ALAN PLUMMER ASSOCIATES, INC.
ENVIRONMENTAL ENGINEERS AND SCIENTISTS

TECHNICAL MEMORANDUM

City of Willow Park, Texas
Proposed Wastewater Treatment Plant
Process Evaluation

Project No.: 3123-001-01

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City of Willow Park

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INTRODUCTION

The City of Willow Park, Texas (City) commissioned Alan Plummer Associates, Inc. (APAI) to evaluate treatment process options for the proposed wastewater treatment plant (WWTP). The proposed WWTP will replace the existing plant, which is nearing the end of its useful life. The existing plant has also reached more than 75 percent of its rated capacity, which triggers a Texas Commission on Environmental Quality (TCEQ) rule requiring planning for additional treatment capacity.

This memorandum provides a comparison of three treatment process options and provides an opinion of probable construction cost (OPCC), an estimate of the annualized operation and maintenance (O&M) costs for a 20-year operating period, and the associated net present worth for a 20-year term for each option. The three treatment process options compared are as follows:

- Option 1: Conventional Activated Sludge (CAS) Process
- Option 2: Bio-Wheel™ Activated Sludge Process
- Option 3: Membrane Bioreactor (MBR) System

The proposed rated capacity of the plant will be an average of 1 million gallons per day (MGD), with a maximum capacity of up to 4 MGD during a 2-hour peak flow event. The process assumptions for the basis of design in developing the options are summarized in Table 1.

Table 1: Basis of Design Assumptions

Parameter	Design Value
Design Flow	1 MGD
Peak 2-Hour Flow	4 MGD
Influent BOD_5[a] Concentration	250 mg/L
Influent TSS[b] Concentration	250 mg/L
Influent NH_3-N[c] Concentration	35 mg/L

TREATMENT PROCESS OPTIONS

The three process options compared in this evaluation were selected based on their ability to meet the existing WWTP's effluent permit requirements, as well as their ability to perform nitrification or treatment of ammonia by biological conversion to nitrate (NO_3^{-1}). The existing effluent permit limits are as follows:

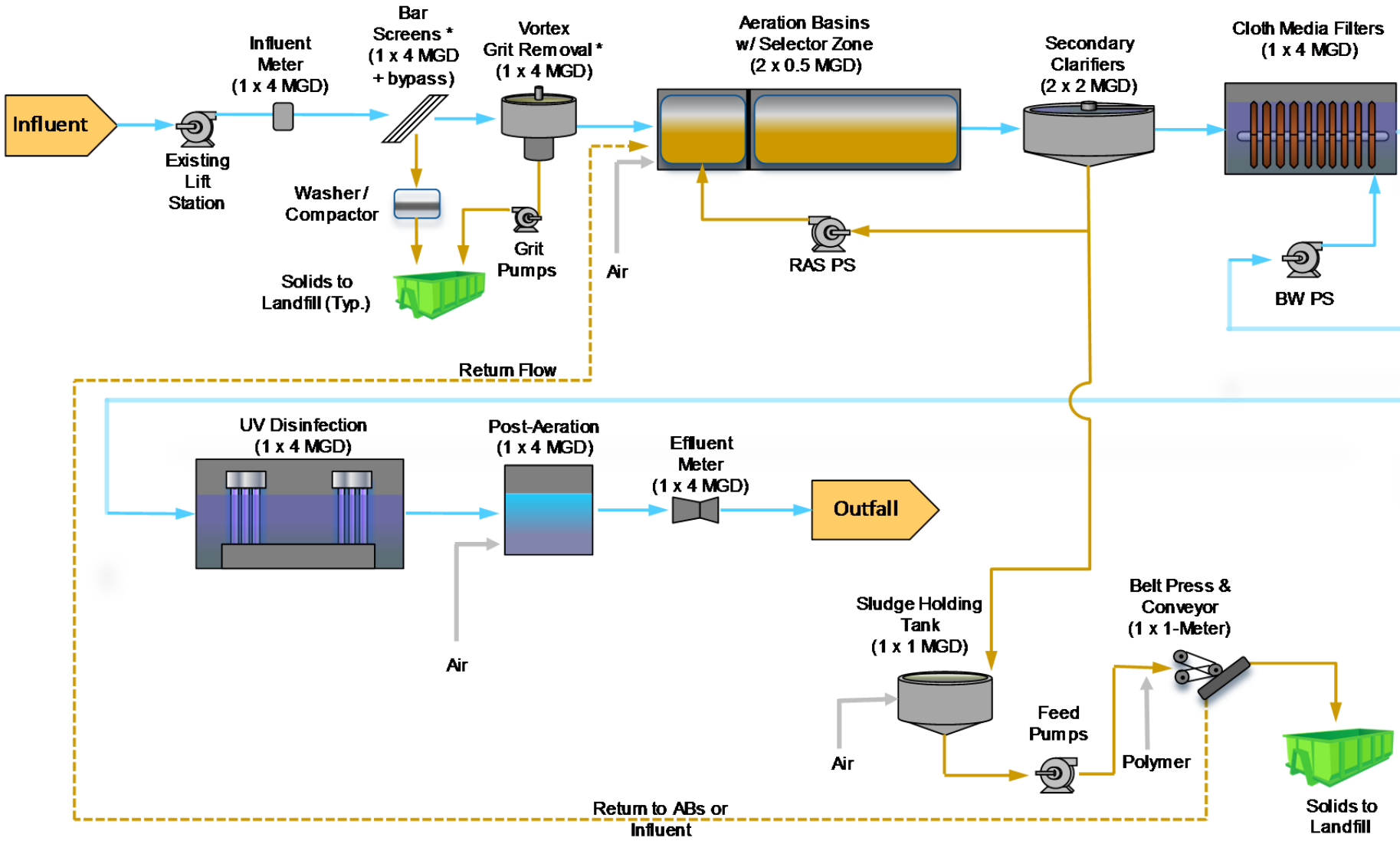
- Carbonaceous Biochemical Oxygen Demand – 10 mg/L
- Total Suspended Solids – 15 mg/L
- Ammonia, Nitrogen – 3 mg/L

Table 2 compares the treatment processes that are included for each option compared. Figures 1, 2, and 3 illustrate the treatment process for each of Options 1, 2, and 3, respectively.

Table 2: Treatment Process Comparison For Options 1-3

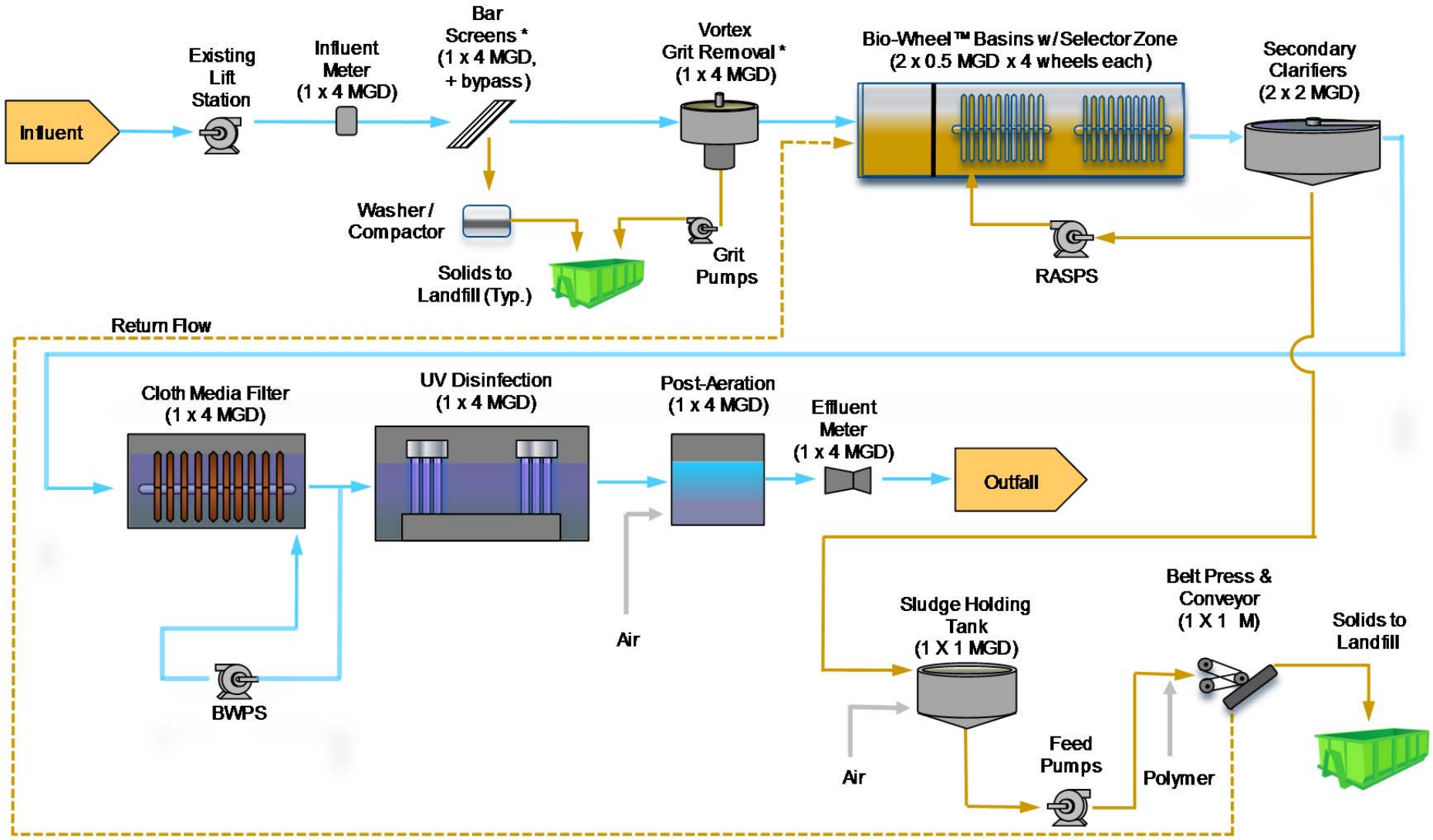
Treatment Process	Option 1: CAS	Option 2: Bio-Wheel™	Option 3: MBR
Influent Flow Meter	X	X	X
Influent Bar Screens	X	X	X
Grit Removal	X	X	X
Flow Equalization Tank			X
Fine Screens			X
Aeration Basins	X		X
Bio-Wheel™ Basins		X	
Membrane Bioreactors[d]			X
Secondary Clarifiers	X	X	
Effluent Filters	X	X	
UV Disinfection	X	X	X
Post-Aeration	X	X	X
Effluent Flow Meter	X	X	X
Solids Handling & Dewatering	X	X	X

[a] 5-day biochemical oxygen demand – the amount of oxygen consumed by biological organisms in a sample over a 5-day period.
[b] Total suspended solids.
[c] Ammonia nitrogen.
[d] MBR systems require additional screening to protect the membranes, but provide treatment efficiencies that replace the need for clarifiers and filters.



* Headspace treated by Vapex System for odor control.

Figure 1: Option 1, Conventional Activated Sludge Process Flow Diagram



* Headspace treated by Vapex System for odor control.

Figure 2: Option 2, Bio-Wheel™ Activated Sludge Process Flow Diagram

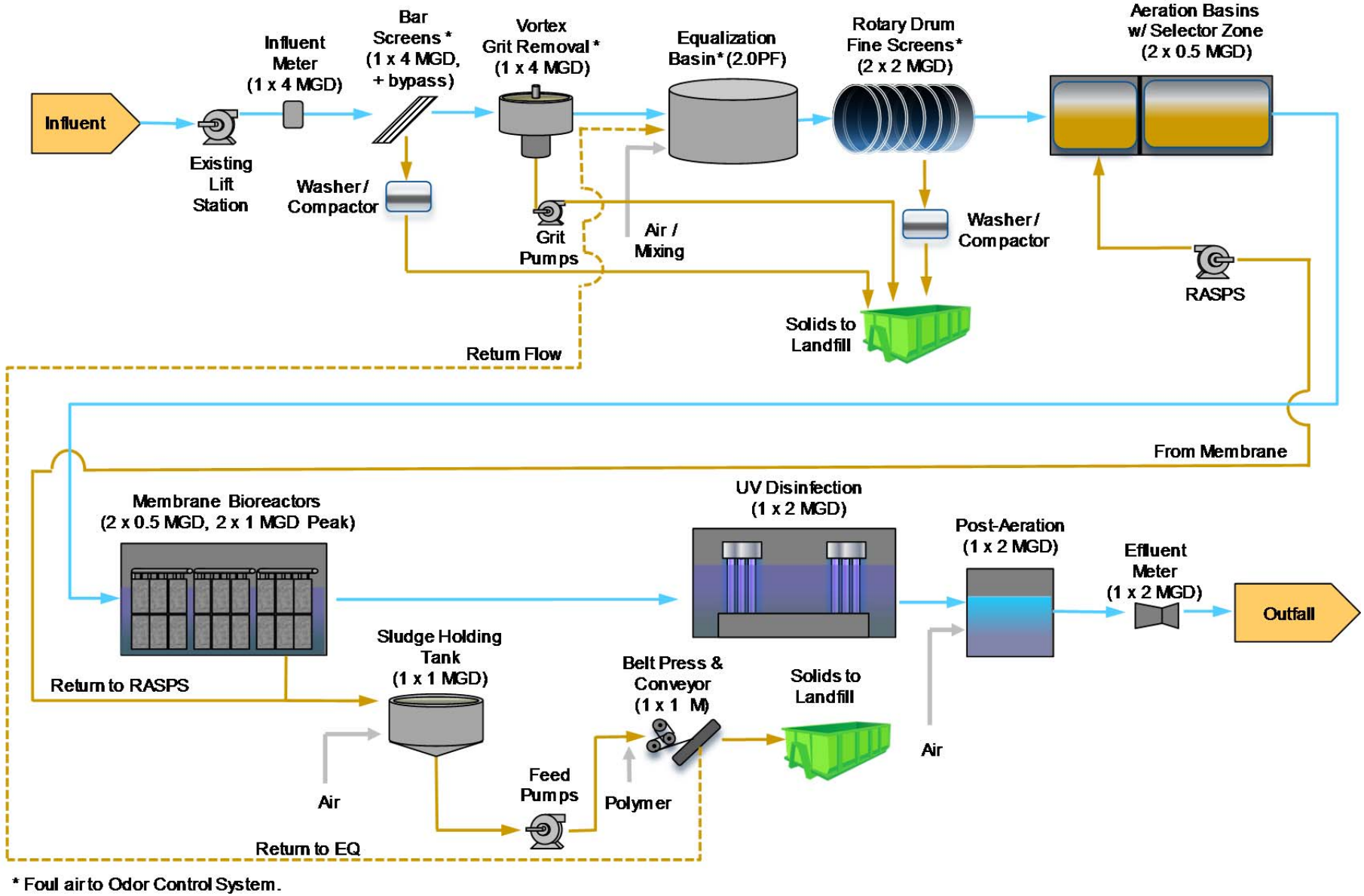


Figure 3: Option 3, Membrane Bioreactor Process Flow Diagram

Options 1 and 2 are identical, except for the aeration method in the secondary treatment biological process. Option 1 uses fine-bubble diffusers to supply oxygen, while Option 2 uses the Bio-Wheel™ process for aeration. The Bio-Wheel™ system consists of a large plastic-media wheel, which rotates through the wastewater, trapping air as it rotates above the water line, and gradually releasing the air in the form of tiny bubbles as it rotates below the water line.

Option 3 differs from Options 1 and 2 in that the MBR equipment is not capable of accepting the same average-to-peak flow ratios during peak flow events (2:1 for MBR vs. 4:1 for CAS and Bio-Wheel™) and requires a storage basin to limit the flow that goes to the MBR processes. However, MBRs are capable of providing a higher-quality effluent and do not require downstream clarification and filtration equipment.

COMPARISON

As part of this evaluation, a preliminary opinion of probable construction cost (OPCC) was developed for each option (Table 3). In order to compare the estimated cost of ownership for the proposed WWTP for the next 20-year period, annualized O&M costs were also developed. These OPCC and annualized O&M costs were combined for each option, applying a 3-percent rate of inflation over a 20-year period, to provide a net present worth for each system (Table 4). The net present worth is the estimated cost of the construction and ownership for the indicated duration.

Table 3: Preliminary Opinions of Probable Construction Costs for Options 1-3

Option	Opinion of Probable Construction Cost
Option 1 – CAS with Aeration Basins	$ 11.8M
Option 2 – CAS with Bio-Wheel™	$ 12.5M
Option 3 – Membrane Bioreactors	$ 22.6M

Table 4: Preliminary Life-Cycle Costs for Options 1-3

Option	Opinion of Probable Construction Cost	Annualized O&M Costs[5]	20-Year Present Worth
Option 1 – CAS with Aeration Basins	$ 11.8M	$ 0.40M	$17.8M
Option 2 – CAS with Bio-Wheel™	$ 12.5M	$ 0.39M	$18.4M
Option 3 – Membrane Bioreactors	$ 22.6M	$ 0.54M	$30.6M

RECOMMENDATION

Each process option presented in this memorandum is capable of providing a wastewater treatment process that will provide a discharge water quality that can meet the TCEQ's assumed water quality discharge limits. Costs for Options 1 and 2 are very similar and would provide a similar level of water quality. Option 3 is significantly more expensive because it provides a higher level of treatment. However, due to its costs Option 3 is not recommended because the water quality required for discharge into a stream or most reuse applications can be achieved using either of the other two, lower-cost options. Option 2 is recommended for the City because aeration using the Bio-Wheel™ requires fewer aeration blowers than Option 1. Consequently, Option 2 will generate less noise and will require less effort for operation and maintenance.

[5] Assumes 1-MGD flow each year; actual costs may be less, depending on actual flow.