Wastewater System Alternative Design Concepts Evaluation Matrix
Phase 3

Criteria	Criteria Indicator	Alternative 1 Membrane Bioreactor	Alternative 2 Sequencing Batch Reactor (SBR)	Alternative 3 Aerobic Foam Media Trickling Filter	Alternative 4 Moving Bed Biofilm Reactor (MBBR)	Consultant
SOCIO-CULTURAL ENVIRONMENT						
Operational Nuisance Impacts (noise, odours)	• Permanent or long-term noise impacts during operation of wastewater treatment plant or other wastewater system facilities. • Operational odours from treatment technology.	Noise associated with the operation of the membrane bioreactor system can be mitigated to ensure applicable noise guidelines are met at the proposed and existing noise sensitive receptors. Odours mitigated through the use of enclosed tanks and carbon filters on vents.	Noise associated with the operation of the SBR system can be mitigated to ensure applicable noise guidelines are met at the proposed and existing noise sensitive receptors. Odours mitigated through the use of enclosed tanks and carbon filters on vents.	Limited mechanical equipment with this technology, no air blowers or large equipment, so minimal noise generation. Odours mitigated through the use of enclosed tanks and carbon filters on vents.	Noise associated with the operation of the MBBR system can be mitigated to ensure applicable noise guidelines are met at the proposed and existing noise sensitive receptors. Odours mitigated through the use of enclosed tanks and carbon filters on vents.	Jade / Burnside
		Less Preferred	Less Preferred	More preferred	Less Preferred	
Operational Traffic Impacts	• Localized traffic impacts based on frequency of operation and maintenance activities.	Process requires periodic removal of primary solids and aerobic sludge by licensed hauling trucks. Estimated frequency twice per year.	Process requires periodic removal of primary solids and aerobic sludge by licensed hauling trucks. Estimated frequency twice per year.	Process requires periodic removal of primary solids only; no aerobic sludge generated by this process. Estimated frequency once per year.	Process requires periodic removal of primary solids and aerobic sludge by licensed hauling trucks. Estimated frequency twice per year.	Burnside
		Less Preferred	Less Preferred	Most Preferred	Less Preferred	
SUMMARY OF SOCIO-CULTURAL ENVIRONMENT EVALUATION		**4/10 Less Preferred**	**4/10 Less Preferred**	**9/10 Most Preferred**	**4/10 Less Preferred**	
TECHNICAL ENVIRONMENT						
Ability to meet water treatment / storage criteria		Best available technology for phosphorus removal. Can meet objectives for other parameters (BOD, TSS, pathogens) Somewhat inconsistent nitrate removal performance; may require supplemental equipment/ processes.	Can meet effluent objectives for most parameters (BOD, TSS, pathogens and phosphorus). May not be able to provide nitrate removal to desired levels; may require supplemental equipment/ processes.	Can meet all effluent objectives.	Can meet effluent objectives for most parameters (BOD, TSS, pathogens and phosphorus). Somewhat inconsistent nitrate removal performance; may require supplemental equipment/ processes to meet objectives.	Burnside
		Somewhat preferred	Less preferred	Most preferred	Less preferred	
Land area requirements	• Footprint of above ground equipment. • Footprint of below ground equipment including piping.	Above ground building to house UV disinfection equipment, chemical dosing, controls, membranes and associated pumps, air blowers. Below ground concrete tanks to contain pre-treatment, aerobic and anoxic process. Most compact overall footprint, but largest above ground building footprint.	Above ground building to house UV disinfection equipment, chemical dosing, controls, air blowers, tertiary filters. Below ground concrete tanks to contain SBR aerobic and anoxic processes. Similar to Alternative 4.	Above ground building to house UV disinfection equipment, chemical dosing, controls, tertiary filters. Below ground tanks (650 to 700 m2) would contain the majority of treatment equipment and processes. Could be entirely housed in above ground containers. Similar overall footprint to Alternatives 2 and 4. Smallest building footprint.	Above ground Control Building to house UV disinfection equipment, chemical dosing, controls, air blowers, tertiary filters. Below ground tanks to contain the majority of treatment equipment and processes including bioreactors, clarifiers, anoxic tanks. Similar to Alternative 2.	Burnside
		Less Preferred	Somewhat Preferred	More Preferred	Somewhat Preferred	
Modularity	• Degree of flexibility of system size and phasing.	System can be modular. Number of treatment “trains” will be variable depending on specific membrane supplier and associated capacities. Suspended growth process is not resilient to low flows and loadings during initial phase as	System is somewhat modular. Can be constructed as multiple parallel treatment trains, but may require more initial capital outlay than other options. Suspended growth process is not resilient to low flows and loadings during initial phase as dwellings	High degree of flexibility to accommodate multiple treatment trains and modular installation. Fixed film process is resilient to low flows and loadings during initial phase as dwellings gradually become occupied.	System is somewhat modular. Can be constructed as multiple parallel treatment trains. Process contains both suspended growth and fixed film, but only somewhat resilient to low flows and loadings during initial phase as dwellings gradually become occupied.	Burnside

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		dwellings gradually become occupied. Plant may struggle to meet effluent objectives during initial phases of development due to low incoming sewage volumes.	gradually become occupied. Plant may struggle to meet effluent objectives during initial phases of development due to low incoming sewage volumes.		Plant may struggle to consistently meet effluent objectives during initial phases of development due to low incoming sewage volumes.	
		Less Preferred	Least Preferred	Most preferred	Somewhat preferred	
Operation and Maintenance requirements and complexity	• Frequency of maintenance. • Maintenance resources required (e.g., staffing, training / certifications, etc.). • Regulatory testing and sampling.	Operator on site 3x per week for system checks Highest level of mechanical parts and complex equipment. Requires air blowers, Chemical addition required for removal of phosphorus and nitrogen. Regular membrane cleaning and replacement required.	Operator on site 3x per week for system checks Moderate level of mechanical parts and complex equipment. Requires air blowers. Chemical addition required for removal of phosphorus and nitrogen.	Operator on site 1x per week for system checks Minimal mechanical parts and no complex equipment. No air blowers required. Chemical addition required for removal of phosphorus and nitrogen.	Operator on site 1x per week for system checks Moderate level of mechanical parts and complex equipment. Requires air blowers. Chemical addition required for removal of phosphorus and nitrogen.	Burnside
		Least Preferred	Less Preferred	Most Preferred	Somewhat Preferred	
SUMMARY OF TECHNICAL ENVIRONMENT EVALUATION		**8/20 Less Preferred**	**8/20 Less Preferred**	**19/20 Most Preferred**	**11/20 Somewhat Preferred**	
FINANCIAL ENVIRONMENT						
Comparative capital costs	• Estimate of capital costs.	$3.4 million	$3.1 million	$2.5 million	$2.8 million	Burnside
		Least Preferred	Less Preferred	Most Preferred	Somewhat Preferred	
Estimated operations and maintenance costs	• Estimate of operational costs per year.	$160,000 to $180,000	$160,000 to $180,000	$60,000 to $80,000	$80,000 to $100,000	Burnside
		Less Preferred	Less Preferred	Most Preferred	Somewhat Preferred	
Estimated life cycle costs	• Estimate of life cycle cost	$6.2 million	$5.9 million	$3.6 million	$4.2 million	Burnside
		Least Preferred	Less Preferred	Most Preferred	Somewhat Preferred	
SUMMARY OF FINANCIAL ENVIRONMENT EVALUATION		**2/10 Least Preferred**	**2/10 Least Preferred**	**10/10 Most Preferred**	**6/10 Somewhat Preferred**	
OVERALL EVALUATION		**5/15 Less Preferred**	**5/15 Less Preferred**	**15/15 Most Preferred**	**8/15 Somewhat Preferred**	
RECOMMENDATION		**Not Carried Forward**	**Not Carried Forward**	**Carried Forward**	**Not Carried Forward**	

Ranking Order of Preference

Least Preferred

Less Preferred

Somewhat Preferred

More Preferred

Most Preferred

Water System Alternative Design Concepts Evaluation Matrix
Phase 3

Criteria	Criteria Indicator	Alternative 1A Primary Disinfection-Ultraviolet Disinfection	Alternative 1B Primary Disinfection - Chlorine	Alternative 2A Aesthetic (Hardness) - Ion Exchange	Alternative 2B Aesthetics (Hardness) - Softening Membranes	Alternative 2C Aesthetics (Hardness) - Crystallization Technology	Alternative 3A Storage – Above Ground	Alternative 3B Storage – Below Ground	Consultant
NATURAL ENVIRONMENT									
Impacts to Natural Environment	• General impacts to the natural environment	• None. Most preferred	• Negative impact on natural environmental in the event of a spill. Least preferred	• Potential impact to soils as result of spray irrigation to golf course. Least preferred	• Minimal to no impact. Most preferred	• Minimal to no impact. Most preferred	• Minimal to no impact. Most preferred	• Minimal to no impact. Most preferred	Others
SUMMARY OF NATURAL ENVIRONMENT EVALUATION		**3/3 Most Preferred**	**1/3 Least Preferred**	**1/3 Least Preferred**	**3/3 Most Preferred**	**3/3 Most Preferred**	**3/3 Most Preferred**	**3/3 Most Preferred**	
SOCIO-CULTURAL ENVIRONMENT									
Operational Nuisance Impacts (noise, odours)	• Permanent or long-term noise impacts during operation of wastewater treatment plant or other wastewater system facilities. • Operational odours from treatment technology.	• Minimal noise. • No odours from treatment. • Minimal operational nuisance. Most preferred	• Minimal noise related to pump operation. • Minimal chlorine odour. • Ventilation system required to ensure cycling of air for chemical room. • Moderate operational nuisance. More preferred	• Minimal noise related to pump operation. • Moderate noise for short duration during operation/cleaning. • Higher operational nuisance. More preferred	• Minimal noise related to pump operation. • Higher operational nuisance. More preferred	• Minimal noise and operational nuisance. • Maintenance for each residential unit within the development would be required. Least preferred	• Minimal noise. • No odour. • Minimal operational nuisance. Most preferred	• Minimal noise. • No odour. • Moderate operational nuisance (difficult to service and inspect). More preferred	Jade
Operational Traffic Impacts	• Localized traffic impacts based on frequency of operation and maintenance activities	• Minimal traffic impact due to regular inspection and maintenance. More preferred	• Minimal traffic impact due to re-supply of chemicals (3 to 4 weeks) and regular inspection and maintenance. More preferred	• Minimal traffic impact due to salt deliveries (3 to 4 weeks) and regular inspection and maintenance. More preferred	• Minimal traffic impact due to regular inspection and maintenance. More preferred	• Minimal to no traffic. Most preferred	• Minimal traffic impact due to regular inspection and maintenance. More preferred	• Minimal traffic impact due to regular inspection and maintenance. More preferred	TYLin
Visual impacts	• Visual impacts to adjacent residences	• None as the equipment will be located inside a building. Most preferred	• None as the equipment will be located inside a building. Most preferred	• None as the equipment will be located inside a building. Most preferred	• None as the equipment will be located inside a building. Most preferred	• None as the equipment will be located inside a building. Most preferred	• Can be observed at grade. • Less architectural options compared to Alternative 3b. • Susceptible to vandalism. More Preferred	• Cannot be observed at grade. Most preferred	TYLin
SUMMARY OF SOCIO-CULTURAL ENVIRONMENT EVALUATION		**8/9 Most Preferred**	**7/9 More Preferred**	**7/9 More Preferred**	**7/9 More Preferred**	**7/9 More Preferred**	**7/9 More Preferred**	**7/9 More Preferred**	

Water System Alternative Design Concepts Evaluation Matrix
Phase 3

Criteria	Criteria Indicator	Alternative 1A Primary Disinfection- Ultraviolet Disinfection	Alternative 1B Primary Disinfection - Chlorine	Alternative 2A Aesthetic (Hardness) - Ion Exchange	Alternative 2B Aesthetics (Hardness) - Softening Membranes	Alternative 2C Aesthetics (Hardness) - Crystallization Technology	Alternative 3A Storage – Above Ground	Alternative 3B Storage – Below Ground	Consultant
TECHNICAL ENVIRONMENT									

Ability to meet water treatment / storage criteria	• Can this technology meet the water treatment / storage criteria?
	• Formation of by-products or impact to the water quality.
	• Impact to water taste/odour.
	• Production of wastewater.
		• Can be met.
		• Minimal formation of disinfection by-products.
		• Does not change the taste and odour of water.
		• No chlorine residual in treated water and as such offers no protection against re-infection during distribution.
		• Effective against Cryptosporidium and Giardia.
		• Effective as part of a multi-barrier approach to provide a second form of treatment.
			• Can be met.
			• Formation of disinfection by-products.
			• Distinctive odour and taste in treated water.
			• Chlorine residual remains in the storage and distribution stages to allow for maintenance of water quality.
			• Negative impact to ion exchange (Alternative 2a) and softening membranes (Alternative 2b) efficiency.
			• Not effective against Cryptosporidium.
			• Effective as part of a multi-barrier approach to provide a second form of treatment.
				• Can be met.
				• Similar level of hardness removal efficiency as Alternative 2b.
				• Regular resin regeneration may result in potential salt buildup in golf course lands.
				• Wastewater production (5 to 8% of feed water) during the regeneration process.
				  ○ This system will produce less wastewater than Alternative 2b.
					• Can be met
					• Similar level of hardness removal as Alternative 2a.
					• Membranes don't tolerate exposure to chlorine, and repeated chlorine exposure can lead to lower efficiency.
					• Does not generate salt.
					• Increased amount of wastewater (10% of feed water).
					  ○ This system will produce more wastewater than Alternative 2a.
						• Can be met on small scale, but further investigation into commercial scale is required.
						• Residents may switch to salt softeners, resulting in potential salt build up in golf course lands.
						• Lower efficiency than Alternative 2a and 2b.
						• Not suitable for well water with Iron.
						• Does not remove minerals (calcium and magnesium ions) from water but converts them from one state to the other (precipitate).
						• Difficult to test for effectiveness as it does not remove calcium and magnesium ions.
						• Does not use salt or other chemical conditioning agents.
						• Treated water would still result in some soft scale formation on external surfaces.
						• Does not produce wastewater.
						  ○ There is no backwashing or salt discharge.
							• Can be met.	• Can be met.	TYLin

		Most preferred	More preferred	More preferred	Most preferred	Least preferred	More preferred	More preferred	
Land area requirements	• Footprint of above ground equipment. • Footprint of below ground equipment including piping.	• Similar to Alternative 1b.	• Similar to Alternative 1a.	• Similar to Alternative 2b.	• Similar to Alternative 2a.	• No spatial requirements within water treatment plant, only in residential units.	• Larger building footprint as a result of two separate structures.	• Minimal increase in footprint. Reservoir can be integrated into the below ground foundation design of the WTP.	TYLin
		More preferred	More preferred	More preferred	More preferred	Most preferred	More preferred	Most preferred	

Water System Alternative Design Concepts Evaluation Matrix
Phase 3

Criteria	Criteria Indicator	Alternative 1A Primary Disinfection-Ultraviolet Disinfection	Alternative 1B Primary Disinfection - Chlorine	Alternative 2A Aesthetic (Hardness) - Ion Exchange	Alternative 2B Aesthetics (Hardness) - Softening Membranes	Alternative 2C Aesthetics (Hardness) - Crystallization Technology	Alternative 3A Storage – Above Ground	Alternative 3B Storage – Below Ground	Consultant
Modularity	• Degree of flexibility of system size and phasing.	• Additional equipment can be phased with minimal upgrades requirements.	• Flexible as an additional pump or chemical storage tank can be installed if required.	• Additional equipment can be phased with minimal upgrades requirements.	• Additional equipment can be phased with minimal upgrades requirements.	• N/A	• Can be expanded vertically, if required. • Second tank can be provided for additional capacity with similar foundation design, if required.	• Additional water reservoir cells can be constructed. • Complexity to expand a subgrade reservoir is higher than expanding an above ground tank due to excavation, existing foundation constraints, and shoring.	TYLin
		More preferred	More preferred	More preferred	More preferred		Most preferred	More preferred	
Operation and Maintenance requirements and complexity	• Frequency of maintenance. • Maintenance resources required (e.g., staffing, training / certifications, etc.). • Regulatory testing and sampling.	• Quartz sleeves and Teflon tubes needs to be cleaned regularly by mechanical wipers, ultrasonics, or chemicals. • Inspection of UV chamber interior required every six months. • Safe for operators as there is no chemical handling, transportation, or storage. • Requires less contact time than Alternative 1b.	• Cleaning and maintenance of the system components is required every six months. • Equipment and chlorine storage tank to be inspected and cleaned annually. • Chemical delivery every 3 to 4 weeks. • Regular inspection of the equipment, chlorine solution and free chlorine residual levels, adjustment of equipment and dosage rates as required. • All forms of chlorine are highly corrosive and toxic as such, storage, shipping, and handling pose a risk to operators and require increased training and safety procedures than Alternative 1a.	• Ion exchange resin needs to be replaced every 8-12 years. • Chemical delivery (dry salt) required every 3 to 4 weeks. • Regular regeneration of resin is required. • Periodic inspection and maintenance of brine tank.	• Membranes replacement (approx. every 10 years). • Regular cleaning of membranes is required. • Periodic inspection and maintenance.	• Media or cartridge replacement range is from 1 to 3 years. • No drainage required. • Pre-filter to be replaced every 3 to 6 months. • Periodic inspection and maintenance • Residents would be responsible for operation.	• Minimal inspection and maintenance requirements. • Manways provided for easy access. • Defects/leaks are easily identified and repaired. • More prone to freezing during the winter.	• Minimal inspection and maintenance requirements. • Increased confined space training and safety procedures. • Difficult identifying and repairing cracks and leaks. • Natural protection against the extreme cold and heat, easier to maintain temperate.	TYLin
		Most preferred	More preferred	More preferred	Most preferred	Least preferred	Most preferred	More preferred	
SUMMARY OF TECHNICAL ENVIRONMENT EVALUATION		**10/12 Most Preferred**	**8/12 More Preferred**	**8/12 More Preferred**	**10/12 Most Preferred**	**5/9 Least Preferred**	**10/12 Most Preferred**	**9/12 More Preferred**	
FINANCIAL ENVIRONMENT									

Water System Alternative Design Concepts Evaluation Matrix
Phase 3

Criteria	Criteria Indicator	Alternative 1A Primary Disinfection-Ultraviolet Disinfection	Alternative 1B Primary Disinfection - Chlorine	Alternative 2A Aesthetic (Hardness) - Ion Exchange	Alternative 2B Aesthetics (Hardness) - Softening Membranes	Alternative 2C Aesthetics (Hardness) - Crystallization Technology	Alternative 3A Storage – Above Ground	Alternative 3B Storage – Below Ground	Consultant
Comparative capital costs	• Estimate of capital costs.	• Higher	• High	• Similar to Alternative 2b.	• Similar to Alternative 2a.	• Higher capital costs to install all residential units when compared to a single system at the water treatment plant.	• Moderate ○ Less excavation and shoring systems ○ Dependent on soils and groundwater ○ Insulation and mixing required	• High ○ Deeper and larger excavation and shoring systems ○ Dependent on soils and groundwater ○ Insulation and waterproofing required	TYLin
		More preferred	Most preferred	Most preferred	Most preferred	More preferred	Most preferred	More preferred	
Estimated operations and maintenance costs	• Estimate of operational costs.	• High ○ Ballasts and quartz sleeves to be replaced every 5 years. ○ Lamps to be replaced annually. ○ High energy consumption.	• Higher ○ Costs required for training and emergency preparedness. ○ Moderate energy consumption. ○ Re-supply of chemicals (3-4 weeks). ○ Increased ventilation requirements.	• High ○ Regular regeneration and maintenance of resin. ○ Re-supply of dry salt. ○ Moderate energy consumption.	• High ○ Cleaning of membranes. ○ Membrane replacement (every 10 years). ○ High energy consumption.	• High due to number of units ○ Media or cartridge to be replaced every 1 to 3 years. ○ No drainage. ○ Low energy consumption.	• Low ○ Similar pumping costs. ○ Can be visually inspected. ○ Moderate cost of repairs as tank is above grade.	• Low ○ Similar pumping costs. ○ Higher cost of repairs due to confined space and potential excavation. ○ Higher costs of training and emergency preparedness.	TYLin
		Most preferred	More preferred	More preferred	More preferred	More preferred	Most preferred	Most preferred	
Estimated life cycle costs	• Estimate of life cycle cost	• Similar	• Similar	• High	• High	• High due to the number of units	• Low	• Low	TYLin
		More preferred	More preferred	More Preferred	More preferred	More preferred	More preferred	More preferred	
SUMMARY OF FINANCIAL ENVIRONMENT EVALUATION		**7/9 Most Preferred**	**7/9 More Preferred**	**7/9 Most Preferred**	**7/9 Most Preferred**	**6/9 More Preferred**	**8/9 Most Preferred**	**7/9 More Preferred**	
OVERALL EVALUATION		**12/12 Most Preferred**	**7/12 More Preferred**	**8/12 More Preferred**	**11/12 Most Preferred**	**8/12 More Preferred**	**11/12 Most Preferred**	**9/12 More Preferred**	
RECOMMENDATION		**Recommended**			**Recommended**		**Recommended**		

Evaluation Order of Preference

Least Preferred

More Preferred

Most Preferred

Assumptions List:

1. UV Disinfection will be provided for Primary Disinfection followed by Chlorine disinfection for Secondary. This provides a multi-barrier approach for disinfection. Since chlorination will be used this is the more preferred method to provide the multi-barrier approach.

Water System Alternative Design Concepts Evaluation Matrix
Phase 3

2. UV disinfection is required due to the downstream softening membranes. Chlorination for primary disinfection would have negative impacts on the membranes.
3. Softening membranes will provide the most effective solution for removing water hardness without using water softeners that are typically salt based solutions. The alternatives are problematic when tying into the irrigation design for potential of salt accumulation within the irrigation ponds potentially killing the grass long term.
4. Evaluation for above ground storage will only proceed to evaluate a standpipe. Elevated Tank is ruled out due to economic factors
5. System design will meet 4log requirements for virus removal.