Table 4-1—Evaluation of Secondary Treatment Process Alternatives for Key Criteria

	Secondary Treatment Process									
Criteria	**Two-Stage Activated Sludge**	**Four-Stage Activated Sludge**	**Oxidation Ditch (Carousel)**	**Phased Isolation Ditch**	**Nitrox™**	**Sym-Bio®**	**SBR**	**MBR**	**VERTREAT**	**BAF**
Process Performance History	- Well established in U.S.	- Well established in U.S.	- Well established in U.S.	- Well established in Europe but only a few installations in U.S.	- Patented process - Sound concept but not in widespread use.	- Patented process - Sound concept but not in widespread use.	- Well established - A history of problems with decanting systems.	- Relatively new technology, but being used successfully in several U.S. plants.	- Only a few installations in the U.S., mostly by industries. - No denitrification facilities were identified.	- Well established for nitrification, but relatively few denitrification applications.
Ease of Operation	- Simple operation	- Simple operation	- Simple operation	- Simple operation	- Simple operation	- Simple operation	- High level of operator skill required to manage the length of the periods when treating to stringent standards. - Decanting systems require operator skill and attention.	- Simple operation - Need to periodically remove membrane cassettes for cleaning.	- Large amount of dissolved oxygen in the liquid exiting the deep shaft would complicate the denitrification step.	- Simple operation
Flexibility to Meet Changing Permit Requirements	- Not able to reduce TIN below 5 mg/L.	- Able to achieve TIN of 2 mg/L with methanol addition in second anoxic zone.	- Would require an external anoxic reactor and methanol addition to achieve TIN of 2 mg/L.	- Would require an external anoxic reactor and methanol addition to achieve TIN of 2 mg/L.	- Would require an external anoxic reactor and methanol addition to achieve TIN of 2 mg/L.	- Would require an external anoxic reactor and methanol addition to achieve TIN of 2 mg/L.	- Would require methanol addition to achieve TIN of 2 mg/L.	- Able to achieve TIN of 2 mg/L with methanol addition in second anoxic zone.	- Would require an external anoxic reactor and methanol addition to achieve TIN of 2 mg/L.	- Would require a post-anoxic stage with methanol addition to achieve TIN of 2 mg/L.
Power Requirement	- Similar or slightly less than Four-Stage Activated Sludge.	- Moderate power usage.	- Slightly more than Four-Stage Activated Sludge.	- Slightly more than Four-Stage Activated Sludge.	- Slightly more than Four-Stage Activated Sludge.	- Claims have been made that this process saves power as compared to Four-Stage Activated Sludge.	- Similar or slightly less than Four-Stage Activated Sludge.	- Significantly more than Four-Stage Activated Sludge (50-80% more)	- Claims to have low power use; however, too few installations to substantiate claims.	- Similar or slightly more than Four-Stage Activated Sludge.
Digester Gas Production (Energy Recovery)	- Allows for high level of digester gas production.	- Allows for high level of digester gas production.	- Less digester gas would be produced due to greater sludge stabilization achieved aerobically during secondary treatment.	- Less digester gas would be produced due to greater sludge stabilization achieved aerobically during secondary treatment.	- Less digester gas would be produced due to greater sludge stabilization achieved aerobically during secondary treatment.	- Probably comparable to Four-Stage Activated Sludge.	- Allows for high level of digester gas production.	- Allows for high level of digester gas production.	- Allows for high level of digester gas production.	- Allows for high level of digester gas production.
Capital Cost	- Slightly less than Four-Stage Activated Sludge due to less tankage.	- Moderate capital cost.	- Comparable to Four-Stage Activated Sludge.	- Comparable to Four-Stage Activated Sludge.	- Comparable to Four-Stage Activated Sludge.	- Comparable to Four-Stage Activated Sludge.	- Slightly less than Four-Stage Activated Sludge.	- Comparable to Four-Stage Activated Sludge.	- More than Four-Stage Activated Sludge.	- Comparable to Four-Stage Activated Sludge.
O&M Cost	- Moderate O&M cost.	- Slightly more than Two-Stage Activated Sludge due to mixing in additional anoxic and aerobic zones.	- Comparable to or slightly more than Four-Stage Activated Sludge due to greater power cost.	- Comparable to or slightly more than Four-Stage Activated Sludge due to greater power cost.	- Comparable to or slightly more than Four-Stage Activated Sludge due to greater power cost.	- Comparable to Four-Stage Activated Sludge.	- Less than Two-Stage and Four-Stage Activated Sludge.	- Significantly more than Four-Stage Activated Sludge due to greater power cost and membrane replacement after 7-10 years.	- Not enough history to evaluate.	- Comparable to or slightly more than Four-Stage Activated Sludge due to media replacement and underdrain maintenance.
Overall Evaluation	- Inability to achieve 2 mg/L TIN could be problematic.	- Appears to be good choice.	- Appears to be good choice if energy recovery is not employed.	- Not well-established in California.	- Patented process that is not well-established in California.	- Not in widespread use.	- High level of operator skill and attention is required.	- Appears to be good choice depending on cost of power.	- Patented process. - Not well established. - May pose problems for denitrification.	- Not well established for denitrification.