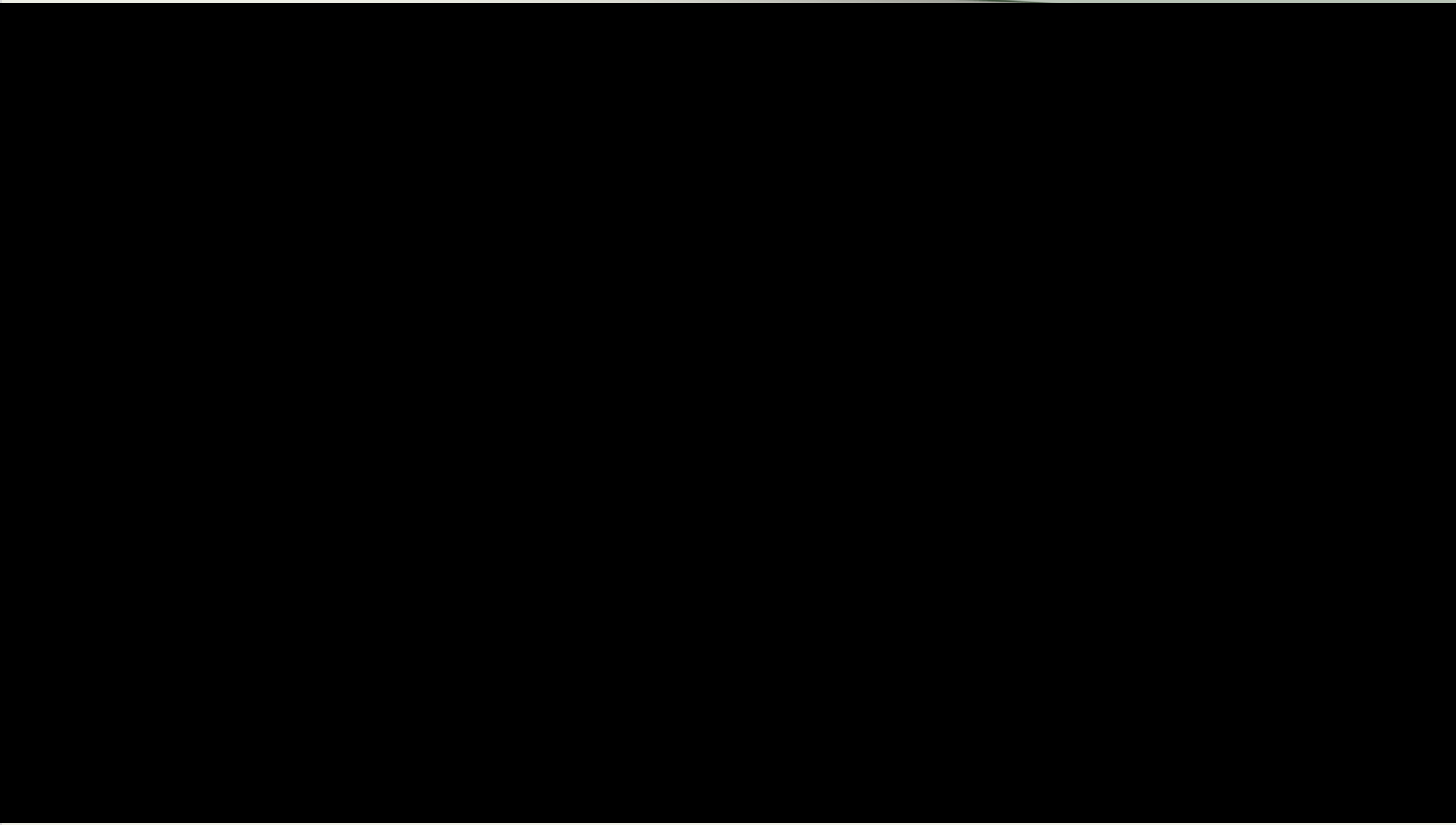
WATER REUSE IN GOLF COURSES



INTRODUCTION

Sustainable water management is an important aspect of golf course management

This includes maintaining water features to irrigating with recycled water.

INTRODUCTION

Water Recycling

- Reusing treated wastewater and is commonly reclaimed from municipal wastewater or sewage. (clubhouse, herringbone system in fairways, rainwater collection, etc.)
- Often characterized as **planned** or **unplanned**

Unplanned – occurs when courses draw water supplies from rivers, lakes, ponds, other surface water sources

Planned – those that are developed the goal of beneficially reusing a recycled water supply

SUSTAINABLE WATER USE FOR GOLF COURSES

- According to Brandon Bourdages, maintaining water features to irrigating with recycled and desalinated water, sustainable water management is an important aspect.

- A typical 150-acre (about 60 hectares) golf course uses 757,082,356 million liters of water a year. That is about 2.1M liters/day.

GOLF COURSE WATER REUSE

- In 2014 at Orange County, 13% of U.S. golf courses were irrigated with recycled water.
- Using recycled water is not only better for the environment, but it's also cheaper than using potable water.
- Benefits include lower leaching, a firm/fast course, significant water savings, and drastic cuts in gypsum, herbicide, and topdressing requirements.

DECENTRALIZED REUSE IN GOLF COMMUNITIES AND RESORTS

- Resort guests and buyers are concerned with their environmental footprint.
- It makes more sense to treat wastewater on-site and then reuse it locally.
- Recycling wastewater from sources directly adjacent to the course, one of the main cost barriers to irrigation reuse – pipelines – becomes negligible.

- Sewage Plant: Gray water sourced from hotels and residential areas in Soma Bay (a coastal resort) in Egypt is treated to stringent standards for reuse.
- In the concession areas for use in the portable toilets, saving 5,000 gallons of water.
- Additionally, the Thunderbirds tournament restored 500 million gallons (1,892.5 million liters) of water to Verde River Valley (Arizona) in 2020, and 320 million gallons (1,211.2 million liters) over five years.

- The design of Belas Clube de Ocampo (Lisbon, Portugal) ensures that all course runoff is collected into lakes before being re-used for irrigation, greatly reducing the possibility of any negative impacts on water quality.
- The wastewater from Costa Navarino (Greece) facilities is treated in a larger-scale wastewater treatment facility. 100% recycled and used for irrigation.

- Costa Navarino purchased equipment for the measurement of rainfall and soil humidity levels to control sprinklers individually. On a total of 920,000 m2 course surface, 735,000 m3 of rainfall was collected.

UNDERSTANDING GREY WATER

- Every household uses and drains out two types of water, **POTABLE** and **NON-POTABLE**
  Potable = Drinking Water
  Non-potable = Water used for cleaning, washing, etc.

- Wastewater from the toilets is the **GREY WATER**
  - this is much easier to handle in terms of recycling, treatment, and reuse

TREATING GREY WATER

- Treated Grey water can be used for many other purposes.
- Grey water also contains a trace amount of pathogens due to dead skin cells from baths or clothes that have been washed.
- Grey water from kitchen sinks is loaded with organic matter, fats, oils, and grease so it too requires some treatment before being stored in Grey water storage tanks for further processing.

STEPS IN PROCESSING GREY WATER

- **First step: Correct plumbing**
  - Grey water should be separately collected through proper plumbing.

  - If the plumbing is already in place, an expert should be called in as to how best the water can be separated by using direct methods or installing new pipes without disturbing the plumbing in place.
  - USE FOG removal if kitchen greywater is to be used

STEPS IN PROCESSING GREY WATER

- **Second step: Assessing the usage of Grey water**

  - It can be used immediately or stored for further use.

  - If being used immediately, not much processing is required.

  - In case one needs to store the water for further use, it needs storage treatment.

STEPS IN PROCESSING GREY WATER

- The treatment process used for filtration, storage, and further use of grey water will depend on the scale of use.

2 KINDS OF SYSTEMS CAN BE ESTABLISHED FOR PROCESSING:

1. Biological System
2. Mechanical System

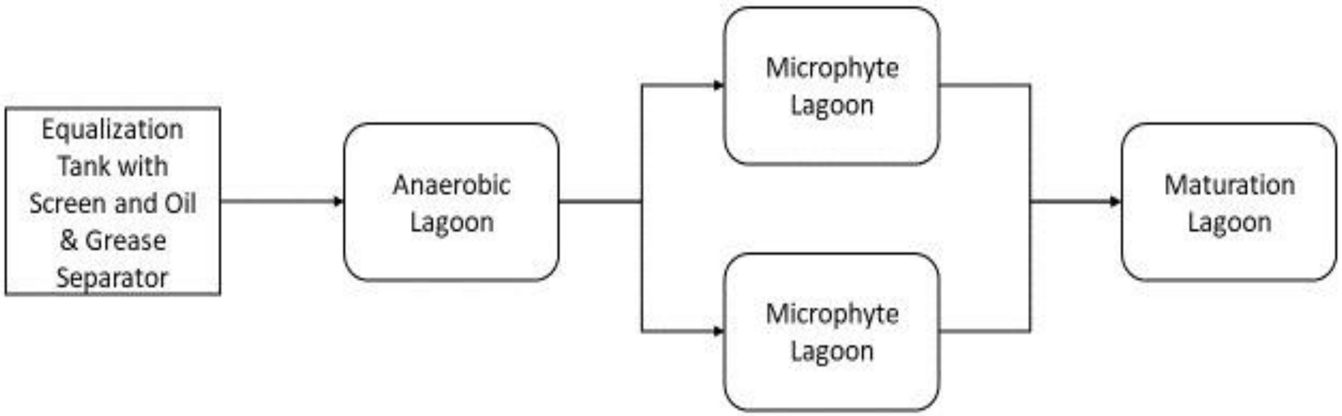
METHODS

1. Creating a wetland is one method in which a marked area is filled with grey water and suitable plants are planted on it.

2. Sand filter method has the grey water first filtered through sand which removes large particles.

3. Grey water laden with food waste needs to be pre-treated in a septic tank which can then be treated using either of the above-mentioned methods.

Assuming: Greywater
inlet of 1000 cmd



Anaerobic Lagoon: Usually deeper for anoxic conditions
Facultative/Microphyte Lagoon: uses algae and ecosystem of bacteria, phytoplankton and bacteria
Maturation Lagoon: to finish/polish effluent before discharge

EVERY DROP OF WATER SAVED TODAY MATTERS FOR A BETTER TOMORROW!

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WATER REUSE

- Water reuse should take public acceptance and security into account.

  - DENR 2021-19 Standards
    - SB – Water for recreational purposes
    - SC – For fish and wildlife sanctuaries
  - Odor Control (Hydrogen Sulfide, etc.)
  - Treatment Process

UPDATED WATER QUALITY GUIDELINES

4.1 Updated WQG and GES for Ammonia as NH_3-N

Table 1 presents the updated WQG and GES for Ammonia as NH_3-N for all water bodies.

Table 1. Updated WQG and GES for Ammonia as NH_3-N

Water Body Classification	Unit	WQG	GES
Class AA	mg/L	0.06	NDA
Class A	mg/L	0.06	2
Class B	mg/L	0.06	3
Class C	mg/L	0.06	4
Class D	mg/L	0.30	9
Class SA	mg/L	0.04	NDA
Class SB	mg/L	0.06	3
Class SC	mg/L	0.06	4
Class SD	mg/L	0.30	9

Note: *NDA – No Discharge Allowed*

UPDATED WATER QUALITY GUIDELINES

4.4 Updated WQG and GES for Fecal Coliform

Table 4 presents the updated WQG and GES for Fecal Coliform for all water bodies.

Table 4. Updated WQG and GES for Fecal Coliform

Water Body Classification	Unit	WQG	GES
Class AA	MPN/100 mL	20	NDA
Class A	MPN/100 mL	50	100
Class B	MPN/100 mL	100	200
Class C	MPN/100 mL	200	400
Class D	MPN/100 mL	400	800
Class SA	MPN/100 mL	20	NDA
Class SB	MPN/100 mL	100	200
Class SC	MPN/100 mL	200	400
Class SD	MPN/100 mL	400	800

Note: *NDA – No Discharge Allowed*
MPN/100mL – Most Probable Number/100 ml of sample

UPDATED WATER QUALITY GUIDELINES

4.5 Updated WQG and GES for Phosphate as Phosphorus (Total, Reactive)

Table 5 presents the updated WQG and GES for Phosphate as Phosphorus (Total, Reactive) for all water bodies.

Table 5. Updated WQG and GES for Phosphate as Phosphorus (Total, Reactive)

Water Body Classification	Units	WQG	GES
Class AA	mg/L	0.025	NDA
Class A	mg/L	0.025	1
Class B	mg/L	0.025	1.5
Class C	mg/L	0.025	4
Class D	mg/L	0.05	10
Class SA	mg/L	0.1	NDA
Class SB	mg/L	0.2	2
Class SC	mg/L	0.2	4
Class SD	mg/L	0.4	10

***Note:** NDA – No Discharge Allowed*

Current Water Usage in Golf Courses

According to Metropolitan Waterworks and Sewerage System in the year 2023, Golf Courses in Metro Manila source their water from deep wells or from Angat Dam which consumes at least 700 cubic meters to 1,400 cubic meters per month

WATER REUSE

- According to a recent survey by the water-market intelligence firm Bluefield Research, the reuse market stands at $1.8 billion and is expected to grow 27 percent by 2027.
- In the U.S. alone, the volume of produced recycled water is projected to increase from 4.8 billion gallons per day (BGD) to 6.6 BGD by 2027, marking a staggering increase of 37 percent.
- 39 of 50 U.S. states currently have reuse regulations or guidelines

WATER REUSE IN SINGAPORE AND NEIGHBORING COUNTRIES

- Singapore's successfully executed water supply initiative called Four National Taps[1] has set an impressive precedent for its neighboring nations to follow. Its robust and diversified water supply system is based on four "water pillars":
- 1. high-grade reused water, also called NEWater;
- 2. local catchment (i.e., rain and stormwater reservoirs);
- 3. imported water (primarily from Malaysia); and,
- 4. desalinated water.

- Singapore’s four main strategies that include natural and artificial water sources, when intertwined, are designed to solidify the nation’s resilience against frequent natural disasters and seasonal water scarcity.

The 2017 "World Water Development Report,"[2] for example, focused on

wastewater as a safe and sustainable water resource

A SMART REUSE-MANAGEMENT PLAN HELPS FACILITIES:

- Reduce freshwater demand
- Bring down generated wastewater volume
- Minimize subsequent discharge permits
- Bring down the costs of freshwater acquisition and effluent treatment
- In some cases, provide recycling opportunities for certain industrial byproducts.

- Reuse requires knowledge, financial, and investment
- Weighing the pros against the cons, implementing a reuse-management plan often proves to be the most sustainable, resource-efficient, cost-effective, and environmentally oriented alternative.

- **Our ground- and surface-water supplies are at risk of overuse around the world, and it's only a matter of time before demand will surpass water supplied by rain, rivers, lakes, and reservoirs.**

The Experience at Koele Golf Course, on the Island of Lanai, has used recycled water for irrigation since 1994. The pond shown is recycled water, as is all the water used to irrigate this world-class golf course in the state of Hawaii.

Incline Village, Nevada, uses a constructed wetland to dispose of wastewater effluent, expand the existing wetland habitat for wildlife, and provide an educational experience for visitors.

WHAT IS THE FUTURE OF WATER RECYCLING?

- Water recycling has proven to be effective and successful in creating a new and reliable water supply without compromising public health.

- While water recycling is a sustainable approach and can be cost-effective in the long term, the treatment of wastewater for reuse and the installation of distribution systems at centralized facilities can be initially expensive compared to such water supply alternatives as concessionaire water, groundwater, or the use of gray water onsite from homes.

RECOMMENDED WATER USAGE:

- 4mm to 8mm per square meter

ACTUAL:

at 45 hectares or 450,000 sqM

use .004Meter

450,000 x .004 = 1,800 cuM

Watering Window: 8 to 12 hours

Water Reuse Technologies

Rainwater Harvesting Systems

- Harvested rainwater can provide a source of alternative water
- Rainwater harvesting captures, diverts, and stores rainwater from rooftops of clubhouses, etc. for later use.

Water Reuse Technologies

1. Treatment system: Filtration and disinfection system that treats the water to non-potable or even potable standards
2. Pump: Pump to move water through the system to where it will be used
3. Backflow prevention: Backflow preventer to ensure that under negative pressure water cannot flow backward through the system into the make-up water system

Water Reuse Technologies

4. Flow meter: Flow meter (with data logger) to measure water production (not necessary)

5. Power supply: Systems may use either conventional power sources or, to improve off-grid capabilities, alternative sources such as stand-alone or grid-tied solar systems

6. Water level indicator: Monitors the water level in the storage tank

Water Reuse Technologies

Greywater recycling systems

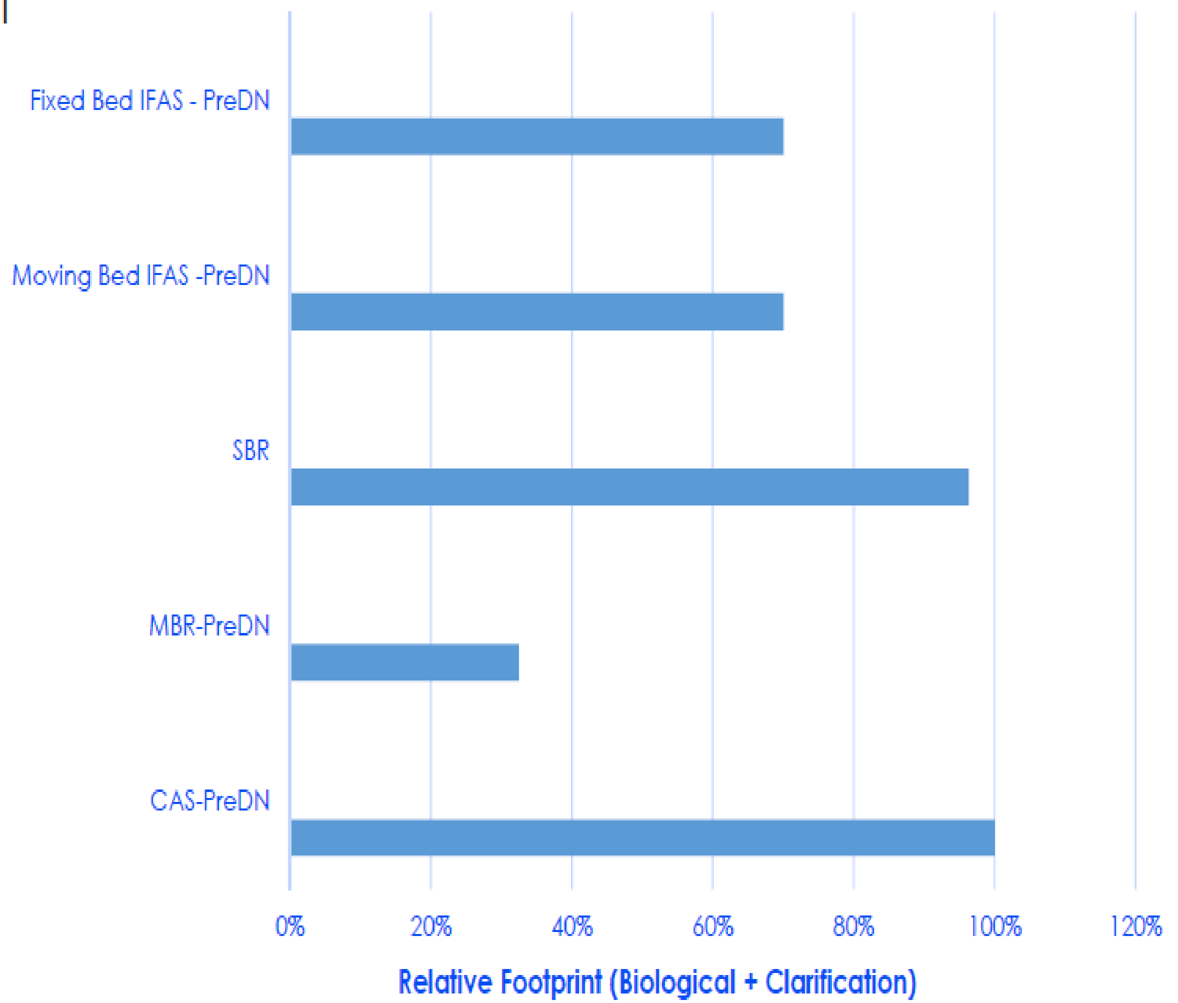
- Treatment process for Grey Water can be **Biological or Mechanical System**

  - **CAS – Pre-DN**
  - **Moving Bed – Pre-DN**
  - **SBR**
  - **MBR – Pre-DN**
  - **Fixed Bed – Pre-DN**

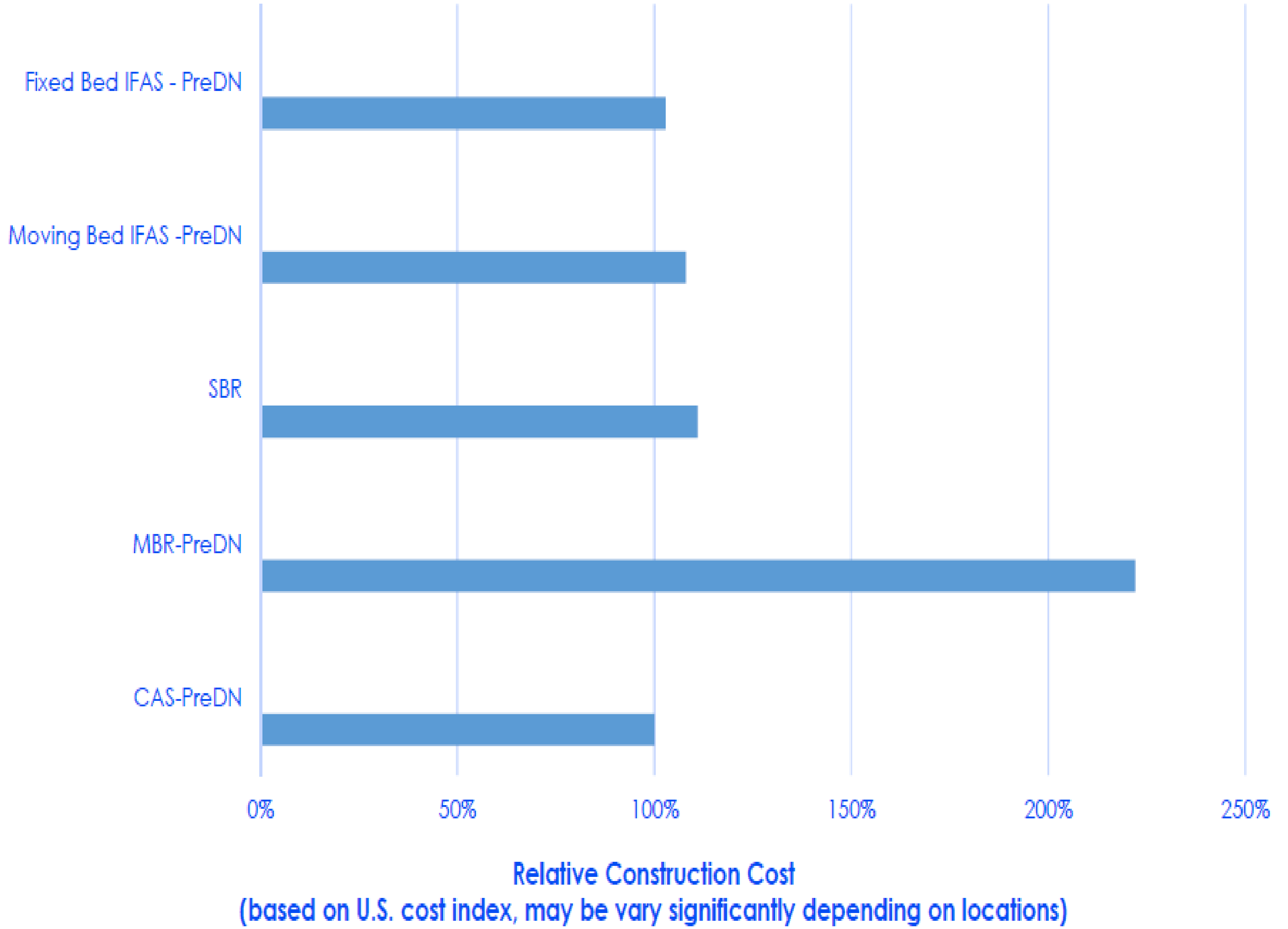
Technology Advantages and Limitations

Technologies	Advantages	Limitations
CAS-PreDN	• Adaptable to existing AS processes • Saves energy • Eff. TN <10 mg/L is achievable	• Eff. TN concentration • Largest footprint
MBR-PreDN	• Smallest footprint • Eff. TN<6 mg/L is achievable • High quality effluent due to low TSS	• High capital cost • Energy intensive • Unable to handle flow surge • Membrane fouling control required
SBR	• Flexible operation • Simple layout • Eff. TN<8 mg/L is achievable	• Suitable for small plants • Complex process design and operation • Redundant units required for reliability • Equalization tank may be required
Moving Bed IFAS - PreDN	• Smaller footprint • Shock load resistance • Easy to install • Eff. TN<10 mg/L is achievable	• Higher mixing energy required • Risk of biomass carrier escape from aeration tanks • Require complex hydraulic design • Difficult to maintain and operate
Fixed Bed IFAS - PreDN	• Smaller footprint • Easy to maintain and operate • Shock load resistance • Eff. TN<10 mg/L is achievable • Partial simultaneous nitrification and denitrification	• Newer technology

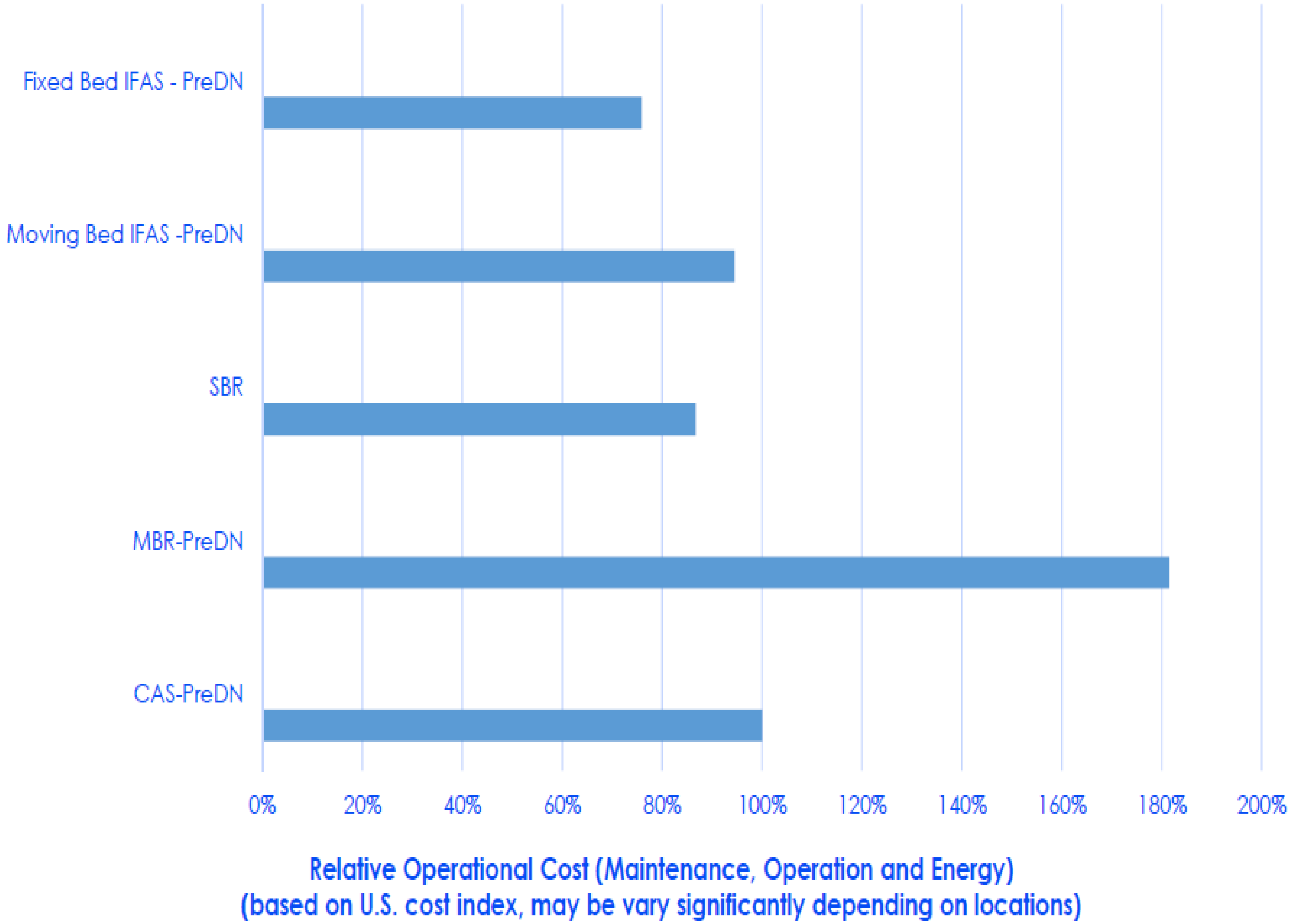
Footprint


Fixed Bed IFAS - PreDN
Moving Bed IFAS -PreDN
SBR
MBR-PreDN
CAS-PreDN
0%
20%
40%
60%
80%
100%
120%
Relative Footprint (Biological + Clarification)

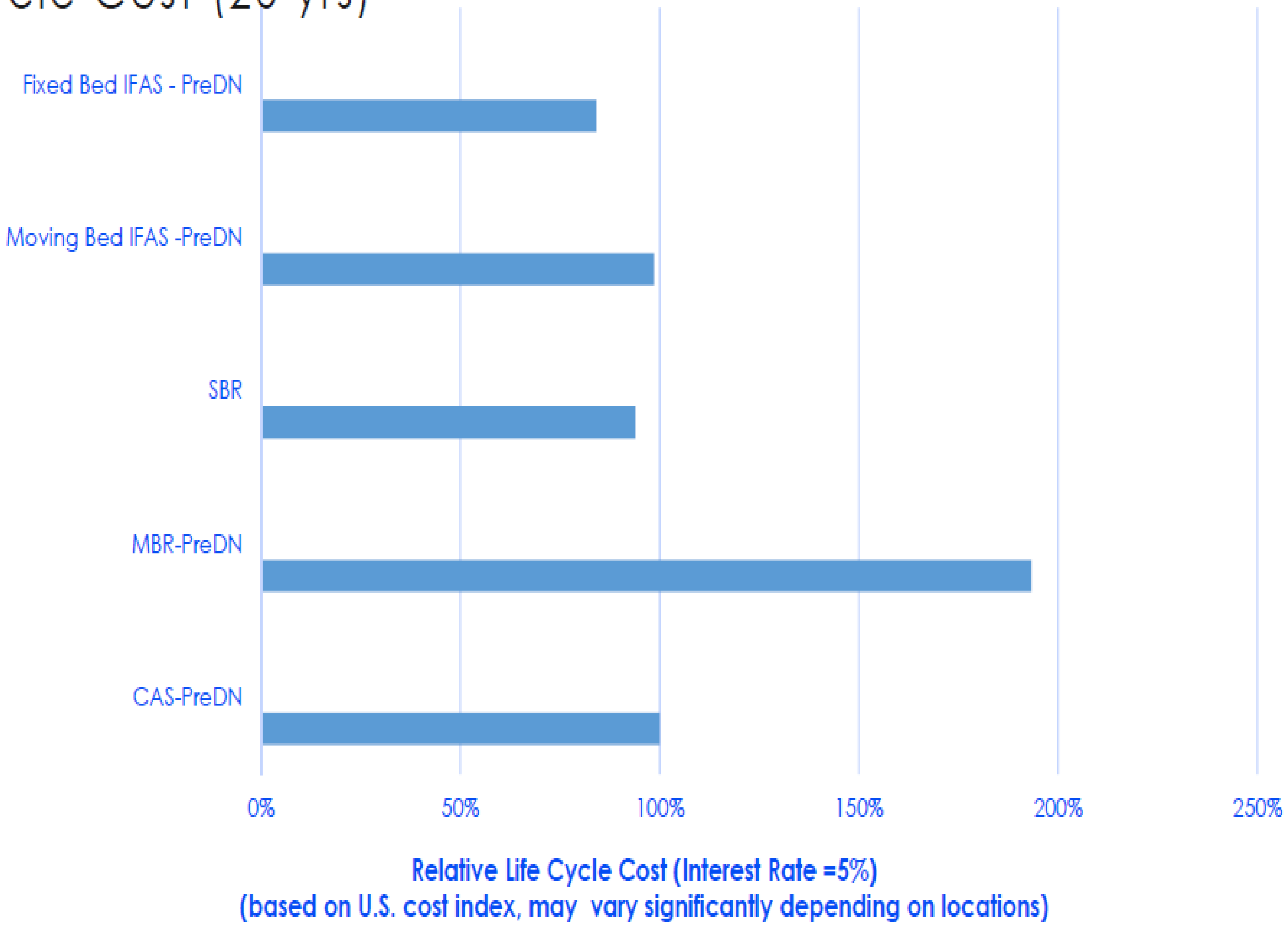
CAPEX


Fixed Bed IFAS - PreDN
Moving Bed IFAS -PreDN
SBR
MBR-PreDN
CAS-PreDN
0%
50%
100%
150%
200%
250%
Relative Construction Cost
(based on U.S. cost index, may be vary significantly depending on locations)

OPEX


Fixed Bed IFAS - PreDN
Moving Bed IFAS -PreDN
SBR
MBR-PreDN
CAS-PreDN
0%
20%
40%
60%
80%
100%
120%
140%
160%
180%
200%
Relative Operational Cost (Maintenance, Operation and Energy)
(based on U.S. cost index, may be vary significantly depending on locations)

Life Cycle Cost (20 yrs)



Implementation Considerations

- Site assessment and feasibility studies
- Regulatory requirements and permits
- Capital investment and operational costs
- Maintenance and monitoring considerations
- Integration with existing irrigation systems

Case Studies

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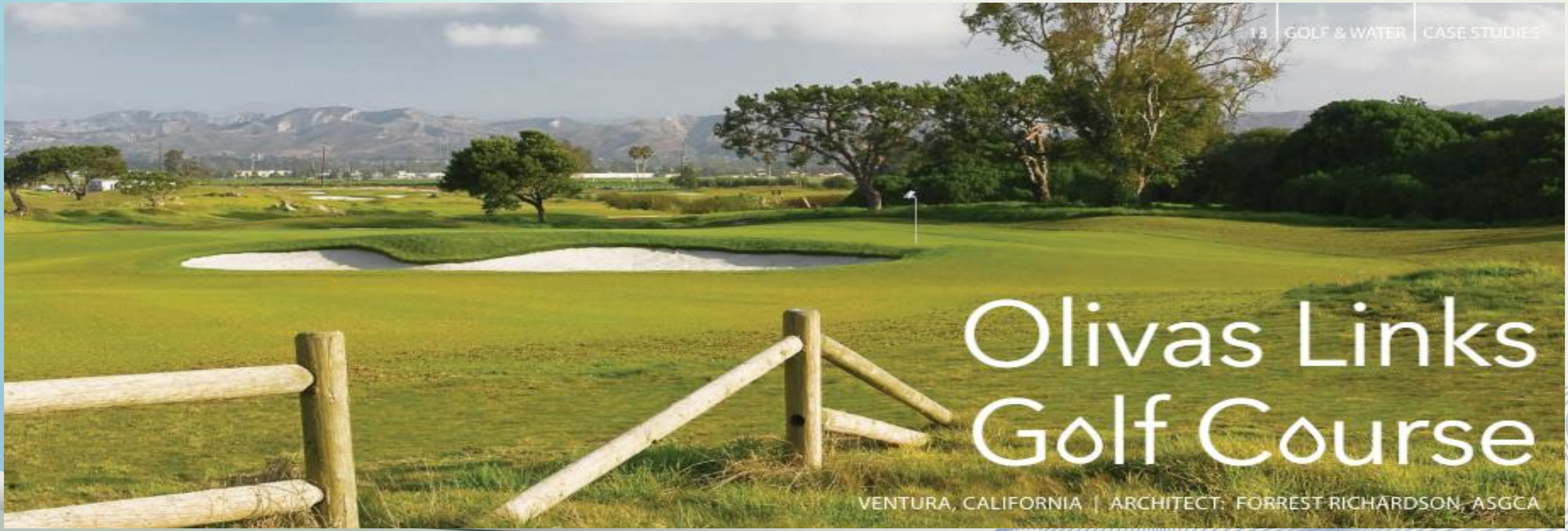

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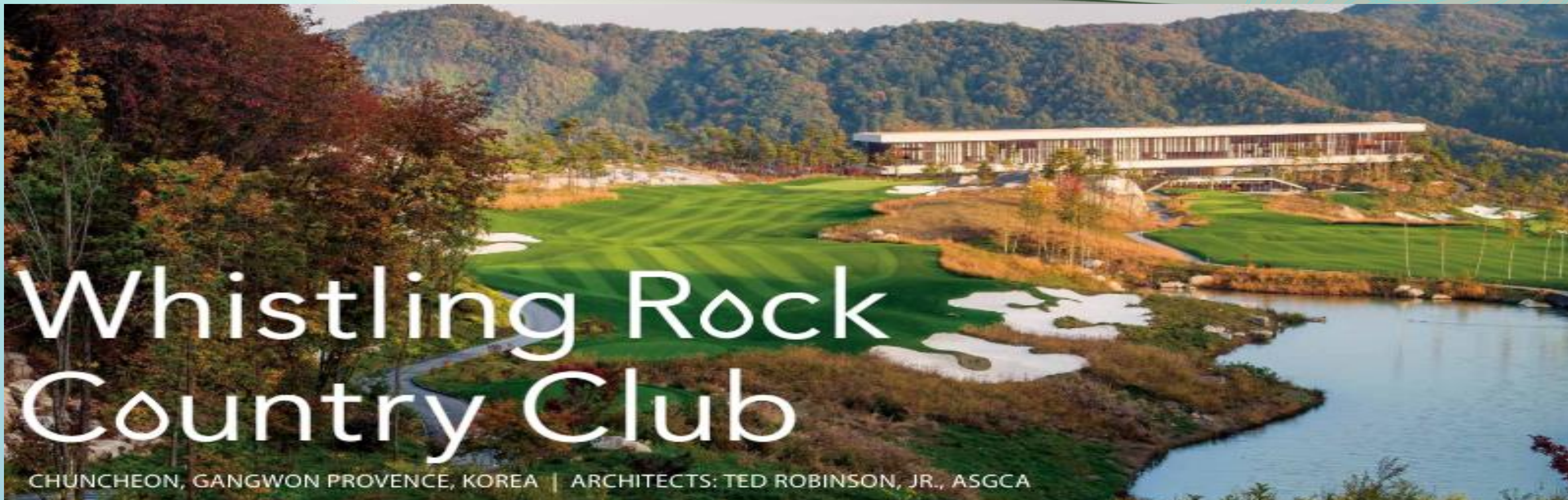

Best Practices

- Recommendations for golf course managers considering water reuse initiatives
- Importance of stakeholder engagement and education
- Strategies for optimizing water reuse systems for maximum efficiency

Future Trends

- Emerging technologies and innovations in water reuse for golf courses
- Potential for collaboration and knowledge-sharing within the industry
- Anticipated regulatory changes and their impact on water reuse practices

Conclusion

- importance and value of water reuse for sustainability in golf course management
- Encourage further adoption of water reuse strategies
- Call to action for industry stakeholders to prioritize environmental stewardship towards sustainability through water conservation efforts.

Q&A Session

THANK YOU!