SEWPCC Upgrading/Expansion
Conceptual Design Report

SECTION 5 - BNR Process Selection

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5.0 BNR Process Selection

5.1 INTRODUCTION

Section 4.0 - BNR Process Refinement demonstrated that both Option C and G could be successfully implemented at the SEWPCC. In this section, further details are provided on the relative advantages and disadvantages, operating considerations, and capital and operation/maintenance costs associated with each option. This information is evaluated so that a recommendation on the preferred option to be carried forward in the Conceptual Design for the SEWPCC Upgrade/Expansion.

5.2 BIOREACTOR DESIGN DETAILS

5.2.1 Option C - Modified Johannesburg BNR Process

The process description for Option C was presented earlier in the PDR and discussed extensively throughout the Preliminary and Conceptual Design Review Meetings. A summary of the bioreactor design is presented below.

Table 5.1 - Bioreactor Design for Option C

Bioreactor	Unit	Value
Total Volume	ML	31.3
Number of Trains		4
Bioreactor Volume/Train	ML	7.825
Bioreactor Zone Volumes/Train:		
Pre-Anoxic	ML	0.325
Anaerobic		0.450
Anoxic-1		0.80
Anoxic-2		0.80
Aerobic-1		1.3625
Aerobic-2		1.3625
Aerobic-3		1.3625
Aerobic- 4		1.3625

A typical bioreactor layout is shown in Figure 5.1. For the purpose of bioreactor layout, it was assumed that the existing HPO trains 1 and 2 (with maximum liquid depth of 4.5 m) will be converted to the un-aerated zones (i.e. Pre-Anoxic, Anaerobic, Anoxic-1 and Anoxic-2) of Bioreactor Train No. 1. Similarly, the existing HPO trains 3 and 4 will be utilized for the un-aerated zones for Bioreactor Train No. 2. The aerobic zones associated with the proposed BNR Trains 1 , 2, 3 and 4 however will be constructed with a maximum liquid depth 6.5 m. Also, the new tankages associated with BNR Trains No. 3 and 4 will be constructed with an overall maximum liquid depth of 6.5 m for all the bioreactor zones.

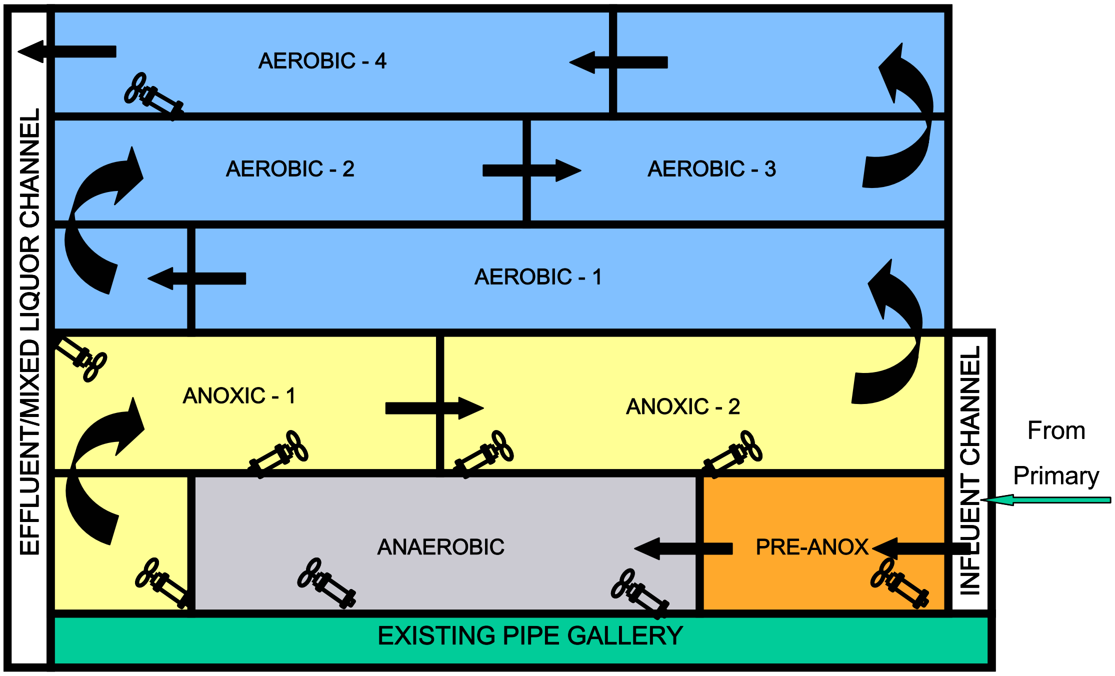

Figure 5.1: Typical Bioreactor Train for Option C

Advantages

- Established and reliable process for BNR.
- Very good track record with several installations in Western Canada operating under conditions similar to SEWPCC.
- The ongoing BNR upgrade to the City's WEWPCC is a variation of the MJP. This will allow the City to train Operators effectively and share operating/troubleshooting knowledge.
- High process flexibility to respond to flow and load fluctuations.
- Use of pre-anoxic zone provides a good protection of the anaerobic zone to sustain biological phosphorus removal.
- The growth of biomass increases aerobic SRT, which in turn promotes nitrification.

Disadvantages

- Larger bioreactor compared to Option G.
- Requires a good knowledge of BNR fundamentals for plant operations.

5.2.2 Option G - Modified Johannesburg BNR Process with IFAS media

As presented earlier, Option G includes a high rate Modified Johannesburg (MJ) BNR process with biofilm carrier elements or IFAS media in the aerobic zones of the bioreactor. The biofilm carriers are retained within the aerobic zones by utilizing media retention screens. A mixed liquor recycle zone was incorporated downstream of the last aerobic zone to facilitate internal recycle of mixed liquor to the first Anoxic zone (for denitrification). As explained in Section 4.0, several types of media are available in the market, which will ultimately impact the bioreactor sizing and design. For the purpose of this memorandum, Anox Kaldness K1 media (see attached) was used as a design basis. Stantec has contacted the following additional suppliers and proposals are anticipated:

- M^2T Technologies (Linpor™ sponge media)
- Hydroxyl System Inc. (ActiveCell515 biofilm carriers)
- Siemens AGAR^{TM} Process

The key design features of this proprietary K1 media are summarized below:

- Length = 7 mm
- Diameter = 10 mm
- Specific Area = 500 m^2/m^3
- Media Specific Volume = 0.13 m^3/m^3
- Material of construction = Plastic

A summary of the bioreactor design is presented in Table 5.2.

Table 5.2 - Bioreactor Design for Option G

Bioreactor	**Unit**	% of Fill of biofilm carrier	**Value**
Total Volume	ML		26.6
Number of Trains			4
Bioreactor Volume/Train	ML		6.65
Bioreactor Zone Volumes/Train:			
Pre-Anoxic			0.325
Anaerobic			0.450
Anoxic-1			0.80
Anoxic-2	ML		0.80
Aerobic-1		32.8	2.135
Aerobic-2		49	2.135

A typical bioreactor layout is shown in Figure 5.2.

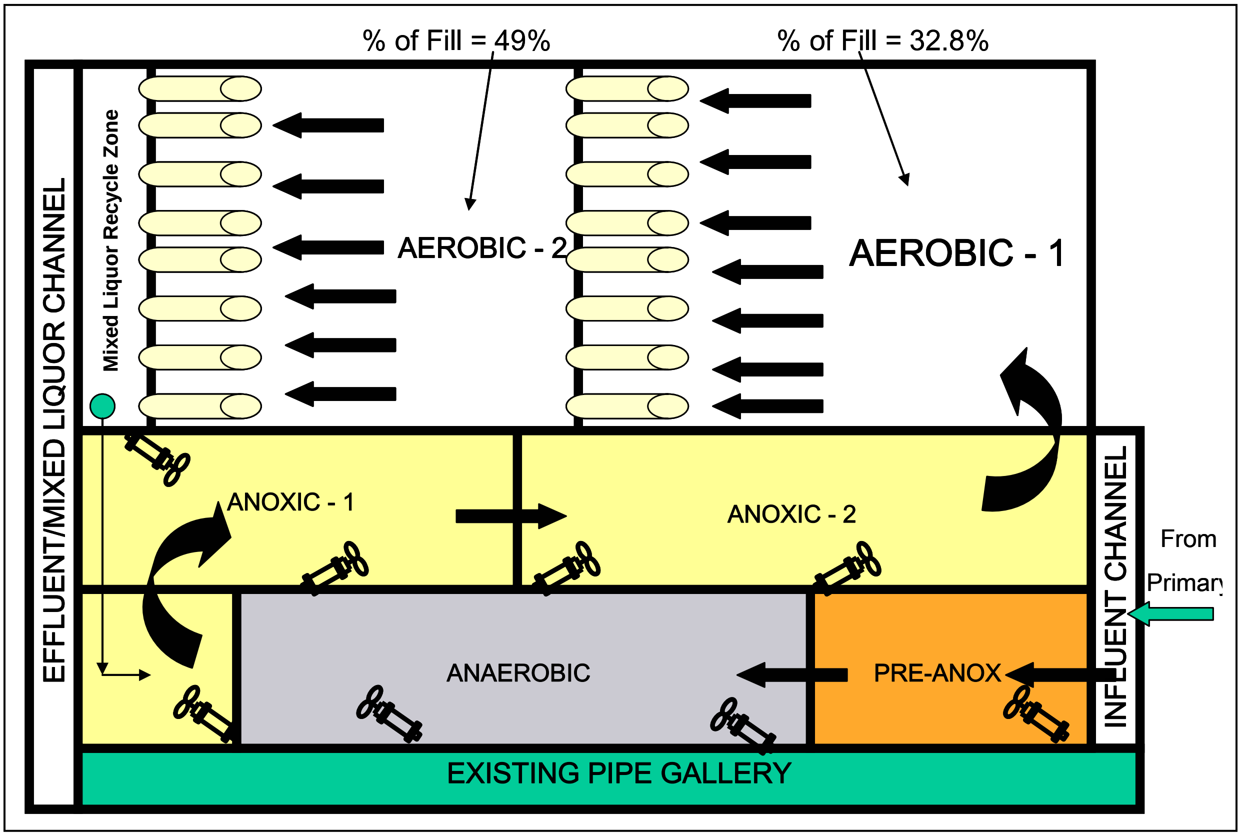

Figure 5.2: Typical Bioreactor Train for Option G

Advantages

- IFAS media reduces the overall bioreactor size required for the MJ process.
- The process allows the total biomass to increase in the bioreactor without increasing the solids loading rate on the secondary clarifier.
- IFAS media promotes growth of nitrifiers on the carrier material and provides a higher level of protection of the nitrifier population against washout, shock loads or a toxic spill.
- The nitrification process recovers more quickly than a suspended growth system.
- The growth of biomass increases aerobic SRT, which in turn promotes nitrification.

Disadvantages

- IFAS processes use a proprietary technology.

- There is one (1) known full-scale operating plant in Canada (City of Peterborough, ON). There are no plants in Western Canada.
- Media loss/replacement over time increases O&M costs.
- Most IFAS plants operate with higher dissolved oxygen levels in the aerobic zone compared to conventional processes. This equates to higher energy costs and impacts the BNR process due to high DO in the internal recycle stream.
- The media retention adds additional headloss to plant hydraulics and can be an operational concern due to plugging.
- Management of the biofilm media during tank draining can be challenging and may involve transfer of media to adjacent tanks.

5.3 SECONDARY CLARIFIERS

A summary of the secondary clarification requirements for each of two options are presented in Table 5.3.

Table 5.3 - Clarification Requirements for Options C and G

	Option C	Option G
Number of clarifiers added	2	2
Diameter (m)	45.7	45.7
Added clarification area (m^2)	3,280	3,280
Total surface area (including existing 3400 m^2)	6,680	6,680

5.4 SOLIDS HANDLING

5.4.1 Projected Sludge Quantities

For the purpose of calculating annual Operations and Maintenance costs, sludge production at annual average flows (AAF) for the two short-listed treatment options were calculated. As discussed with the City, only 50% of the primary sludge would undergo pre-fermentation with the remaining primary sludge being transferred directly to the sludge holding tanks. Fermentation is expected to reduce the overall feed sludge by approximately 30%. Waste Activated Sludge (WAS) wasted directly from the last aerobic zone of the bioreactors will undergo thickening via DAF and the thickened WAS (TWAS) would be transferred to the sludge holding tanks. A summary of the various sludge streams are provided in Table 5.4.

Table 5.4 – Sludge Production Rates at AAF for Options C and G

	Primary Sludge (unfermented)	Primary Sludge (fermented)	TWAS	Total Sludge Production
	Kg/d	Kg/d	Kg/d	Kg/d
Option C	7,180	5,020	8,950	21,150
Option G	7,180	5,020	9,315	21,515

5.5 COSTS

In order to compare the treatment options, the costs presented in Section 23 of the PDR, Tables 23.1a and 23.1b, have been updated to reflect Conceptual Design information presented to the City to-date. It should be noted that these updates are based on rough cost information available at the time the comparison was made and are updated in more detail for the selected option in Section 25. The items that were updated are summarized as follows:

- Additional Climber Screens were deleted.
- Existing aerated grit chambers will continue to function. Allowances have been made for improvements to the existing system components. Additional grit removal capacity to meet peak pumping rate of 415 ML/d is provided via a new high efficiency vortex grit system complete with fine screening of the bypass flows.
- Lamella Primary Settling Tank (PST) was deleted. An allowance for upgrades to the existing PST components and scum piping was added.
- Primary sludge fermenters were reduced to one from three. Costs for associated building (DAF, new storage, odour room, sludge storage etc.) were recalculated.
- Capital cost reflects a four (4) bioreactor train for both the options and updated IFAS costs (Option G only).
- Solids handling cots were adjusted to allow for larger DAF (to reflect thickening of WAS wasted directly from the bioreactors vs. secondary clarifiers).
- UV costs were updated based on a current proposal from Trojan to expand the existing disinfection system.
- Inflation allowance during construction period was increased from 20% to 30% to reflect actual 2007 construction inflation rates and current trends in market conditions.

The cost for the two options is presented in Table 5.5.

5.6 EVALUATION OF OPTIONS

5.6.1 Evaluation Criteria

The evaluation criteria utilized for comparing Option C and Option G remains unchanged from our previous exercise during the Preliminary Design. For the benefit of the Steering Committee, the following sections have been reproduced from the final PDR in order to assist in the process selection exercise.

5.6.2 Criteria Groups

The following Groups were previously established for the evaluation criteria.

1. ***Technical Group*** includes criteria related to the ability of each short listed treatment option to meet the treatment objectives.

2. ***Operational Group*** includes criteria related to the ease of operation and maintenance of the short listed treatment options and includes a general overview of any inherent safety risks to staff.

3. ***Monetary Group*** includes criteria related to the cost to construct, operate and maintain the facility.

The following is a breakdown of the Criteria Groups as established during the Preliminary Design.

Table 5.6 – Criteria Groups for Process Selection

Technical Group
- Effluent Quality
- Reliability and Risk of Failure
- Ability to Operate at Low DWF
- Ability to Accommodate WWF
- Track Record in Similar Climate
- Flexibility to Upgrade
- Expandability
- Ease of Construction
- Environmental Impact
- Ability to Meet Construction Deadlines

Operational Group
- Ease of Operation
- Ease of Maintenance
- Operator Safety

Monetary Group
- Capital Cost
- Operating Cost
- Phasing Potential

Table 5.5
SEWPCC Upgrading/Expansion Project
Opinion of Probable Cost (June 5, 2008)

	Description	Option C	Option G
1.0	General Requirements	$8,990,000	$8,590,000
2.0	Siteworks	$9,410,000	$9,410,000
3.0	Septage Receiving Station with Storage Tanks:	$2,580,000	$2,580,000
4.0	Headworks	$2,390,000	$2,390,000
5.0	Primary Clarifiers	$270,000	$270,000
6.0	Fermenters and Adjacent Building (includes DAF bldg., Odour Rooom, Sludge Holding Tanks, Storage Rm)	$7,400,000	$7,720,000
7.0	Bioreactors and Adjacent Building (includes Blower Room, Electrical Room, Alum Room)	$26,620,000	$22,942,000
8.0	Solids Separation (Secondary Clarifiers)	$15,520,000	$15,520,000
9.0	Solids Handling (Sludge Blending and Thickening)	$5,100,000	$5,100,000
10.0	Chemical Feed Systems	$1,490,000	$1,490,000
11.0	UV Disinfection Systems	$2,590,000	$2,590,000
12.0	Electrical, Control, Instrumentation, and Standby Generator	$14,980,000	$14,310,000
13.0	Standby Diesel Generator Room Expansion	$300,000	$300,000
14.0	Ancillary Items	$1,250,000	$1,250,000
	Subtotal	**$98,890,000**	**$94,460,000**
	Contingencies (10% of Subtotal)	**$9,890,000**	**$9,450,000**
	Engineering (15% of Subtotal & Contingencies)	**$16,320,000**	**$15,590,000**
	Estimating Allowance (25% of Subtotal, Cont. & Eng.)	**$31,280,000**	**$29,880,000**
	Inflation Allowance for 2009 - 2012 Construction Period (20% of Above)	**$46,910,000**	**$44,810,000**
	Total Project Cost	**$203,290,000**	**$194,190,000**
	Annual Operation Cost	**$6,150,000**	**$6,800,000**
	20-Year Life Cycle Cost at 6% discount rate	**$273,830,000**	**$272,190,000**

* Costs presented in this table reflect PDR costs with updates to the items noted in Section 5.4. Refined costs on the selected option are presented in Section 25.0.

A weighting system was also established via a survey of Project Team members during the Preliminary Design. The following table summarizes the average weight for each group that was used in the evaluation process.

Table 5.7 – Weighting for Groups of Criteria

Criteria Groups	Weight
Technical Group	36.5
Operational Group	38.5
Monetary Group	25.0
Total Weight	100.0

After establishing the group weights, the Project Team members had assigned a weight to each of the individual evaluation criteria. The weights provided ranged from 1 to 10 and were pro-rated to establish the average weight for each criterion that was used in the evaluation. The following table summarizes the weight for the individual criterion used in the evaluation process.

Table 5.8 – Weighting for Individual Evaluation Criteria

Evaluation Criteria	Weight
Technical Group	
Effluent Quality	4.67
Reliability and Risk of Failure	4.61
Ability to Operate at Low DWF	3.89
Ability to Accommodate WWF	3.71
Track Record in Similar Climate	3.77
Flexibility to Upgrade	3.23
Expandability	3.11
Ease of Construction	3.41
Environmental Impacts	3.05
Ability to Meet Construction Deadlines	3.05
Subtotal – Technical Group	***36.5***
Operational Group	
Ease of Operation	12.82
Ease of Maintenance	12.60
Operator Safety	13.09
Subtotal – Operational Group	***38.5***
Monetary Group	
Capital Cost	8.97
Operating Cost	9.43
Phasing Potential	6.60
Subtotal – Monetary Group	***25.0***
TOTAL WEIGHT	**100.0**

5.6.3 Project Team Evaluation Process

The Project Team had performed the evaluation of the short listed treatment options C and G during a Project Team meeting held on October 5, 2007 to evaluate Options G, K, L and C-1, K-1 and L-1 and using Option C (originally selected based on a Project Team meeting held on December 11, 2006) as the base for scoring.

The evaluation process was comprised of the following steps.

1. Review the definition and scoring philosophy for the specific evaluation criterion that was being considered. The definition and scoring philosophy for each criterion is summarized in the following section.

2. Discuss advantages and disadvantages for each option related to the specific evaluation criterion that was being considered.

3. Provide a recommended score for each option for the specific evaluation criterion being considered. The scoring system was based on 1 point being the minimum score and 5 points being the maximum score.

4. Receive input from the Project Team members regarding the recommended score and revise, if necessary, in order to reach a consensus.

5. Tabulate the unweighted and weighted scores for each option and select the preferred treatment option(s) that would be carried forward for further evaluation in Conceptual Design.

5.6.4 Criterion Definitions and Scoring Philosophy

Prior to scoring the short listed treatment options, the following description of each criterion and the scoring philosophy was provided to the Project Team. The following is a description or definition of each criterion along with the philosophy for awarding a score for each criterion. This information is summarized below:

Technical Group

Criteria in the Technical Group are related to the ability of each option to meet the license for the SEWPCC upgrade and expansion.

- **Effluent Quality:** Options capable of producing an effluent quality that consistently meets or does better than the effluent quality criteria for the project received the most points. The effluent quality criteria for the project are based on a 30-day rolling average.

- **Reliability and Risk of Failure**: Consistent production of high quality effluent is a major requirement in Winnipeg. The options that are robust to withstand operational variations and those with some degree of redundancy for equipment malfunction received a higher score (i.e. the higher number of points was assigned to options with the highest degree of reliability and lowest risk of failure).

- **Ability to Operate at Low Dry Weather Flows**: The SEWPCC has to be designed for a wide range of flows and loads. The requirement to treat high wet weather flows and yet operate well during extended periods of dry weather flow creates challenges for some options. The options that can accommodate extended low flow and loading events while minimizing operational challenges received higher points.

- **Ability to Accommodate Wet Weather and Snow Melt Flows**: Extreme high wet weather peaks occur suddenly, particularly during spring snowmelt and summer storm events. The spring snowmelt flows are also accompanied by sudden temperature decreases. These events require the treatment process to very quickly adjust to increased flows and loads, especially in spring when flows traditionally jump from dry weather flow rates to high, coldwater snowmelt flows within one to two days. The processes that can accommodate these sudden flow increases and temperature decreases (snow melt) while minimizing operational challenges received higher points.

- **Track Record in a Similar Climate**: Most of the processes considered have a track record in Canada, the USA or Europe and the number of installations and track record of existing operating facilities was considered in the evaluation. The number of installations in similar climates was also being considered to a lesser degree. The higher score was assigned to options with a higher number of successful installations.

- **Flexibility to Upgrade**: There has been a trend in Western Canada for effluent quality standards to become increasingly stringent particularly with respect to nutrients and microbiological and toxicity parameters. Winnipeg will likely not be an exception. Those processes that can be easily modified to meet more stringent effluent criteria received the highest points. Some of the options might already achieve lower levels of a particular parameter and this was not considered when assigning a score to this criterion because this factor was already considered as part of the Effluent Quality criterion.

- **Expandability**: A significant amount of growth is predicted in the SEWPCC service area and there is the potential for higher growth rates during the design period as well as future growth beyond the design period. Options that can be most readily expanded by adding process trains in the future to accommodate higher growth rates or populations beyond 2031 received the most points.

- **Ease of Construction:** Construction of the proposed SEWPCC upgrade and expansion will require the existing facility to remain in operation during construction. Points for this criterion were allocated based on how easily the key components of the proposed improvements can be constructed around the existing facility while minimizing disruption to plant operations.

- **Environmental Impact:** The upgrading and expansion of the SEWPCC will impact the environment **beyond** the quality of effluent produced. Some of these impacts include odor emissions, noise, changes in sludge quality, effects on area drainage, aesthetic considerations and others. The option that resulted in the lowest environmental impact scored the highest points.

- **Ability to Meet Construction Deadlines:** The License for the SEWPCC upgrade and expansion includes strict deadlines to complete construction and have the new facility operational. The stipulated deadline is December 31, 2012. The length of construction can be affected by the amount of new work, scheduling around plant operations and the extent of modifications to existing processes. The higher score was assigned to options with the lowest risk of not meeting the deadlines in the License.

Operational Group

Operational Criteria relate to the ease of operation and maintenance of the process by City staff and includes a general overview of any inherent safety risks to staff.

- **Ease of Operation**: Operational complexities can result from operational protocols to handle fluctuating flows and loads, multiple numbers of unit processes, etc. The more complex a process is either from a process, hydraulic, mechanical or instrumentation and control point of view the lesser number of points was awarded. Options with one or more different unit processes also received fewer points.

- **Ease of Maintenance**: The extent of maintenance requirements is related to the amount of mechanical equipment. Namely, the more pieces of equipment and different types of equipment (for common unit processes) increase maintenance requirements (i.e. routine maintenance, stocking spare parts, etc). The least mechanically complex processes received the highest score in this category. Processes requiring multiple mechanical pieces of equipment with significant routine adjustment and preventative maintenance received fewer points.

- **Operator Safety**: Some treatment processes, although designed with operator safety as a priority, contain inherent risks to the operating staff. Unit processes that minimize any potential operational safety risks received higher points.

Monetary Group

Monetary Criteria relate to the cost to construct, operate and maintain the facility.

- **Capital Cost**: The estimates presented in Section 23 – Opinion of Probable Cost formed the basis of the evaluation for this criterion. The capital costs were compared to the project budget of $204 M. The option with the lowest capital cost was awarded maximum points. All other options were awarded points according to a comparison between the lowest capital cost option, the project budget and the capital cost of the option being considered.

- **Operating Cost**: The estimates presented in Section 23 – Opinion of Probable Cost formed the basis of the evaluation for this criterion. The option with the lowest operating cost was awarded the maximum allowable points. The other options were assigned points based on a comparison between the operating cost for the option being considered and the lowest operating cost option.

- **Phasing Potential**: The City of Winnipeg is faced with upgrades to their wastewater collection and treatment system that are approaching the maximum financial ability of the utility ratepayers. As such, the City is examining options to defer borrowing. Phasing, if it does not require duplication of work, has the potential to provide benefit in this area. Phasing also provides an opportunity for the City to reassess, at some future time, the growth projections that were used during the design and adjust subsequent phases to reflect actual growth rates and needs. Options that allow phasing of the work and potential deferment received the highest points.

5.6.5 Evaluation Summary Table

Table 5.9 provides a revised Evaluation Summary Table highlighting the advantages and disadvantages related to each option for the specific evaluation criterion. During the Conceptual Design Project Team Meeting No. 6, the information in the tables was reviewed with the Project Team in order to finalize scoring of Options C and G.

5.7 SCORING OF OPTIONS

The scoring of the two options was carried out through Conceptual Design Project Team Meeting No. 6. For each individual criteria and alternative, Stantec's scoring was discussed with the Project Team and modified as required.

5.7.1 Scoring Summary

Table 5.10 summarizes the evaluation process including the un-weighted and weighted scores for each criterion as modified by the Project Team during the process selection meeting. It may be noted that the weights and weighted scores for each criterion in the table have been rounded to two significant digits. Accordingly, there are some minor discrepancies in additional that are attributed to rounding the weight and weighted scores. These discrepancies do not have an impact on the outcome of the overall score for each option.

5.8 PROCESS RECOMMENDATION

Based on capital costs (Table 5.5) and scoring conducted by the Project Team (Table 5.10), the two options can be considered essentially the same. Although the annual O&M costs for Option G is higher, the life cycle costs are the same. Stantec recommended Option G for the following reasons:

- IFAS media provides enhanced process reliability.
- 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 diligence regarding operational issues associated with the IFAS process. Operational issues are further discussed in Section 9 - BNR Bioreactor.

TABLE 5.9 - Summary Table

City of Winnipeg SEWPCC - Evaluation of Treatment Options C & G

Category	Criteria	Option C MJP	Option G MJP with IFAS
Technical	Effluent Quality	Blended effluent meets 30-day rolling average criteria at all times. Process must be pushed to 150% of design capacity during storm flows to meet $cBOD_5$.	Blended effluent meets 30-day rolling average criteria at all times. Potential for oxygen recycle from the last aerobic zone to anoxic zone which can impact denitrification.
	Reliability and Risk of Failure	The existing Primary Clarifiers operated as a CEPT allows more uniform load to bioreactor and consistent quality under high flows and loads. Multiple bioreactors and final clarifiers provide good redundancy to system.	Similar to Option C. The IFAS bioreactor provides the ability to withstand shock loads and retain nitrifying biomass during high flow events. The process will also recover faster compared to Option C.
	Ability to Operate at Low Dry Weather Flow and Load	Experience at large number of installations in Western Canada has shown that at low loads, this optimized BNR system can operate very effectively. BioWin™ modeling shows that treatment efficiency will not be compromised at low flows.	Similar to Option C.
	Ability to Accommodate Wet Weather Flows	The use of existing Primary Clarifiers operated on a CEPT mode for flows in excess of 175 ML/d will dampen effect of high storm flows. Ability to download BNR bioreactor during periods when storms and snowmelt ramp up flows and loads will make it easier for operators to achieve blended effluent limits.	Same as Option C

Category	Criteria	Option C MJP	Option G MJP with IFAS
	Track Record in Similar Climate	The MJP has a long standing track record in North America and particularly Western Canada. Operating the Primary Clarifiers as CEPT under flows greater than 175 ML/d combined with an optimized MJP will provide better process stability and performance.	Only one (1) known full-scale application of IFAS (City of Peterborough, ON). No plants in Western Canada Limited plants with Bio-P and operating on a full BNR mode.
	Flexibility to Upgrade	This high rate BNR process could also be upgraded to achieve low effluent Total P by adding effluent filtration or alum augmentation to ≤ 0.5 mg/L in the future. For total nitrogen to say < 8 mg/L may require additional BNR bioreactor capacity.	Same as Option C for Total P IFAS provides added flexibility to add additional media if required.
	Expandability	Expansion of Option C requires additional BNR bioreactor capacity and more final clarifiers as well as additional Primary Clarifiers for CEPT capacity.	Similar to Option C; however, there is possibility to add more media to aeration tank.
	Ease of Construction	BNR bioreactors would be stand alone systems. High rate system would have to tie-in with existing clarifiers and existing HPO system would have to convert to MJ/BNR.	Similar to Option C.

Category	Criteria	Option C MJP	Option G MJP with IFAS
	Ability to Construct within Schedule	To implement this option, it will be necessary to complete construction, start-up and commissioning of new BNR reactors and Clarifiers prior to converting existing HPO. The new BNR reactors needs to be operated for a fairly significant time prior to starting work on existing HPO reactors to ensure BNR process achieves equilibrium conditions and produces an effluent that meets limits.	As Option G involves proprietary equipment, project schedule may require pre-selection and ordering of IFAS related equipment. Relatively smaller bioreactor than Option C which will require shorter construction time.
	Environmental Impact (Odor, sludge, etc.)	Likely highest impact on site disruption. Good quality effluent achieved for high range of flows and loads with a reasonable level of site impact. Significant impact on sludge quality due to more inerts during storm flows.	Similar to C but slightly smaller footprint and marginally higher sludge production (approx. 4%) than Option C. Greater potential of noise pollution from larger blowers
Operational Criteria	Ease of Operation	The high rate MJ/BNR system will operate well at the low load end of the spectrum. At higher loads the CEPT system will dampen the effect of high flow variations. The system will be easily automated for the biological process.	Similar to C
	Ease of Maintenance	The MJP requires operation of only a single sludge treatment system beyond primary treatment. Will require maintenance of chemical feed and dosage equipment for CEPT operation	Proper maintenance of the media retention screens are required to prevent plugging. One potential concern is the extra care required when taking IFAS tank out of service.

Category	Criteria	Option C MJP	Option G MJP with IFAS
	Operator and Staff Safety	The only operator and safety issue is regarding handling/maintenance related the chemical feed systems.	Similar to Option C
Monetary Criteria	Capital Cost	Option C has a slightly (7%) higher capital cost than Option G.	Lowest capital cost among the two options considered.
	Operating Cost	Option C has lower O&M cost compared to Option C.	Highest O&M cost among the two options considered. Higher energy costs due to bigger blowers, higher residual dissolved oxygen in the aerobic zones and the use of medium/coarse bubble diffusers.
	Phasing Potential	Secondary Treatment: There may be some opportunity to phase the MJ/BNR bioreactor modules. Clarifier capacity could be phased to match the load and flow growth.	Similar to Option C

TABLE 5.10 - Summary of Scoring Results

		Option C		Option G	
Evaluation Criteria	**Weight**	**Score (1 to 5)**	**Weighted Score**	**Score (1 to 5)**	**Weighted Score**
Technical Criteria					
Effluent Quality	4.67	4	18.68	4	18.7
Reliability and Risk of Failure	4.61	4	18.44	5	23.1
Ability to Operate at Low DWF	3.89	5	19.45	5	19.5
Ability to Accommodate WWF & Snow Melt	3.71	4	14.84	5	18.6
Track Record in Similar Climate	3.77	5	18.85	4	15.1
Flexibility to Upgrade	3.23	4	12.92	5	16.2
Expandability	3.11	4	12.44	4	12.4
Ease of Construction	3.41	4	13.64	4	13.6
Environmental Impact	3.05	5	15.25	5	15.3
Ability to Construct / Commission within Schedule	3.05	4	12.20	4	12.2
Subtotal Technical Criteria	36.5		156.71		164.49
Operational Criteria					
Ease of Operation	12.82	5	64.10	5	64.1
Ease of Maintenance	12.6	5	63.00	5	63.0
Operator Safety	13.09	4	52.36	4	52.4
Subtotal Operational Criteria	38.51		179.46		179.46
Monetary Criteria					
Capital Cost	8.97	5	44.85	5	44.9
Operating Cost	9.43	5	47.15	4	37.7
Phasing Potential	6.6	5	33.00	5	33.0
Subtotal Monetary Criteria	25.00		125.00		115.57
Totals			461.2		459.5