EXECUTIVE SUMMARY

Table of Contents

INTRODUCTION E.1
REGULATORY REQUIREMENTS E.1
REFINE WET WEATHER FLOW E.2
BNR PROCESS REFINEMENT E.3
BNR PROCESS SELECTION E.4
PROCESS FLOW DIAGRAM AND MASS BALANCE E.5
HEADWORKS E.5
PRIMARY TREATMENT E.6
BIOREACTOR DESIGN E.7
SECONDARY CLARIFIERS E.8
EFFLUENT DISINFECTION E.8
YARD PIPING AND OUTFALL E.9
HYDRAULIC PROFILE EVALUATION E.10
SOLIDS HANDLING E.10
HAULED WASTEWATER E.11
ODOR CONTROL E.12
ELECTRICAL AND INSTRUMENTATION E.12
CONTROLS PLATFORM AND AUTOMATION E.13
SITE DEVELOPMENT MASTER PLAN E.14
ADMINISTRATION BUILDING E.15
BUILDING ENVELOPE AND STRUCTURAL ASSESSMENT E.16
ASBESTOS ABATEMENT E.16
OPINION OF PROBABLE COST E.17
IMPLEMENTATION PLAN E.18
RISK ASSESSMENT UPDATE E.19

Executive Summary

INTRODUCTION

This Conceptual Design Report (CDR) summarizes the findings of engineering studies for the upgrade and expansion of the South End Water Pollution Control Centre (SEWPCC) for the City of Winnipeg (City).

The Conceptual Design study was performed based on input provided following review of the Preliminary Design Report (PDR), which was completed in March 2008.

The City of Winnipeg has been a leader in wastewater treatment since the mid 1970's. The City was one of the first communities in North America to use high purity oxygen (HPO) technology. Due to increasingly more stringent effluent discharge regulations, the City has been proactively planning the upgrade / expansion of the South End Water Pollution Control Centre (SEWPCC) from secondary treatment to advanced biological nutrient removal (BNR) for the past six years. In January of 2006 the City engaged the services of the Stantec Consulting Ltd. (Stantec) Team to design an upgrade / expansion to the SEWPCC.

In order to meet the City's commitment to the Province, the upgraded plant must be commissioned in early 2012 so that the operational intricacies can be worked out and the plant's biological process stabilized and optimized prior to the licence requirements coming into effect on December 31, 2012. The upgrades will take approximately three years to construct, leaving one year for functional design, detailed design, tendering, and contract award. The December 2012 deadline can only be met by proceeding on a very aggressive design schedule.

The Stantec Team consisting of Stantec Consulting as prime consultant and TetrES and EMA as sub-consultants has prepared this CDR as a required follow-up to the PDR.

This section is intended to outline the major findings presented in the report with an emphasis on the wastewater treatment process selection. This section has been organized according to the sequence of the report, starting with the updated evaluation of data, moving through the refinement of alternatives and the discussion of critical factors influencing the facility design. All of these activities contribute to the refinement of the treatment upgrade / expansion that was selected in the PDR.

REGULATORY REQUIREMENTS

The regulatory requirements for the upgrading / expansion of the SEWPCC are primarily based on the Environment Act License # 2716 issued by Manitoba Conservation and were previously discussed in the Section 3 – Regulatory Requirements of the PDR.

Subsequent to the PDR, Manitoba Conservation issued a draft revision to the License. The revision addressed the City's request to regulate 5 day carbonaceous biochemical demand ($cBOD_5$) and total suspended solids (TSS) on a 30-day rolling average as opposed to the original "never-to-exceed" basis. These were seen as positive revisions. However, at the same time the revision imposed a $cBOD_5$ "never-to-exceed" limit of 30 mg/L, making the 30-day rolling average limit meaningless as the never-to-exceed limit will govern the design of the facility.

The City met with Manitoba Conservation to explain that designing the new facility based on a $cBOD_5$ never-to exceed limit of 30 mg/L means the facility will be designed based on the single worst day of the year, rather than the maximum month loading that is typically used. This will result in an oversized facility, a facility that will have to operate in a very low load condition the majority of the year. Unfortunately, BNR facilities are difficult to operate when they are under loaded and as a result will not produce optimum effluent quality during the most sensitive period for the receiving environment. Over sizing the facility to achieve the never-to-exceed limit will add approximately $60 million to the SEWPCC project cost.

As part of the meeting with Manitoba Conservation, the City also requested a modification to the license to eliminate the disinfection of flows greater than 175 ML/d. The rationale behind this request is that at the SEWPCC secondary treatment is only provided for 175 ML/d, all flows in excess of 175 ML/d are bypassed around the secondary process. Disinfection of effluent receiving secondary treatment is very effective. However, it is impractical to disinfect bypassed flows with UV disinfection, and disinfection of these flows with chlorine will likely result in the formation of chlorinated byproducts. Therefore, it is only practical to disinfect flows up to 175 ML/d.

For this report Stantec was directed to proceed based on meeting the effluent $cBOD_5$ limit on a 30-day rolling average and only provide disinfection for flows up to 175 ML/d. The City is still waiting further resolution on these issues from Manitoba Conservation.

REFINE WET WEATHER FLOW

A final determination was made of the design Wet Weather Flow being conveyed to the SEWPCC in order to proceed with the sizing of new pumps, the determination of total and firm pumping capacity requirements, stand-by power requirements, by-pass channel capacity, the proposed outfall twinning and other items in the plant required to convey the Wet Weather Flow.

This determination incorporated the following findings:

- It was determined that with the addition of the Waverley West Interceptor, the interceptor system will have the capacity to convey the Year 2031 Maximum Hour Design Flow of 480 ML/d to the plant without any basement flooding, provided the upstream restrictions such as undersized pumping stations are upgraded. The calibrated InfoWorks model developed as part of the Phase 1 South End Pollution Control Centre (SEWPCC) Service Boundary

Inflow/Infiltration and Cross-Connection Study shows that the maximum capacity of the St. Mary's Interceptor is 430 ML/d. This number is consistent with the results presented in Section 4 of the March 2008 SEWPCC Upgrade / Expansion PDR.

- The June 2007 letter issued by Manitoba Conservation requires only the treatment of 300 ML/d of flow. Therefore, based on the capacity of the interceptor and the Manitoba Conservation requirements for treatment, a firm pumping capacity of 300 ML/d complete with standby power and a total pumping capacity of 415 ML/d is recommended for the SEWPCC expansion.

There is a need in the future to reduce the amount of extraneous inflow that enters the system. Any extraneous flow removed from the system in the future will result in the reduction of flow to the SEWPCC, freeing up additional capacity in the existing SEWPCC collection system and providing additional basement flooding protection during extreme wet weather events.

BNR PROCESS REFINEMENT

As part of the Conceptual Design, a series of refinements was made to the basic BioWin^{TM} models for the short-listed Options C and G, which were described in the March 2008 PDR. This included conducting sensitivity analysis related to nitrifier maximum specific growth rate, wet weather flow strategies, Chemically Enhanced Primary Treatment (CEPT) efficiency and, number of bioreactor trains. In addition, an overall comparison of the Modified Johannesburg Process (MJP) with the Westbank Process for the Option C configuration was undertaken, including impact of low flows on BNR performance and comparison of Option C with Option G performance.

A summary of the findings is as follows:

- Dynamic simulation of the design year spring period indicated that the effluent total nitrogen (TN) discharge limits of 15 mg/L could be met on a 30-day rolling average even with reduced nitrifier growth rates. It was recommended that testing utilizing the low Food to Microorganism Rates method be undertaken to confirm the nitrifier growth rate.
- Steady-state modeling showed no significant difference in process performance between lamella plate clarification and conventional CEPT with excess flows (bypassing primary treatment) going directly to the bioreactors (up to 100 ML/d) during wet weather events.
- A comparison of the Westbank process was evaluated side-by-side with the MJB. For the most part, BioWin^{TM} simulation predicted that the two processes performed essentially the same.
- The bioreactor configuration designed for 2031 was checked for plant performance under low flows using February 2007 data as the influent input in the BioWin^{TM} model. This month had the lowest flow during the whole year and the model was dynamically simulated for one

week. Although the TN limit of 15 mg/L was exceeded for approximately 13 hours, on a daily average basis, the effluent TN met the licence.

- Based on operational considerations, a bioreactor design incorporating a 4-train system is recommended given the size of the proposed SEWPCC facility and the desired process flexibility for the system.
- Process modeling results indicated that both Options C and G provided the same level of performance and met the effluent criteria. It was concluded that both options could be successfully implemented at the SEWPCC.

BNR PROCESS SELECTION

The BNR Process Refinement demonstrated that both Option C (MJP) and Option G (MJP with biofilm carrier elements or Integrated Fixed Film Activated Sludge (IFAS) media could be successfully implemented at the SEWPCC. Both options were analyzed and evaluated in detail on the basis of relative advantages and disadvantages, operating considerations, capital costs, operation/maintenance costs and life cycle costs. The two options were scored by the Project Team based on an evaluation matrix developed similar to the one used during the Preliminary Design stage. The evaluation matrix consisted of three criteria groups, ***Technical, Operational and Monetary***. The overall scores for both the options were essentially the same with Option C receiving 461 points and Option G receiving 460 points. Based on capital costs ($203 M for Option C and $ 194 M for Option G) and scoring conducted by the Project Team (Table 5.10), the two options can be considered essentially equal. Although the annual O&M cost for Option G is higher ($6.8 M compared to $6.2 M for Option C), the life cycle costs were the same ($273.8 M for Option C and $272 M for Option G). Stantec recommended Option G based on the following rationale:

- IFAS media provides enhanced process reliability.
- Option G system maintains lower solids loading to the secondary clarifiers on a consistent basis.
- IFAS is now well established in North America and is no longer an emerging technology.
- Several media options are available in the market.
- IFAS offers reasonable financial benefits with respect to capital costs.
- There is potential to reduce risk of cost escalation (cost of concrete and steel are going up, while media costs have gone down).

The Project Team was in agreement with Stantec's recommendation with the caveat that Stantec carry out due diligence regarding operational issues associated with the IFAS process. These operational issues were subsequently addressed in the bioreactor design.

PROCESS FLOW DIAGRAM AND MASS BALANCE

The Process Flow Diagram (PFD) is a line and symbol graphic representation of the major wastewater and residual solids streams through the SEWPCC in the proposed expanded and upgraded configuration. The PFD drawing includes lines representing pipelines and channels, and symbols representing major treatment unit tanks and equipment, as well as valves. The PFD for the SEWPCC does not show all plant systems and features, but provides the framework for those other systems.

The PFD is a design tool that is modified and refined through the detailed design and construction phases, and that will provide guidance for the operation of the upgraded plant. The PFD provides a representation of process material flows through the treatment plant for the following media: wastewater, wastewater treatment residual solids including sludge and sludge decant liquid. Wastewater treatment aeration air feed, and wastewater treatment chemical feeds are indicated only to a limited extent on the PFD.

The full PFD is included as a large-format print in Appendix D. The PFD serves as the framework for the detailed design of support systems.

The mass balance is a diagrammatic representation of the quantities of liquid volume and pollutant mass flows through the treatment plant. The mass balance represents the balance of materials through the treatment process, including the liquid flowrate (in ML/d) and the flux of key pollutants (in kg/d) such as TSS, COD, TN, and TP.

The mass balance diagrams have been substantially completed for all key wastewater loading scenarios. Key influent flowrate and loading scenarios, with temperature, have been addressed.

HEADWORKS

The PDR identified that the SEWPCC must be capable of conveying a flow of 415 ML/d, close to the maximum interceptor capacity of 430 ML/d. The existing headworks were examined to review the current equipment capacities and to determine what upgrades are required.

The wet well pumps can presently handle flows ranging from 22 ML/d to 388 ML/d. In order to achieve the required capacity of 415 ML/d, six options were investigated. The recommended option is to install a new pump to replace one of the existing low flow pumps.

The existing wetwell has adequate space for the required upgrade, but requires repair of the influent sluice gates to facilitate maintenance and to reduce the chance of flooding should a catastrophic mechanical failure occur. Operation set points relating to wet well level that control the pumps need to be adjusted, and further work on this is recommended. The existing grit pump and associated mechanical should be upgraded, as this provides grit protection to the

main raw sewage pumps (RSPs) and also is the system used when pumping down the wet well to its lowest level.

Previous pump vibration problems were investigated and it was found that adjustments made by the SEWPCC operations staff over the past 3 years have resulted in a reduction and near elimination of those vibration problems. No further work is recommended to reduce pump vibration.

The existing 12.5 mm screens were evaluated. Each of the three screens has a capacity of 180 ML/d. Several upgrade options were investigated. It is recommended to retain use of the existing screens and install two new 6 mm screens to handle the plant bypass flow, downstream of the new grit removal equipment.

The existing grit removal tanks have a capacity ranging between 220 ML/d and 360 ML/d depending on the retention time. The new operational strategy will be to divert 200 ML/d through these tanks. Construction of two new vortex grit tanks is recommended to remove grit from the bypass flow (max. capacity of 215 ML/d).

The existing grit channels have high conveyance capacity that results in low velocities and grit deposition in the channels during low flow periods. Channel baffles are recommended to provide flow splitting and increase velocities during these low flow periods, resulting in less grit deposition.

PRIMARY TREATMENT

The purpose of primary treatment is the removal of readily settleable solids and the separation of fats, oils and grease. There are three existing primary settling tanks (PST) in parallel that have a total treatment capacity of 175 MLD. A traveling bridge equipped with a scraper mechanism moves the settled primary sludge to the influent end in all three clarifiers. The current practice is to operate the sludge pumps on a timer to maintain a primary sludge total solids concentration of 2.5 to 3 percent. Primary sludge is pumped to the sludge holding tanks. From there it is trucked to the NEWPCC for treatment and disposal. The primary scum is collected at the effluent end in primary settling tanks no. 1 and 2 (PST-1 & PST-2) and at the influent end of primary settling tank no. 3 (PST-3). The scum pumps are operated manually on a daily basis to pump the scum to the sludge holding tanks. The operators have reported that they periodically have problems with scum congealing in the scum lines. This problem is addressed by steam cleaning the scum lines on an annual basis.

Alternative scum system modifications to improve the effectiveness of the current configuration were evaluated. It was determined that the operational budgets of the proposed system modifications did not justify the associated capital cost of the modifications. It is recommended to optimize the removal of scum by transferring some of the scum either to the proposed dissolved air flotation (DAF) system or to the fermenter for thickening prior to trucking to the

NEWPCC. It is also recommended that the City carry out fat, oil and grease testing downstream of the primary clarifiers to determine if any further scum control actions are required.

To meet the new license for the SEWPCC, the existing PST capacity will be increased to 200 MLD during wet weather events. This will be accomplished by converting the existing PSTs into chemically enhanced primary clarifiers for flows greater than 175 MLD and less than 200 MLD, using alum and polymer.

A new chemical feed room north of PST-1 is proposed to house the alum and polymer feed systems. The existing sludge pumps will continue to be used, although they will operate continuously to maintain a low sludge blanket in the clarifiers. The primary sludge will be pumped to the new fermenters for the generation of volatile fatty acids (VFA).

BIOREACTOR DESIGN

The bioreactors provide biological treatment of the incoming primary effluent or any raw sewage that bypasses primary treatment directly to the bioreactors during high flows greater than 200 ML/d. For the SEWPCC, the proposed bioreactor design is based on a 3-pass, 4-train high rate MJ BNR process with biofilm carrier elements or IFAS media in the aerobic zones of the bioreactor (44% fill in aerobic zone 1 and 60% fill in aerobic zone 2). The biofilm carriers are retained within the aerobic zones by utilizing media retention screens. A mixed liquor recycle zone, with no media, is incorporated downstream of the last aerobic zone to facilitate internal recycle of mixed liquor to the first anoxic zone, for denitrification.

The existing HPO tanks will be converted to the un-aerated zones (pre-anoxic, anaerobic and anoxic zones) of trains 1 and 2, with additional aerated tankages added to the north and south to achieve the desired configuration. Other key components of the bioreactor design include influent flow distribution (primary effluent, return activated sludge and primary bypass flows), medium bubble aeration system, submersible mixers in un-aerated zones, mixed liquor recycle pumping, waste activated sludge pumps, and media retention screens. The Conceptual Design is based on the premise that the new bioreactors will be covered.

To meet the range of air flows for process operation, a total of four (4) single-stage blowers are proposed, including three (3) duty blowers and one (1) standby unit. Each blower will have a maximum throughput of 15,190 Nm^3/hr[1] at 8.3 psig and will be equipped with a 400 hp high-efficiency motor. The turn-down capability of each blower is estimated down to 6,100 Nm3/hr. The proposed blower system will be equipped with a Master Control Panel (MCP), which brings blowers on-line or off-line as required based on the dissolved oxygen set points in the bioreactor aerobic zones. The blower room will be constructed adjacent the south west end of the existing primary clarifier and adjacent to the proposed Bioreactor Train No. 1. Several process control

[1] Nm^3/hr = Normal cubic meters per hour.

instruments are proposed for the bioreactor system including oxygen reduction potential probes for the anaerobic and anoxic zones of the bioreactor, dissolved oxygen (DO) probes in the two aerobic (IFAS) zones of each bioreactor train and an on-line Nutrient Analyzer for real time effluent quality monitoring for ammonia-N, NO2-/NO3- and ortho-P.

SECONDARY CLARIFIERS

The purpose of the secondary clarifiers is to provide solids-liquid separation of the mixed liquor downstream of the bioreactors and prior to disinfection. They also provide some thickening of the settled solids.

There are three (3) existing clarifiers with two sized at 33.5m diameter and one (1) at 45.7m diameter. In order to handle the projected 20-year design flows, two (2) 45.7m diameter clarifiers need to be added. There is an opportunity to defer the construction of one clarifier for approximately 10 years, as only 1 additional 45.7m clarifier is required to handle the 10-year loading. The projection of timing of secondary clarifier construction was based on an average surface overflow rate (SOR) of 24 $m^3/m^2/d$ (max SOR 44 $m^3/m^2/d$) and an average solids loading rate (SLR) of 144 $kg/m^2/d$ (max SLR 216 $kg/m^2/d$).

The existing influent and effluent channels were determined to have adequate capacity for the proposed maximum flow of 175 MLD.

The new secondary clarifiers are proposed to be constructed adjacent to the existing mixed liquor channel. The existing pipe gallery and main floor walkway will be extended for access. Insulated aluminum domes are proposed for covering of the secondary clarifiers, with ventilation provided.

The existing secondary clarifiers will need to be retrofitted as part of the process upgrade. This involves changing the existing draft tube sludge collection mechanisms to helical sweeps to prevent sludge aging. This conversion will require modifications to existing mechanisms and piping.

Waste activated sludge (WAS) will no longer be pumped from the secondary clarifiers, so no new WAS pumping equipment will be installed. However, the existing equipment will remain. Return activated sludge (RAS) and scum will be handled and pumped in a manner similar to current practice. Slightly larger RAS pumps will be required for the new clarifiers, but the mechanical layout will remain unchanged. Scum tanks and pumps that duplicate the existing installations will be provided for each of the new secondary clarifiers.

EFFLUENT DISINFECTION

The purpose of the effluent disinfection unit process is to reduce the number of pathogens in the treated wastewater to safe levels. The SEWPCC currently uses ultraviolet (UV) light to disinfect

flows up to 100 ML/d. The existing license requires that the fecal coliform level in the effluent be less than 200 Most Probable Number (MPN) / 100 mL, as determined by the monthly geometric mean.

The existing system was designed for: flows up to 100 ML/d; total suspended solids (TSS) less than 10 mg/L; and UV transmissivity (UVT) greater than 50%. Due to blending of any bypassed flows with the treated effluent upstream of the UV disinfection, the TSS can frequently exceed 10 mg/L in the treated effluent, resulting in reduced disinfection efficiency and occasional exceedance of the license requirements.

The revised license requires that flows less than 175 ML/d receive disinfection to the same standard stated in the previous license. Process modifications will be made upstream of effluent disinfection to prevent bypass flows greater than 175 ML/d from being combined with the secondary effluent prior to disinfection. In the spring and fall, up to 50 ML/d of primary effluent will be blended with 125 MLD of secondary effluent prior to receiving disinfection. To achieve the license requirements, the existing system will be twinned and Trojan 4000 Plus UV equipment will be installed in the new channels. The existing building will be expanded over the new channels. The new setup will be designed for flows up to 175 ML/d, TSS less than 25 mg/L on a 30 day rolling average, and UVT greater than 45%.

YARD PIPING AND OUTFALL

Site piping modifications are required to realign a portion of the existing onsite watermain and wastewater sewer infrastructure to accommodate the proposed SEWPCC expansion. Modifications are also required to increase the hydraulic capacity of the outfall via a bypass/secondary outfall and to address the requirement by Manitoba Conservation to provide continuous flow and quality monitoring of the plant effluent .

The proposed expansion to the SEWPCC site results in some of the new structures being constructed near or on top of some of the existing onsite watermains and wastewater sewers. It is therefore recommended that a portion of the existing watermain and wastewater sewer system at the plant be abandoned and or replaced to accommodate the proposed expansion.

In regards to the hydraulic capacity of the outfall, it is recommended that 1000 metres of 2100 mm diameter “Twinned” Outfall / Bypass pipe be constructed in order to maintain operation of the UV Disinfection Facility during high river levels and high flows from the plant. This will allow 415 MLD of flow to be conveyed to the Red River while maintaining operation of the UV Disinfection Facility using the revised Trojan operating criteria at a 20-year river level of 228.4 m. At river levels higher than the 20-year elevation, 415 ML/d can still be conveyed to the river but the UV Disinfection Facility will no longer be operational.

HYDRAULIC PROFILE EVALUATION

InfoWorks® CS modeling software from Wallingford Software was used to model the hydraulics of the SEWPCC in its proposed upgraded and expanded configuration.

To address high wet-weather flows, the SEWPCC design incorporates a set of flow limits on certain treatment stages to achieve the license requirements. These operational scenarios require flow control structures that divert and bypass all or portions of the flow based on trigger flow rates. These features and trigger values have been entered into the base hydraulic model. The proposed new twinning section of the SEWPCC outfall pipeline system has also been entered into the model.

Influent flowrates have been simulated in the model for a range of critical conditions spanning the expected flowrates, ranging from 20 ML/d to 422 ML/d, with high water elevation entered for the Red River during the high plant flowrate periods. For each scenario, model outputs were obtained and reviewed. These included output data tables, plan diagrams of flow distribution, and vertical profile cross-sections through selected critical pathways.

The modeling performed as part of the Conceptual Design phase indicates that the SEWPCC upgrade / expansion will result in a treatment plant that will be capable of passing the projected flows without overflowing. The modeling demonstrates that the capacity that the proposed new outfall twinning pipeline section will provide is critical to the overall hydraulic stability of the treatment plant.

Additional modeling and hydraulic evaluation will be performed during the detailed design phase to further refine the plant design features.

SOLIDS HANDLING

Solids handling consists of the treatment and disposal of fermented primary sludge, waste activated sludge (WAS) and scum. The current practice at the SEWPCC is to pump primary sludge, co-thickened with WAS in to the primary clarifiers, and scum to sludge holding tanks. The combined sludge and scum is trucked to the NEWPCC where it is anaerobically digested, dewatered and then land applied. The existing sludge holding tanks have approximately one day storage capacity.

Following conversion to BNR, WAS will no longer be pumped back to the PST for co-thickening. Primary sludge will be pumped continuously to the proposed fermenters for VFA production and thickening. While only one (1) 20 meter diameter fermenter is required to satisfy the bioreactor's VFA needs, two (2) fermenters are proposed to thicken all the primary sludge and thereby reduce the volume to be hauled to the NEWPCC. Supernatant from the fermenters will be pumped to the anaerobic zone of the bioreactor trains, while the thickened fermented sludge will be pumped to the proposed sludge holding tanks.

WAS will be drawn directly from the mixed liquor suspended solids (MLSS) recycle zone of the IFAS bioreactors for solids retention time (SRT) control. The WAS will be pumped to four (4) proposed DAF units for thickening. The DAF subnatant will be pumped to the PSTs, while the thickened WAS will be pumped to the proposed sludge storage tanks.

The proposed sludge storage facility will be comprised of three (3) sludge storage tanks that provide three days of storage, a basement pumping room, and a truck bay equipped with a control room, washroom and a mezzanine level for air handling equipment.

HAULED WASTEWATER

The purpose of the hauled wastewater (HWW) facility is to receive, record and convey to the headworks facility, HWW from the 33 registered wastewater haulers. The current HWW Facility consists of a receiving manhole connected to a discharge manhole that controls the discharge of hauled liquid waste (HLW) to the interceptor upstream of the SEWPCC headworks facility.

A separate study (Winnipeg Regional Hauled Wastewater Plan (WRHWWP), Stantec 2007) was carried out to develop a long-term HWW handling strategy for the City's three Pollution Control Centers. The study involved extensive hauled wastewater sampling, analysis and option evaluation. The option selected for the SEWPCC by the WRHWWP Steering Committee and endorsed by the SEWPCC Project Team includes:

- Adding an automatic swipe card manifest tracking system.
- Adding flow measurement.
- Improving sampling capabilities.
- Adding a 35 m^3 discharge containment tank with the ability to expand the equalization capacity and add pumping and mixing in the future if required.
- Improving the site security and access to the upgraded facility.

Wastewater characterization and nitrifier growth rate testing results obtained in October 2008 indicated that HLW reduced the growth rates for Ammonia Oxidizing Bacteria (AOB) and Nitrite Oxidizing Bacteria (NOB) from 0.9 d-1 and 0.7 d-1 to 0.7 d-1 and 0.6 d-1 respectively. Additionally, the fraction of influent TKN that is soluble and unbiodegradable (f_{NUS}) was determined to be 0.07, higher than typical values that range from 0.02 ~ 0.04 mg N/mg N. The f_{NUS} component is untreatable and makes meeting low effluent TN difficult.

The implication of these findings is that in order to treat HLW at the SEWPCC, the City will either have to address the nitrifier growth rate inhibitors in the HLW or increase the bioreactor tank size. It is recommended that the City proceed with design / construction of the SEWPCC based on typical nitrifier growth rates, and undertake additional sampling and toxicity testing in an effort to identify the potential HLW source(s) of inhibition. If these source(s) can be identified

and diverted to the NEWPCC, no other action will be required. If the source(s) cannot be identified, the City will have to either divert all HLW from the SEWPCC to the NEWPCC or add pre-treatment of HLW at the SEWPCC at some point in the future, when required by increased loading to the plant.

ODOR CONTROL

The generation and control of odors at the SEWPCC was reviewed. Current conditions were assessed through use of portable field data logging instruments and through collection and testing of odor samples. Testing involved both dilution assessments by a qualified panel of specialists and laboratory tests for specific chemical compounds. Chemicals analyzed included Hydrogen Sulfide and Reduced Sulfur Compounds. Panel assays were reported in terms of "dilution to threshold" values, which provide a means of estimating the overall strength of detectable odors. Odor sources of the existing and proposed expanded treatment plant were ranked according to their potential to generate odor. Current air turnover rates were reviewed for key odor-generating areas of the existing plant. Stantec reviewed current air handling practices for the existing sources, including use of the existing thermal oxidizing system and dispersion stack.

Areas considered to involve relatively high odor generation in the proposed expanded plant included the influent pump station, the screening/grit collection rooms, primary clarifier weirs, sludge fermenters, DAF thickener headspace, and the sludge holding tanks; with the last being considered a strong odor generation source. The primary clarifier area and the bioreactor headspaces were considered to be relatively lesser strength sources. The septage receiving station was determined to be suitable for consideration as a separate stand-alone source with dedicated treatment. Available vapor-phase treatment technologies and approaches for controlling odor emissions from the expanded SEWPCC were reviewed, including thermal oxidation, activated carbon adsorption and biofiltration. Continued or expanded use of thermal oxidation was determined to be unfeasible. Several management alternatives involving different combinations of odor control actions were evaluated. The evaluation concluded with a recommended odor management program including the following major components:

- Separate activated carbon adsorption treatment for the septage receiving station emissions;
- Treatment of high-odor emissions with biofiltration; and
- Routing of less odorous emissions through the existing dispersion stack.

ELECTRICAL AND INSTRUMENTATION

The project requires an increase in capacity both for normal power and for standby power. The plant power distribution is currently well laid out, with parallel divided distribution providing for

redundancy and good reliability. This configuration will be used, expanded on and extended into the new areas.

There is existing power metering at a number of locations in the plant, some of which is capable of being networked and monitored by the Plant Control System. Where possible, this existing metering will be tied into the Plant Control System and new metering will be added at the new main 600 volt distribution centre to achieve a breakdown of energy consumption in the Plant.

In addition to standby generators, uninterrupted power supply (UPS) units will be added to support critical systems in a “bumpless” transfer on loss and restoration of power, and to provide response time in the event of the failure of a generator.

All applicable Manitoba Hydro Power Smart programs will be considered in the design. Stantec will calculate the value of each of the programs and the cost of documenting and implementing the program, and make a final recommendations to the City on which programs to pursue.

Anticipated new instrumentation types are identified with the specific process applications. Plant Operations has expressed a preference for use of bus-based instrumentation wherever practical. This will introduce a new technology to the Plant, one that can provide increased diagnostic detail and reduced commissioning and troubleshooting time for those instruments that can be bus-based.

Existing lighting in the Plant is generally satisfactory and will be left as-is. New lighting will be of energy efficient design, with consideration of new technologies and lighting controls.

Building systems including Fire Alarm, Telephone, Security and CCTV will be expanded and integrated.

HVAC systems control will be designed to be reliable and simple to operate and maintain. Some HVAC alarms will be integrated into the Control System for operator convenience and response.

CONTROLS PLATFORM AND AUTOMATION

The Plant Control System will interface with all monitoring instruments and provide control through actuators, motors and switches. This control function is presented to Operations, Maintenance and Management staffs through the Human Machine Interface (HMI). The HMI gathers information and sends control actions to the Field Controllers that are directly connected to the instruments and control elements.

The needs of the Operations, Maintenance and Management staffs were compiled for the field controllers and HMI through a series of workshops and discussions at the SEWPCC. The needs were documented and a requirements definition was agreed upon. These became the 24 functional requirements for the HMI and 9 functional requirements for the Field Controllers.

The existing Bailey INFI 90 system was evaluated against three systems; the ABB 800xA (the migration system for the INFI 90); the DeltaV system, a competing Distributed Control System (DCS); and the GE FANUC Proficy and RX3i Programmable Automation Controllers (PAC), an Off-the-Shelf (OTS) PAC and HMI system. In the evaluation, it was determined that the INFI 90 system would not be used for new field controllers and that the DeltaV system was not a suitable alternative. Scoring between the ABB V800xA and the GE FANUC system resulted in a statistical tie.

It was concluded that the system vendors would be asked to provide proposals and pricing for the upgrade of the HMI system at the SEWPCC plant and the provision of new field controllers for the SEWPCC upgrade. The proposal evaluation would determine which system would be utilized and which field controller would be selected. The HMI system proposal and evaluation process must be completed as soon as possible, in order to meet the overall SEWPCC project deadline of December 31, 2012. An outline for a system migration and procurement plan was developed.

SITE DEVELOPMENT MASTER PLAN

The main purpose of the Site Development Master Plan is to help minimize potential future problems related to the further expansion and modification of the SEWPCC beyond the current project design year of 2031. The Master Plan plays a role in assessing whether there is sufficient room on site for possible distant future expansions to meet possible new requirements for some future time period.

Development of the Master Plan involved:

- Speculating regarding distant future regulatory restrictions on the discharge of treated wastewater and on the handling and disposal of sludge.
- Performing planning-level conceptual evaluations of appropriate types of treatment system expansions, and related site footprint area requirements to address the possible future regulations.

A Master Plan design horizon year of 2050 was adopted. For that future design year, the design flowrates were projected to range from an Average Dry Weather Flowrate of 79 ML/d to a Maximum Day flowrate of 348 ML/d. These values represent an increase of approximately 16 percent over the corresponding 2031 design year values.

Volumetric capacity expansions will be required to accommodate the increase in design flowrates. In addition, it was estimated that regulatory limits would become more restrictive in the distant future related to certain features, including: Phosphorus limits, wet-weather flow management practices, sludge disposal, and possible controls on complex organic compounds. It was estimated that treatment components similar in impact to the following would have to be added to the site by the year 2031:

- Two additional Primary Clarifiers, PST-4 and PST-5.
- A fifth BNR bioreactor train.
- A sixth Secondary Clarifier.
- A polishing filter to remove P to lower concentrations.
- Addition of an ozonation system to oxidize complex organic compounds and to supplement the UV disinfection system.
- A plant pumping station, to address the additional head losses that will be incurred in the polishing filter.
- A sludge stabilization system, estimated to be similar in scope to a 2-tank anaerobic digestion system.

A preliminary site plan layout drawing was developed, and indicated that there is sufficient room on the site for construction of the projected new treatment components.

It was concluded that the SEWPCC site has sufficient room for future expansion beyond the current project design year of 2031 to a projected distant planning horizon of 2050.

ADMINISTRATION BUILDING

The purpose of the Administration Building evaluation was to determine appropriate modifications to be implemented in conjunction with the SEWPCC upgrade and expansion project. A Building Envelope and Structural Assessment was performed separately and is reported elsewhere. In addition, a Comprehensive Code Review of the SEWPCC was performed separately for the City in 2006 by CH_2M Hill. Stantec reviewed that report as part of the evaluation of the Administration Building. The 2006 Comprehensive Code Review noted several features of the Administration Building as not meeting current code requirements, with some items being potentially grandfathered. Stantec assumed that any new construction or modification construction related to functional features would be designed and constructed following current codes and that all other non-conformance items would remain as is. Stantec recommends that during the detailed design phase for the SEWPCC Upgrade / Expansion project, confirmation be sought from The Authorities Having Jurisdiction regarding exactly how code requirements would be applied to the items noted in the 2006 Code Review.

The existing Administration Building includes a main floor and a basement level, and has a site footprint area of approximately 480 m^2.

Based on projected future staffing levels, additional locker facilities represent one of the most critical needs.

Stantec evaluated several alternatives for providing the additional shower and locker room space needed. From that evaluation, it is recommended that the City implement a program including the following:

- Conversion of a portion of the existing Laboratory Room on the main floor into a new Women's Locker Room.
- Conversion of the existing Women's Locker Room on the lower level to be an expansion of the existing Men's Locker Room.

Stantec recommends that additional washroom capacity on the Main Floor be provided by converting the existing Women's Washroom to a single Unisex Washroom, and conversion of the remainder of the existing Laboratory Room into a new larger Women's Washroom.

It is recommended that the City complete the replacement and upgrade of the failed uninterruptible power source (UPS) in the control area. It is also recommended that the City consider upgrading the visitor advisory system, and the security and smoke/fire alarm systems.

BUILDING ENVELOPE AND STRUCTURAL ASSESSMENT

The majority of action items identified in the "Building Envelope and Structural Assessment" included in the PDR have been completed, or are in the process of being completed, by The City of Winnipeg. A number of remaining action items requiring Stantec involvement are addressed in the CDR.

The majority of the items addressed in the CDR deal with durability issues and items that were not reviewed during the PDR due to facility operations requiring containment structures to remain filled. During March 2008, Primary Settling Tanks No. 1 and 2 were emptied for maintenance purposes. At that time, Stantec reviewed the condition of the concrete components of the clarifiers and found them to be structurally sound. No immediate structural concerns are identified and further review of other system components may be performed during a time of opportunity, when maintenance programs require content removal.

Procedures for concrete slab repair at one corner of Clarifier No. 2 has been addressed in this report.

ASBESTOS ABATEMENT

Provincial health and safety regulations and guidelines for working with asbestos require that specific procedures must be followed to prevent Asbestos Containing Materials (ACMs) from becoming an airborne hazard in their friable state. In 2006 Pinchin Environmental completed a Hazardous Material Information System Report (HMIS) at the SEWPCC for the City of Winnipeg

Water & Waste Department. This report identified the location and extent of both suspected and confirmed ACM building materials throughout the facility.

A room by room assessment of potential ACM disruption identified as part of the SEWPCC project was conducted to identify potential hazards. Stantec has developed recommendations based on both the findings of previous sampling, as well as other available guidance.

It is recommended that the asbestos abatement be completed in advance of the proposed modifications identified for the SEWPCC Project. Completing ACM removal prior to the commencement of modification or expansion works results in the City reducing risks associated with abatement from general contractors. This often simplifies the bidding process and ultimately constitutes better prices for the area modifications. The abatement can be completed well in advance by a certified asbestos abatement contractor.

OPINION OF PROBABLE COST

The Conceptual Design Opinion of Probable Cost for the project is $211,279,000. This cost is based on the recommended work presented in this report as well as discussions and feedback received from the City. This Opinion of Probable Cost is prepared to assist in refining of scope and for budgeting purposes. This Opinion of Probable Cost should be considered to have a level of accuracy ranging from -15 to +30 percent.

The approach for determining the opinion of probable cost was to break down the facility into areas or processes such as the headworks, bioreactors, and secondary clarifiers. These were further broken down into sub-items such as concrete works, piling, specific pieces of equipment, building, HVAC, etc. Projected sizing was undertaken for each of the sub items to determine quantities. Contractors, suppliers, manufacturers and Stantec's experience were relied on to assist in determining unit pricing. From the unit quantities and unit prices, the Opinion of Probable Cost was developed.

Two items are not calculated in detail. These included general conditions and electrical. For each of these items a typical percentage of project cost was utilized.

The Opinion of Probable Cost is based on construction occurring between mid 2009 and mid 2012. The pricing shown is in 2008 dollars. PST has been included but GST has been excluded. Allowances are carried for contingency (10%), engineering (15%), estimating (15%) and inflation (15%).

To assist the City in keeping the project within the available budget, Stantec identified work items that could be deferred, work that is optional but included in the Opinion of Probable Cost and work that is optional but not included in the Opinion of Probable Cost. As the project advances the Project Team will be able to review these items and determine what work should be postponed or cancelled to keep the project within budget.

The Project Team has agreed to basic design criteria, process and components; but there are still many unknown details related to the SEWPCC Upgrading / Expansion project that could impact the Opinion of Probable Cost presented. Sufficient work has been undertaken on each of the components of the conceptual design for Stantec to make informed assumptions based on past experience on similar treatment facilities. Stantec has no control of future construction market conditions, which could significantly impact construction costs. The final cost will be influenced by local market conditions at the time of tender.

IMPLEMENTATION PLAN

Owners currently have a myriad of choices with respect to the way in which projects will be delivered. These choices essentially revolve around the degree of risk transferred from the owner to the contractor team and range from the traditional design-bid-build methodology to the various forms of design-build. The reality, however, is that project delivery methodologies all have advantages and disadvantages that correlate specifically to a project's unique drivers and characteristics. It is this factor that makes selection of an appropriate methodology a complex task. Despite the inherent biases of the proponents of the various methodologies, they do agree on one thing – the selection of an appropriate project delivery methodology is a critical success factor.

For the SEWPCC project, the primary drivers were determined to be:

- **Cost certainty,** defined as delivering the project within the approved budget.
- **Lowest life cycle cost,** providing maximum value to ratepayers who ultimately bear the risk of both capital and operating costs.
- **Minimizing time to market,** in order to minimize the erosion in purchasing capacity of the City given the current escalation in construction costs.
- **Least first cost,** achieved by scope definition, appropriate risk allocation and robust project controls.
- **Maintaining owner control,** to ensure appropriate risk allocation.
- **Meeting the regulatory requirements,** of providing nutrient removal no later than the end of 2012.

A qualitative and quantitative analysis of the various project delivery methodologies was undertaken in relation to the primary project drivers.

The integrated project management option (a form of design-bid-build) is deemed to be the most favorable both on the basis of the qualitative and quantitative analysis. It decreases time to market, maximizes competitiveness favorably impacting costs; provides an opportunity to mitigate non-controllable volatility; is familiar to the City and therefore does not require further development of legal and commercial frameworks; and provides the City with the necessary

degree of control to achieve quality and life cycle considerations and integrate operating requirements.

Should the decision be made to proceed on the basis of an at-risk project delivery mode, the "managed design-build" model is deemed to be the most favorable of the at-risk models.

RISK ASSESSMENT UPDATE

Project risks were assessed with respect to the primary project drivers of maintaining the schedule to meet regulatory requirements; cost containment; and retaining owner control to ensure that the required service levels are maintained. The highest impact risk event associated with maintaining the schedule is the delay in selecting the preferred project delivery methodology. There is virtually no float remaining to meet the regulatory obligation of providing biological nutrient removal by December 2012.

Associated with the project delivery decision is the risk associated with the readiness of the City to implement an alternative project delivery methodology such as design-build. To date, the City has not implemented an alternative project delivery model for a project that carries a regulatory obligation and as such, there is no pre-existing contractual framework. The time required to build this framework will only exacerbate the schedule risk.

The risks associated with maintaining the required levels of service under the current operating parameters must also be highlighted. Bundled into the SEWPCC expansion / upgrade project were improvements to the current infrastructure to minimize operating risks such as basement flooding. Implementation delays prolong the City's exposure associated with these operating risks.

Given the overall risk profile of the project, it is essential to assess the equitability of risk transfer as it relates to cost containment. Inequitable risk transfer to a third party will result in the City paying a premium for the risk transfer, with significant potential impacts to the overall cost of the project. Mitigating these cost pressures through scope reductions could then adversely impact the regulatory and operating risks that will remain with the City, regardless of the contracting methodology.

In summary, the SEWPCC project is complex from both a technical and a constructability perspective, with a commensurate risk profile that has been amplified due to the various delays that have occurred.