal conditions, the Contract Administrator can issue Substantial Performance of the work. In these instances the start of the Warranty Period on the completed works only, will begin 30 days following the Date of Substantial Performance. Documentation to this effect must be stored in the Project file.

When the Contract Administrator determines the conditions of Substantial Performance have been achieved he shall complete a Certificate of Substantial Performance Form in triplicate and obtain the noted signatures. The Contract Administrator shall forward a copy of the signed Certificate of Substantial Performance to the Contractor to prominently display at the contract work site as notice to subcontractors and suppliers of the Contract Completion status. Copies shall also be forwarded to the City and Project File.

Substantial Performance is defined under the Builders' Liens Act as follows the Contract Administrator should review the most current copy of the Builders Lien Act.

For the purposes of this Act, a contract or sub-contract shall be conclusively deemed to be substantially performed when:

(a) the structure to be constructed under the contract or sub-contract of a substantial part thereof is ready for use or is being used for the purpose intended or, where the contract or sub-contract relates solely to improving land, the improved land or a substantial part thereof is ready for use or is being used for the purpose intended; and

(b) the work to be done under the contract or sub-contract is capable of completion or correction at a cost of not more than;

(i) 3% of the first $250,000. of the contract price;

(ii) 2% of the next $250,000. of the contract price; and

(iii) 1% of the balance of the contract price.

Generally, the Works must be ready to use and 97 percent or more complete. The Builders' Lien Act contains sections whereby holdbacks can be released and paid on sub-contracts that are complete. Contract Administrators must be familiar with the terms of the Manitoba Builders Lien Act.

7.7 Total Performance

Total Performance means that the entire work, except those items arising from the provision of Warranty items, have been performed in accordance with the Contract.

Removal of all temporary services for construction including but not limited to site trailers, storage facilities, restoration of laydown areas and debris removal are complete. There can be no deficiencies or defects in the works apparent at Total Performance.

Total Performance Date initiates start of (1) year Warranty Period, but may have extended durations as further specified in the Supplemental Conditions and / or Contract Specifications. The Contract Administrator with the City and Contractor shall complete a final inspection to certify the Date of Total Performance.

The Contract Administrator shall prepare a Certificate of Total Performance Form in triplicate formalizing Total Performance certification. Copies of the completed Certificate of Total performance shall be sent to the City, Contractor and Project file system

Total Performance is also of importance in the Builders' Lien Act, in that it triggers another 40 day lien expiry period for holdbacks on work done post Substantial Performance. Total Performance also triggers the end of the period for Contract Changes. No Contract Changes are permitted after Total Performance.

7.8 Acceptance And Warranty Works

Unless specifically stated otherwise in the Supplemental Conditions of the Contract, the Warranty Period shall begin on the date of Total Performance and shall expire one (1) year thereafter unless specifically stated otherwise.

Prior to expiry of the Warranty Period the Contract Administrator shall arrange an Acceptance inspection with the Contractor and City representatives to identify any outstanding warranty issues

The Contract Administrator shall notify the Contractor in writing of any observed defects or deficiencies which are categorized as warranty items. The Contractor shall remedy all defects or deficiencies identified on the notice to the satisfaction of the Contract Administrator within the time period specified on the notice.

The Contract Administrator shall prepare a Certificate of Acceptance Form in triplicate, for signature of the City and Contractor. Copiers of the completed Certificate shall be sent to the City, Contractor and Project File.

Certification of Acceptance of the work shall not, however, relieve the Contractor from his responsibilities for any breach of Contract including but not limited to, defective or deficient work appearing after the date of Acceptance.

8. PROGRESS PAYMENTS

8.1 Introduction

This section describes the responsibilities of the Contract Administrator respecting Progress payments made to the contractor during the course of the Contract. It is the Contract Administrators responsibility to certify progress of the work for Contracts.

8.2 Progress Payments

By the fourteenth Calendar Day after the end of each month, or as soon thereafter as possible, the Contract Administrator shall, subject to having received all necessary information from the Contractor by the seventh Calendar Day after the

end of the month, prepare a Progress Estimate certifying the value of the work performed during the preceding month. Progress Estimates shall be summarized and reflected in accordance with Form- Standard Progress Estimate Summary.

The Contract Administrator shall forward three hard copies and one .pdf of each Progress Estimate to the Project manager

The Contract Administrator shall obtain the Project Managers approval on the presentation and content reporting of supporting documentation for the Standard Progress Estimate Summary. All approved ACC's shall be listed on the supporting Progress Estimate documentation c/w applicable progress valuation. The Contract Administrator shall attach copies of all ACC's that are being progressed during the period. All Standard Progress Estimates Summaries must reflect Statutory Holdbacks, Holdbacks to Date and Holdback Releases including associated MRST and GST retained.

A requirement to report the value of Manitoba Retail Sales Tax included in the Progress Estimate may apply for manufactured goods within the Province of Manitoba. The Contract Administrator shall ensure the Contractor identifies applicable MRST on the Progress Estimate supporting documentation. An example of MRST identification and reporting can be reviewed. MRST reporting requirements are as set out on the City of Winnipeg's Materials Management website.

In the case were the Contractor is an Equipment Supplier that is not registered as a Manitoba Vendor, the Contract Administrator shall self- assess the MRST value and indicate same on the Standard Progress Estimate Summary.

8.3 Holdbacks and Retention

The Contract Administrator shall apply Statutory Holdbacks to all Interim Progress Payments in the amount stipulated in the Manitoba Builders Lien Act. The Contract Administrator shall also ensure reasonable amounts are withheld to offset uncompleted work. Lien Holdbacks cannot be utilized to set off the cost of deficiency corrective measures should the Contractor abandon the work.

Once Substantial Performance has been achieved as defined in 7.6 above, the Contract Administrator shall prepare a Release of Holdback Progress Estimate identifying the payable date, as the end of the (40 day Lien expiry period).

Retentions that set off deficiency works can be paid out to the Contractor when the corrective measures have been reviewed and accepted by the Contract Administrator.

The Contract Administrator shall also retain Lien Holdbacks on Progress Estimates submitted during the period between Substantial Performance and Total Performance. The release of these holdbacks shall be triggered on the Date of Total Performance and paid at the expiry of another 40 day Lien Period.

9. CONSTRUCTION INSPECTION AND TESTING

9.1 Introduction

This section describes the responsibilities of the Contract Administrator with respect to construction review and testing in conjunction with the Consultant's Inspection and Test Plan.

9.2 Construction Inspection

The Contract Administrator shall perform or cause to be performed construction reviews throughout the duration of the project. The Contract Administrator shall coordinate inspections performed by discipline specific individuals as required to ensure the work conforms to the drawings, specifications and relevant codes. The Contract Administrator shall also notify the City of the planned Construction Review facilitating the City's option to attend the Construction Review.

A Construction Review Record (CRR) shall be completed by the reviewer. Copies of the CRR shall be filed in the appropriate file and a copy forwarded to the Contractor. Should any non-conformances be identified during the construction review the Contract Administrator shall record the items on a) Non Conformance Report (NCR) and transmit the NCR to the Contractor for action. The Contract Administrator shall log the NCR in the NCR Log for tracking, monitoring and disposition. The NCR Log shall be reviewed and updated at Weekly Contractor Site Meetings.

9.3 Testing

The Contract Administrator or his designate shall coordinate 3rd party materials testing firms with progress of the work, receive and interpret test results, request contractor to propose corrective measures and review contractor proposed corrective measures for acceptance. The Contract Administrator shall file all test reports in the project file system.

The Contract Administrator shall compile or cause to be compiled, Equipment and Instrumentation lists. The Contract Administrator shall utilize these lists to track the status of pre-commissioning tests. The Contract Administrator shall witness or cause to be witnessed all Contractor performed pressure tests, water retaining structure leak tests and other tests identified in the specifications or codes. The Contract Administrator shall obtain copies of all test reports from the Contractor and file in the project file system.

10. CONTRACT CHANGES

10.1 Introduction

This section describes the procedures to be utilized by the Contract Administrator for management of Change in the Work. All Changes must be fully documented including the reason the change is necessary, estimate of the cost and schedule impact of the Change, relevant documents detailing the change, contractor pricing, Contract Administrators recommendation for accepting the Change and an Authorized Contract Change signed by Contractor, Contract Administrator and City.

10.2 Project Record Index (PRI)

A Project Record Index is utilized by the City to track and monitor changes in the work. As soon as the Contract Administrator becomes aware of an issue which has the potential to cause amendment to the original contract price, the Contract Administrator shall notify the City of the potential change in work. The PRI number is a unique number that associates all subsequent and associated change management documentation, including the reason a change in work is necessary. These reasons for change can take various forms, such as RFI's, Claims, Owner

requests, Consultant Errors and Omissions, Regulatory changes, Field Instructions and extraordinary events. If the City is in agreement with the potential change, the City shall provide the Contract Administrator with the PRI# for inclusion on subsequent related actions including CCN's, ACC's, FWA's and associated Contractor correspondence.

10.3 Contemplated Change Notice (CCN)

When a Change in the Work is contemplated and the City has provided the Contract Administrator with a PRI number. The Contract Administrator shall compile all technical details supporting the contemplated change and create a Contemplated Change Notice (CCN), Form The Contract Administrator shall include the PRI# on the CCN form. Prior to issue of the CCN to the Contractor, the Contract Administrator shall review the contents of the CCN with the City. If the City is in agreement, the CCN shall be forwarded to the Contractor for his action.

The Contractor will review the contents of the CCN and will respond with a written quotation identifying the increase, decrease or no change in amount on the Contract Price as well as any schedule impact the contemplated Change in the Work will have on Contract Time. A reasonable period of time (typically 10 days) for the Contractor to respond to the CCN should be stated on the CCN as well as the method for valuation of the contemplated change (refer to GC's). The Contract Administrator shall maintain a log of all CCN's and their status.

When receipt of the Contractors response is in hand the Contract Administrator shall record the date of the response and the amount in the CCN Log. The Contract Administrator shall promptly review the cost proposed by the Contractor and if not acceptable shall request the Contractor to provide further substantiation of the costs. If the proposed costs are acceptable to the Contract Administrator, the Contract Administrator will obtain approval from the City to initiate an Authorized Contract Change.

10.4 Authorized Contract Changes

Once the Contract Administrator has received the City's' authorization to proceed, the Contract Administrator shall prepare an Authorized Contract Change Form including references to the PRI number, the CCN number, date of Contractors written quotation, value of change and impact on Contract Time.

The Contract Administrator will obtain the contractors signature confirming contractors agreement to the Change in the Work and affix the Contract Administrators signature recommending the ACC approval. The Contract Administrator will then forward three (3) copies to the City for signature and acceptance of an Authorized Contract Change.

The City shall retain one copy of the fully signed ACC and forward the remaining two copies to the Contract Administrator for recording and distribution to the Contractor. The Contract Administrator shall record the Authorized Contract Change in the ACC log.

The Contract Administrator will also include a copy of respective ACC's with the applicable Progress Estimates (see Section 8).

10.5 Field Work Authorizations

In cases where there is insufficient time, to develop a CCN, the Contract

Administrator shall obtain a PRI number from the City and issue a Field Work Authorization (FWA) Form to authorize the Contractor to proceed immediately. The Contract Administrator shall complete the FWA form identifying the PRI#, a Not to Exceed value, a duration for which the Contractor must submit a final price for conversion into a formal ACC, completion date for the FWA works and the method for valuation of the FWA.

The Contract Administrator shall forward one copy of the FWA to the Contractor, one copy to the City and one copy for the Project files.

10.6 Cost Control

The premise of cost control is to know the complete financial status of all Contracts on a project at any given point in time during progress of the works. Cost Control is a commitment based strategy that provides the City with early indication of estimated final costs for the Project prior to final job cost accounting. A commitment based system means that no costs will be charged against a Contract unless there is a corresponding commitment authorization, in other words invoicing cannot exceed the committed value of a Contract.

The Contract Administrator shall prepare a Monthly Forecast Cost Report, The Monthly Forecast Cost Report will include a summary of all commitments including the Initial Contract Price, Authorized Contract Changes to date by contract and Progress Estimates to date by contract. A Forecast to Complete and Estimated Final Contract Price shall also be presented in the report.

The Forecast to Complete is an estimate of Known Unknowns (Outstanding CCN's, FWA's and pending claims) as well as a sum for Unknown Unknowns (Contingency).

The Forecast Cost Report will be included in the Monthly Project Status Report and include a variance report explaining changes to total contract cost that have occurred during the reporting period.

10.7 Over-Expenditure Analysis

When requested by the City, the Contract Administrator shall provide analysis and documentation supporting Changes in the Work. The analysis and documentation will be utilized by the City as part of the Contract Over-Expenditure Report as required by City of Winnipeg Administrative Directive No. FM-002.

11. CLAIMS AND DAMAGES

11.1 Introduction

This section illustrates the process for addressing Contractor claims during the course of the Contract, identifying the duties of the Contract Administrator and the routing of the associated documentation.

11.2 Claims

Upon receipt of a claim from a contractor, the Contract Administrator shall examine the justification for the claim, evaluate the merit of the claim within the context of the contract documents, develop a recommended course of action and inform the City of the claim. The Contract Administrator shall notify the City within 24 hours of receipt of a Contractors Claim. The City shall create the PRI # and advise the

Contract Administrator to include the PRI number on all further claim associated documentation.

The following steps will be undertaken by the Contract Administrator:

(a) The Contract Administrator will gather pertinent information to verify the existence of a basis for the claim within the scope of the contract. Specifically the circumstances that gave rise to the claim and the principles on which the claim can be contractually considered.

(b) The Contract Administrator will evaluate the Contractor's assessment of his loss and/or delay. The Contract Administrator will also evaluate the criticality of the affected tasks on the Project Critical Path.

(c) The Contract Administrator will assess the causality of the claim. Integral to this shall be a review of any actions that could be reasonably expected that the Contractor should have undertaken to mitigate his losses.

11.3 Damages

If the Contract Administrator makes a determination in favor of the Contractor's claim for damages he shall provide his recommendation to the City, upon receiving authorization from the City, the Contract Administrator shall prepare a ACC reflecting the claim criteria and price and forward the ACC c/w the Contract Administrators recommendation to the City for formal authorization. If the Contract Administrator determines the claim has no merit, the Contract Administrator shall issue a Field Instruction (FI) notifying the Contractor of the rejection of his claim c/w the basis for such rejection. If the Contractor does not agree with the Contract Administrators determination the Contractor can appeal the determination as provided for in the General Conditions.

11.4 Liquidated Damages

In cases when Liquidated Damages are stipulated in the Supplemental Conditions of the Contract. The Contract Administrator shall obtain the Project Managers approval prior to application of Liquidated Damages against the Contract.

12. COMMISSIONING

12.1 General

The Contract Administrator shall be responsible for coordinating implementation of the Commissioning Plan developed by the Consultant. The Contract Administrator will coordinate Contractors' commissioning efforts in relation to the Commissioning Plan. The Contract Administrator shall place all pre-commissioning tests and documentation completed by Contractor in the Project File.

13. TRAINING

13.1 General

The Contract Administrator is responsible for coordinating the training at the job site. The Contract Administrator will receive and review lesson plans submitted by the Contractors and will forward them to the City for review and comment. The submittals shall be tracked via the submittal procedure.

The Contract Administrator in concert with the City, Contractors and Equipment

Vendors will develop the training schedules for both classroom and field level training.

The Contract Administrator shall prepare a Training Session Log of all training sessions. A Certificate of Satisfactory Classroom Training, Form T-1 identifying the component training and sign-offs signifying completion and acceptance for each session will be prepared by the Contract Administrator and recorded on the Training Session Log. A Certificate of Satisfactory Field Training Form identifying field training and sign-offs will also be recorded on the Training Session Log.

When required by the City the Contract Administrator shall coordinate video recording of the training sessions by City designated videographers.

14. WARRANTY

14.1 General

The Contract Administrator shall ensure all warranty documentation as specified in the Contract Documents has been provided and filed in the Project files.

15. SAFETY HEALTH AND ENVIRONMENT

15.1 Introduction

The following section outlines the Contract Administrator's duties in relation to Safety, Health and Environment. The minimum standard for all construction work at the Project shall be City of Winnipeg Safe Work Plans, Workplace Safety and Health Act W210 and Regulation MR 217/2006 and Contractor Safety Management Plan. In the event of a conflict of standards the most stringent standard shall apply.

15.2 Safety

15.2.1 General

Prior to project mobilization, the Contractor shall submit the name and credentials of their proposed health and safety representative for approval by the Contract Administrator. The Contractor shall provide a full time competent safety person to supervise the safety aspects of their work on the project when their total workforce, including sub-contractors, supervisors and administrative personnel, is greater than 25 people or whenever hazardous work of a critical nature is being performed, regardless of the size of the workforce.

The Contract Administrator shall review Contractors' Health and Safety Management plan and Safe Work Plans in conjunction with the City, for conformity with the Contract Documents, facility specifics and other project specific safety requirements. The Contract Administrator shall monitor the Contractors safety performance with respect to Contractors responsibilities as stipulated in the General Conditions and Contractors Health and Safety Management Plan and Safe Work plans. The Contract Administrator shall review Contractors safety performance and status at weekly contractor meetings.

With instances were multiple contractors are working concurrently on the same Project, the City shall identify the Contractor with Prime Contractor responsibilities as referenced in WHSA W210.

15.2.2 Plant Orientations

All Contractor personnel engaged to work on a Wastewater Treatment Plant must undergo City of Winnipeg specific Wastewater Treatment Plant Safety orientation. For more information regarding safety orientations refer to Contractor Safety Health and Environment Orientation Plan

15.2.3 Notifications

The Contract Administrator shall notify the City of any serious incidents within 1 hour of the incident occurrence. The Contract Administrator shall ensure the Contractors Chief Executive Officer has been summoned and will arrive at the site within 24 hours of the incident.

Serious accidents that require the on-site presence of the Contractor's chief executive officer include but not limited to:

(a) Any accident resulting in death or those of a critical nature with a serious risk of death.

(b) Any accident involving a major structural collapse or failure of a building or structure.

(c) Any spill or release of a toxic or hazardous substance.

(d) Any accident that, by regulation, shall be reported to the Minister or person appointed or designated by the Minister.

(e) Any accident that caused damage to any piece of equipment or machinery and thereby caused it to become dangerous (e.g. upset of a crane).

The purpose of this visit is for that person to explain to the Contract Administrator what precipitated the accident, what action has been taken to date, and what changes will be made to prevent recurrence.

15.2.4 Reporting

The Contract Administrator shall include in the Monthly Status Report a listing of all recordable incidents that occurred during the reporting period.

15.2.5 Investigations

The scene shall not be disturbed until permission is given by the Contract Administrator City and by Manitoba Workplace Health and Safety. Investigation of the incident will be performed by Contractor, Prime Contractor's CSO if applicable. The Contract Administrator shall obtain the resultant investigation documentation. The Contract Administrator shall file the generated safety documentation in the Project File's for record purposes.

15.3 Access Control

15.3.1 General

The Contract Administrator shall review the Prime Contractors access control plan. The Prime Contractor shall conduct site orientations for all personnel requiring access to the project site.

15.3.2 Visitors

The Contract Administrator shall obtain prior approval from the City, for Consultants visits of non-resident personnel to the site. The Contract Administrator shall provide the city a list of non-resident personnel c/w the date of visit, reason for their visit and the expected duration of the visit. Time charges for non-resident consultant personnel visiting the site will not be permitted without prior City approval. Non Resident inspectors do not require city approval but must complete an Inspection Report supporting the visit and provide the Contract Administrator a copy for the Project file.

Unscheduled media representatives, journalists and others shall not have access to the site. The Contract Administrator shall refer them to City of Winnipeg Media Relations Bureau as well as immediately notify the City Project Manager of the access request.

15.3.3 Plant Access

Plant access shall be as stipulated during Contractor Site Orientation.as detailed in Contractor Safety Health and Environment Orientation Plan

15.3.4 Security

The Contract Administrator shall review the Contractors' security plan for the site.

15.3.5 Permitting

The Contract Administrator shall ensure the following Permits are completed by the Contractor for work to occur within an operating plant.

(a) Lockout Tag Out Permit;

(b) Hot Work Permit; and

The foregoing permits require Plant Operator in Charge sign off.

The Contract Administrator shall ensure the following permits are produced by the Contractor for work adjacent to an Operating Plant.. Permits for this work do not require Plant Operator in Charge sign off.

(a) Confined Space Permit;

(b) Critical Lift Permit;

(c) Lockout Tag Out Permit; and

(d) Pressure Test Permit.

The foregoing permit process applies to major projects only. In the case of minor projects the Contract Administrator shall review work requirements with the City and establish safety protocols accordingly.

15.4 Environmental

The Worksite is part of the City of Winnipeg Wastewater System. Safe handling and storage of fuel, oils, and chemicals shall be of the highest priority and care. Any mishap shall be immediately reported to the Contract Administrator.

The Contract Administrator shall immediately notify the City of such spills and act in accordance with established City of Winnipeg Environmental Preservation and Compliance protocols and monitor the Contractors containment and remediation actions. The Contract Administrator shall obtain copies of Contractors incident report and investigation and file in the Project File's.

16. OWNER SUPPLIED EQUIPMENT

16.1 Introduction

The City may pre-purchase equipment with long delivery times or when detailed equipment information is required to complete the detailed design works. The following outlines the Contract Administrators responsibilities with respect to Vendor submittals, Factory Acceptance Testing, Receipt of Goods, installation, testing and commissioning of all owner supplied equipment.

16.2 Vendor Submittals

The Contract Administrator shall receive, review and process and log submittals from City Supplied Equipment Vendors. Typical Submittals include manufacturer Shop Drawings, Inspection and Test Plans (ITP) and Operations and Maintenance Manuals. The Contract Administrator shall forward copies of the shop drawings to the installation contractors.

16.3 Factory Acceptance Testing

The Contract Administrator shall review ITP's and coordinate Factory inspection and tests whether they are performed by third party agencies or by the design consultant. The Contract Administrator shall estimate the costs associated with all factory inspections and submit to the city for approval prior to arranging the inspections / tests. The Contract Administrator shall obtain and review all FAT results and incorporate into the Project File's

16.4 Delivery and Receipt of Goods

The Contract Administrator shall coordinate the shipping and receipt of City Supplied Equipment with the Contractor. Once the Goods have arrived to the Contract Administrator, Contractor and Manufacturer shall inspect the goods and complete Form 100-Equipment Deliver Form which transfers the Care and Custody of the Goods to the Contractor. Any deficiencies noted during the inspection shall be listed on the Form. A completed Form 100 shall be provided to the Contract Administrator prior to the Manufacturer leaving the site.

16.5 Installation

Prior to installation of the goods the Manufacturer and Contractor shall complete Form 101 Readiness to Install, Form signifying the Contractor has received adequate instruction relative to installation of the Goods. The Manufacturer shall provide the Contract Administrator with a fully signed copy of the Form prior to leaving the site. The Contract Administrator shall incorporate the signed forms into the Project file.

Once the Contractor has completed installation of the Goods, the Contractor shall notify the Contract Administrator that the Installation of the Goods is ready for inspection by the Manufacturer. The Contract Administrator shall coordinate the Manufacturers inspection and have form 102-Satisfactory Installation Form completed and signed. Any deficiencies in the installation shall be noted on the form. The fully signed form shall be delivered to the Contract Administrator prior to the Manufacturer's representative leaving the site. The Contract Administrator shall incorporate the signed forms into the Project file system.

16.6 Pre-Commissioning

The Contract Administrator shall coordinate the Manufacturer and Contractor to undertake Pre-Commissioning of the Goods. No Pre-commissioning activity shall take place on the goods prior to receipt and review of the O&M Manuals. Once all pre-commissioning checks, run tests, operating checks have been successfully completed the Contractor and Manufacturer shall complete Form 103 Satisfactory Performance Form and submit to the Contract Administrator. The Contract Administrator shall file the Form in the Project File system. Once Form 104 has been signed-off the Contract Administrator will prepare a Certificate of Substantial Performance for the City Supplied Equipment Contract, initiating the Lien Holdback release period.

16.7 Commissioning

The Contract Administrator shall coordinate the presence of the Manufacturer's representative during Process Commissioning. Once process commissioning of the goods has been completed and accepted. The Manufacturer shall complete Form 104-Satisfactory Process Performance Form. A fully signed copy of Form 104 shall be submitted to the Contract Administrator. Receipt by the Contract Administrator shall signify Total Performance of the City Supplied Equipment contract and initiates the start of the Warranty Period. The Contract Administrator shall complete a Certificate of Total Performance and incorporate the signed forms into the Project files.

17. LIST OF FORMS

CD-PM-TO-01 Agenda Preconstruction Meeting

CD-PM-TO-40 Standard Progress Estimate Summary

CD-PM-TO-03 Contemplated Change Notice

CD-PM-TO-04 Approved Contract Change

CD-PM-TO-05 Field Work Authorization

CD-PM-TO-06 Request for Information

CD-PM-TO-07 Field Instruction

CD-PM-TO-08 Daily Construction Report

CD-PM-TO-09 Progress Estimate Mixed Tax Sample

CD-PM-TO-10 RFI Log

CD-PM-TO-11 Submittal Log

CD-PM-TO-12 Construction Review Record

CD-PM-TO-13 Equipment Delivery (Form 100)

CD-PM-TO-14 Readiness to Install (Form 101)

CD-PM-TO-15 Satisfactory Installation (Form 102)

CD-PM-TO-16 Satisfactory Performance (Form 103)

CD-PM-TO-17 Satisfactory Process Performance (Form 104)

CD-PM-TO-21 Non Conformance Report

CD-PM-TO-23 Training Form T-1

CD-PM-TO-24 Training Form T-2

Total Performance Certificate

Acceptance Certificate

Progress Estimate Certificate