# Product Introduction.

**Smart Eco-FBBR STP**

SMART ECO

# About Us

**ICC Smart Eco Solutions**, the newest division of the reputable general contractor, **International Construction Consortium (Pvt) Ltd** introduces a range of Sewage Treatment Plants using German and Chinese Technology to meet every need.

These units are modular in design and can cover a large range of populations to satisfy the needs of domestic, industrial, and municipal wastewater treatment needs.

As an example, the **Nature model** for domestic use, uses NO electricity or chemicals in the treatment process. It uses bacteria available in nature and is totally eco-friendly.
The effluent discharged meets all discharge standards of the world and this is certified by many independent testing houses in Europe.

Larger commercial modular units are currently operated by condominium developers and hoteliers in Sri Lanka. These units carry warranties of 15 years or more. There are many modular MBBR/FBBR units currently in use in Sri Lank
Our systems use the least amount of chemicals, electricity, floor space and labour in comparison to conventional systems.

Although over 70% of the world's surface is covered with water, only about 1% is available for human consumption. Water is precious and we need to safeguard every drop of it.
The wastewater treatment plants we market produce effluent that could be reused for gardening, toilet flushing, vehicle washing etc. saving many thousands of cubic meters of wasted water per day.

In addition to wastewater treatment we also reprocess organic waste to fertilizer using our "Quick composters" converting organic waste to compost in 24 hours.
We market machines for domestic use, processing 2kgs per cycle to tons per day for commercial use.

There is a machine to suit your every need, contact us for further information.

As human beings and dwellers of Mother Nature, we have forgotten that we hold a responsibility to protect our environment from harmful events.

Enacting green and eco-friendly living means taking active steps to minimize our carbon Footprint and reduce waste to ensure sustainability and better environmental conditions.

*Save our Nation from GARBAGE pollution, convert to Compost in 24 hours.*

## Vision

Respect and leverage the planets' organic cycle by catalyzing the recycling process of organic waste and free the future generations of having to live on a polluted earth.

## Mission

ICC Smart Eco division provides the best available technology to every household & organization at an affordable price, and in doing so, makes every citizen responsible for disposing their waste in a manner beneficial to mother earth.

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மத்திய சுற்றாடல் அதிகாரசபை
# Central Environmental Authorty

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"பரிசர பியச", 104, டென்சில் கொப்பேகடுவ மாவத்தை, பத்தரமுல்லை, இலங்கை.
"Parisara Piyasa", 104, Denzil Kobbekaduwa Mawatha, Battaramulla, Sri Lanka. Web: www.cea.lk


අපේ යොමුව / எமது தொடர்பு / Our Ref. 07/LM/Cons./16.1..../2020 ඔබේ යොමුව / உமது தொடர்பு / Your Ref.

දිනය / திகதி / Date 04.../07../2023

Mr..Prasanna...Alahakoon.,.....

Head...of..the..Department.,.....

International...Construction.Consortium.(Pvt)Ltd,

No.70,..S..De..S..Jayasinghe..Mawatha., Kohuwala,
Nugegoda.

Dear Sir/Madam,

**Central Environmental Authority Recognized List of Consultant/Specialists for Environmental Pollution Control for the year 2023/2024**

This is to inform you that your organization has been registered in the Central Environmental Authority (CEA) as a consultant /specialist for technical guidance on Water/~~Air~~/ ~~Noise~~/~~Vibration~~/ ~~Odor pollution contro~~l / ~~Geotechnical Investigations for l~~and ~~application of treated wastewater~~ for the year 2023/2024.

I appreciate your cooperation and willingness to work with the Central Environmental Authority in pollution control activities. In order to provide quality reasonable service to the industrial community, your work will be reviewed throughout the period.

Further you are informed to follow the attached guideline when preparing consultancy reports under your specialty area.

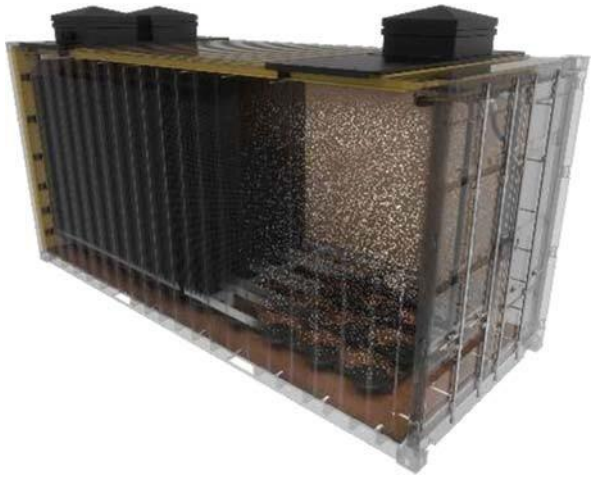
Yours faithfully,

**Dr. R.M. S. K. Ratnayake**
**Deputy Director General**
**Environment Protection Division**
**Central Environmental Authority**

# Introduction

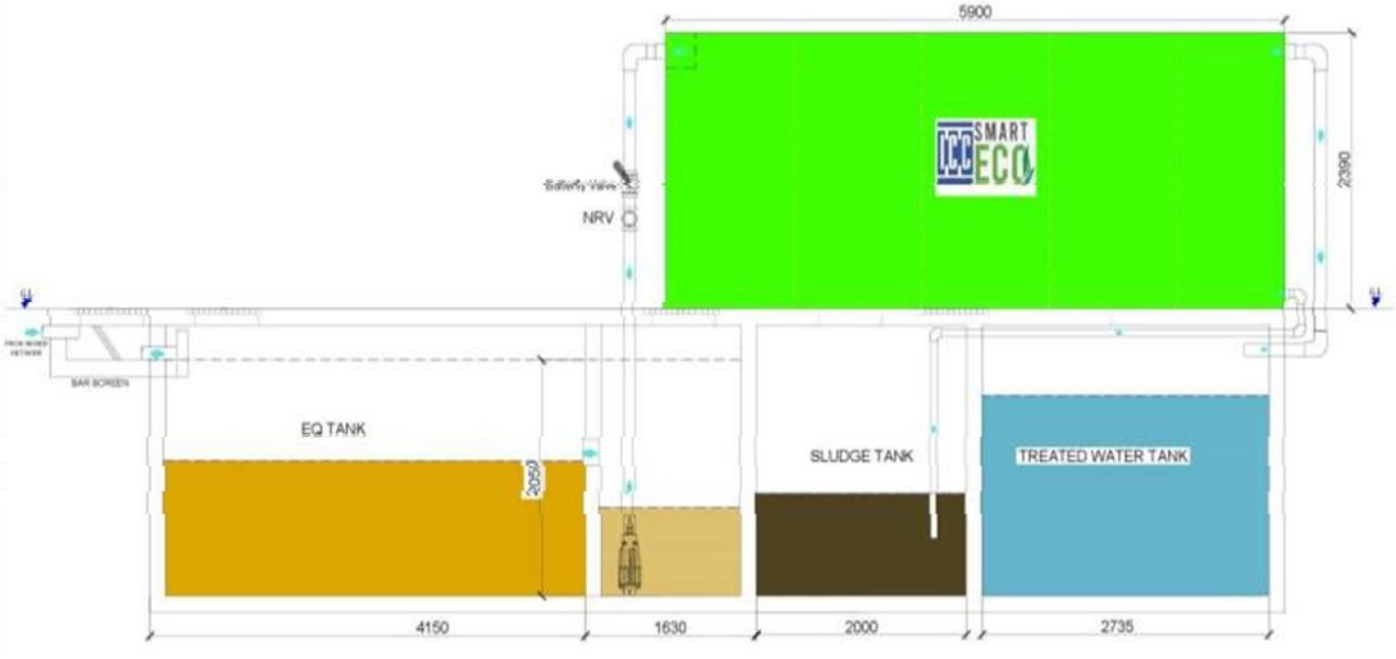
***ICC Smart Eco Solutions***, a division of reputed general contractor ***International Construction Consortium (Pvt) Ltd*****,** in collaboration with ***Aqua Equipment Technologies LLC of USA, (AET)*** design and fabricate **"EcoPac**" containerised modular **"Fixed Bed Bio Reactor"** (FBBR) sewage treatment systems in Sri Lanka. Incorporating state of the art technology, offering a low operational cost, compact modular system with an exceedingly small footprint to process wastewater. The units are designed to handle five different flow rates per day starting from 15m3 per day to 80m3 per day. These units could be coupled to achieve the desired flow rates.

The tanks are fabricated from high-quality MS steel, sand blasted, and FRP coated to withstand the rigours of wastewater. The design is like a sea container in size and looks. This makes installation remarkably simple as all equipment is pre-installed and needs minimal plumbing at site making it a plug play system. All components are imported from Germany as per specifications dictated by AET and carry a full year's warranty from date of commissioning.



The Modular tank is kept above ground, preferably above or close to the underground wastewater collection tank. The wastewater is pumped into the treatment tank with aerated fixed bed bio reactors where all the processing takes place continuously over 24 hours, emitting no foul smells. The system is totally biological meaning it does not use any additional chemicals for processing, hence totally GREEN. The treated water will meet CEA standards for discharge to waterways or could be collected in a sump tank for later use for agriculture, toilet flushing, fishponds etc. A disinfection unit and a tertiary filter will further enhance the quality of treated water for further reuse if needed.

## ELEVATION/SECTION




## Effluent Standards.

# BOD reduction to <30mg/l

# TSS reduction to < 15mg/l

# Sludge collection up to 6 month

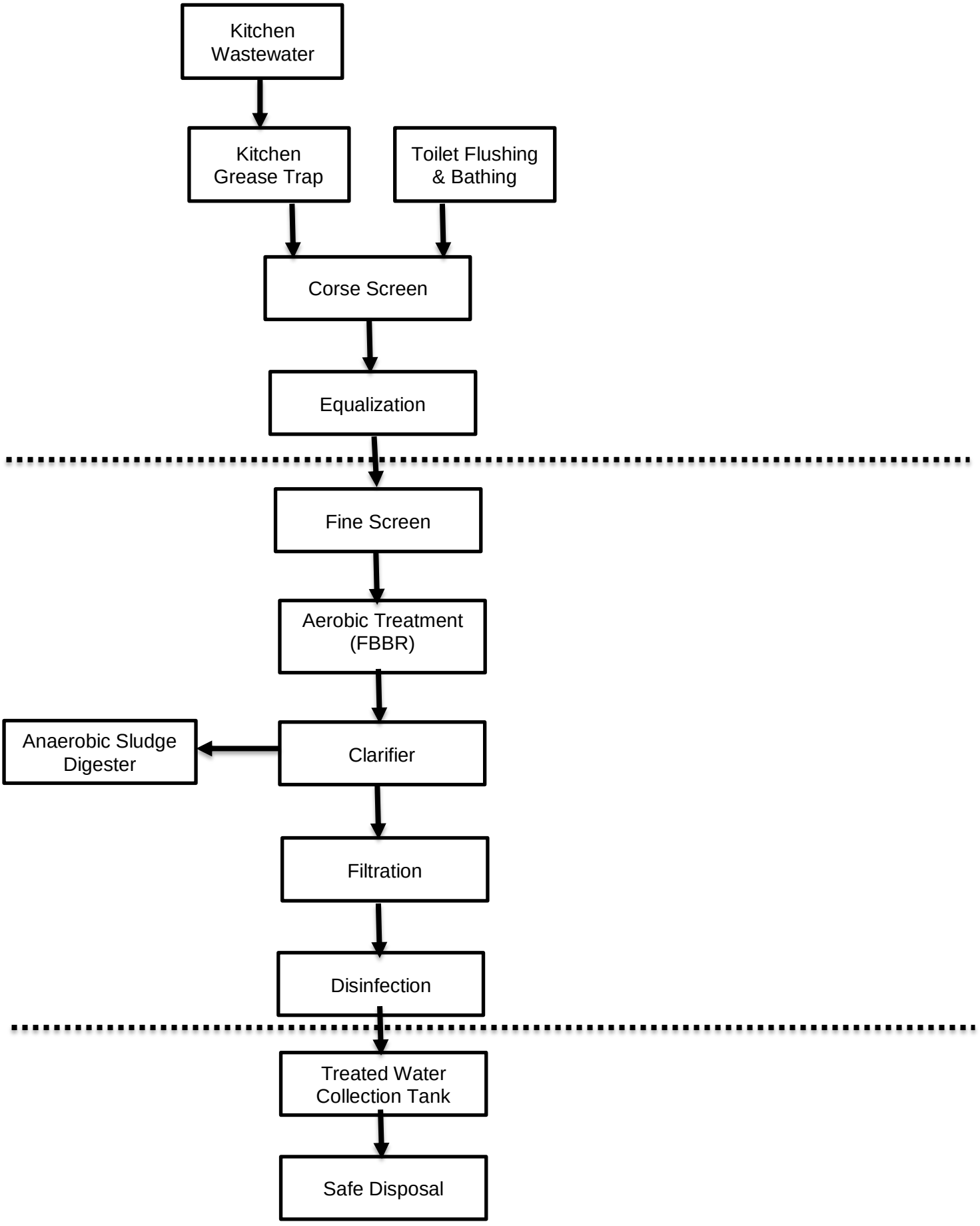
## ECO Pac Modules

| m3/d | 15 | | 30 | | 45 | | 60 | | 80 |
|---|---|---|---|---|---|---|---|---|---|
| PE | 100 | | 200 | | 300 | | 400 | | 533 |

Eco Pac modules are designed at 350mg/l BOD and 150Lts per person per day.

These modules could be brought together to meet the needs of the customers.

## PROCESS FLOW DIAGRAM



# Attached Growth System

Wastewater treatment systems using biofilms that grow attached to a support media can be either an alternative or an improvement to the widely used suspended growth activated sludge process. When the system is operated with a single pass and without return sludge it is called FBBR (Fixed bed Biofilm reactor) or MBBR (Moving bed bio reactor). Especially for industrial pre-treatment FBBRs are a good and advantageous alternative to activated sludge processes. If the system is operated with return sludge it is called IFAS (Integrated Fixed- Film activated sludge).

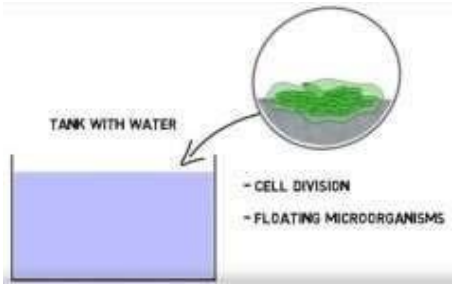


Fill media for water and wastewater applications is used as a carrier medium for Bio-film growth. The fill media blocks consist of corrugated foils which can be manufactured in various forms. These various forms result in different surface areas and channel designs. Additionally, fill media blocks can be manufactured from either Polypropylene (PP) or Polyvinyl Chloride (PVC). Moreover, our customers benefit from a customized fill media solution for their individual project case.

Fixed-bed biofilm reactors use fill media with a vertical flow channel shape. The vertical channel shape facilitates an easy sludge discharge for high organic loadings. This is due to increased biomass growth in FBBR applications. Depending on our customer needs, we design the appropriate fill media which provides the maximum allowable surface area. This also ensures an even distribution of liquid and air for the best treatment results.

Biological processes in wastewater treatment can be classified into two main categories: suspended growth and attached growth/ biofilm processes. In suspended growth processes the microorganisms responsible for wastewater treatment are maintained in liquid suspension by appropriate mixing and aeration…

# Beneficial Biofilm Bacteria in wastewater treatment




Most people relate Biofilm bacteria as something nasty and harmful. This is understandable as we normally come across Biofilm bacteria attached to shower heads, pipes, kitchen sinks or chillers at home or public places. Here Biofilm bacteria can cause corrosion, fouling or even lead to legionella growth. In the last few years public media discovered a high public interest for the dangers of biofilm bacteria as the following headlines show.

However, for treatment of wastewater Biofilm bacteria is greatly beneficial and essential. Water contains free floating microorganisms. When the microorganisms attach to a surface the biofilm growth is initiated. Van der Waals forces and hydrophobic characteristics of the bacteria or the media surface can improve the attachment process. After colonization has started the Biofilm bacteria grow through cell division and other free-floating microorganisms that anchor to the first bacteria colonists.

Wastewater treatment plants use biofilm bacteria to remove BOD and Nitrogen. BOD describes the total amount of dissolved oxygen needed to convert organic waste. Bacteria will decompose the organic waste to solids which can be settled down as sludge. Whereas bacteria for BOD removal are easy to cultivate bacteria for nitrogen removal are more difficult and need certain conditions. Conditions for Nitrifying biofilm bacteria are for example high amounts of dissolved oxygen and nitrogen, a pH value between 7 and 8 as well as a water temperature between 5 and 40 degree Celsius. Nitrifying bacteria have a long lifetime and double only every 20 hours under good conditions. (As a comparison most bacteria double every 30 minutes) Therefore it takes about 4 weeks until a stable nitrifying biofilm is formed and attached to a surface. As more surface for attached biofilm growth is available as more BOD and nitrogen in wastewater can be treated. To significantly increase surface area different types of plastic fill media either fixed or free floating are used in wastewater treatment plants. Plastic fill media as provided by AET consists of corrugated foils that are bonded together.

Depending on the application plastic fill media can provide up to 200m2 surface area per one m3 of tank volume

Organic nitrogen converts into gaseous ammonia (NH3) in wastewater. At a Ph value between 7 and 8 – as usual for municipal wastewater – almost all gaseous ammonia will be found in the ionic form ammonium (NH4+). In the nitrification process nitrifying bacteria facilitate the oxidation of ammonium (NH4+) first to nitrite (NO2) followed by the oxidation of nitrite to nitrate (NO3).

Nitrate is still toxic and contained in the wastewater. Therefore, another step must be taken to convert ammonium into a harmless substrate. Heterotrophic bacteria will denitrify Nitrate (NO3) into Nitrogen Gas (N2). (Click here for more information on Denitrification)

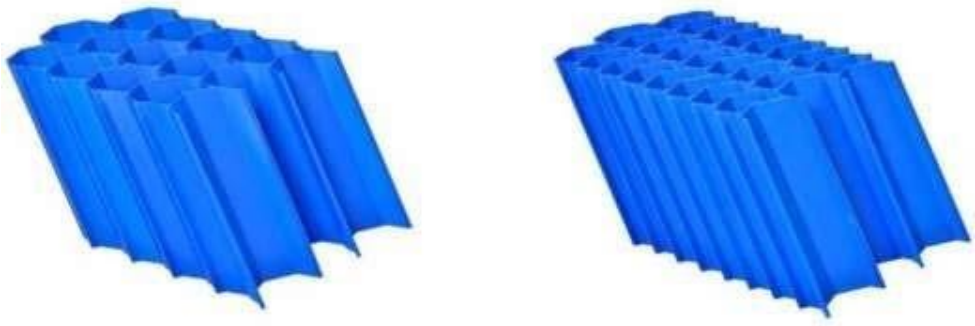
# Tube Settlers

In conventional clarifiers particles with a higher gravity than wastewater will settle down to the tank bottom over time. The closer the gravity of the particles is to the one-off waste water as longer takes the settlement process and as larger the clarifiers have to be build. Lamella clarifiers are a very cost-effective alternative to conventional clarifiers as they reduce the needed tank volume by 2 to 4 times. Lamella clarifiers consist of multiple channels that function as additional surface area to reduce the settling path of the particles in the wastewater. AET provides consulting and lamella clarifier systems consisting of lamella clarifier plate settlers, support- and anti-floating structure, sludge removal and effluent launders.

Equidistant, high- stability PP tube settlers

Tube settlers are used for a wide range of applications with different requirements. Therefore, AET offers different tube settler types varying in channel size, surface area, material, material thickness, dimensions, and other specs. Additionally, we offer support structures, baffle walls, effluent launders, and other tube settler components to provide a fully integrated tube settler system from a single source supplier. AET tube settlers provide the following customer benefits:

- Equidistant channels provide maximum surface area
- Polypropylene material extends product lifetime
- Higher material thickness provides high product stability (walkable design)
- Tongue and groove system allow easy onsite assembly
- Large channel opening size reduces the risk of clogging




Tube settlers/ lamella clarifiers/ plate settlers consist of a series of inclined plates or channels that provide a large effective surface area with a small footprint. As a result, basins with lamella plate separators are significantly smaller than conventional clarifier tanks. The additional surface area shortens the particle settling path along with its sedimentation time. Additionally, a plate inclination between 55° and 60° creates a balanced counterflow of sludge and water. In the end, this enhances the settling process.

One important factor for the selection of the right type of tube settler are structural loading requirements. Accumulated sludge in the tube settler channels can add up to loads of 20 lbs./ft3 or more so that collapse is a possibility. To avoid collapsing media, AET supplies reinforced tube settlers with a superior product stability. During manufacturing, single channel profiles are assembled to a media block through a tongue and groove system and heat welding. The resulting assembled blocks have high out-of-plane compression and shear properties comparable to a honeycomb structure. Therefore, AET tube settlers (in combination with the right support structure) are walkable for maintenance and cleaning purposes.

# Diffused Air Aeration

Aerobic micro-organisms in the Activated sludge process require air for the digestion of organic matter. Depending on the application specifics either fine bubble or coarse bubble diffusers are used to discharge the required air below the water surface. Next to conventional activated sludge plants aeration diffusers are also used in SBR (sequencing batch reactor), CSR (Continuously sequencing reactors) and BNR (Biological nutrient removal) systems.

The retrievable strip diffuser rack systems provide a multi-level system redundancy and a fast and easy
way to maintain diffusers without basin dewatering. The diffuser racks can be designed for any tank geometry (rectangular, round, toroidal) and mounted to basin walls as well as bridges or catwalks. Better oxygen transfer of fine bubble strip diffusers and DO load dependent air supply decrease overall power costs by up to 25%.

Table below shows the pros and cons of all three systems:

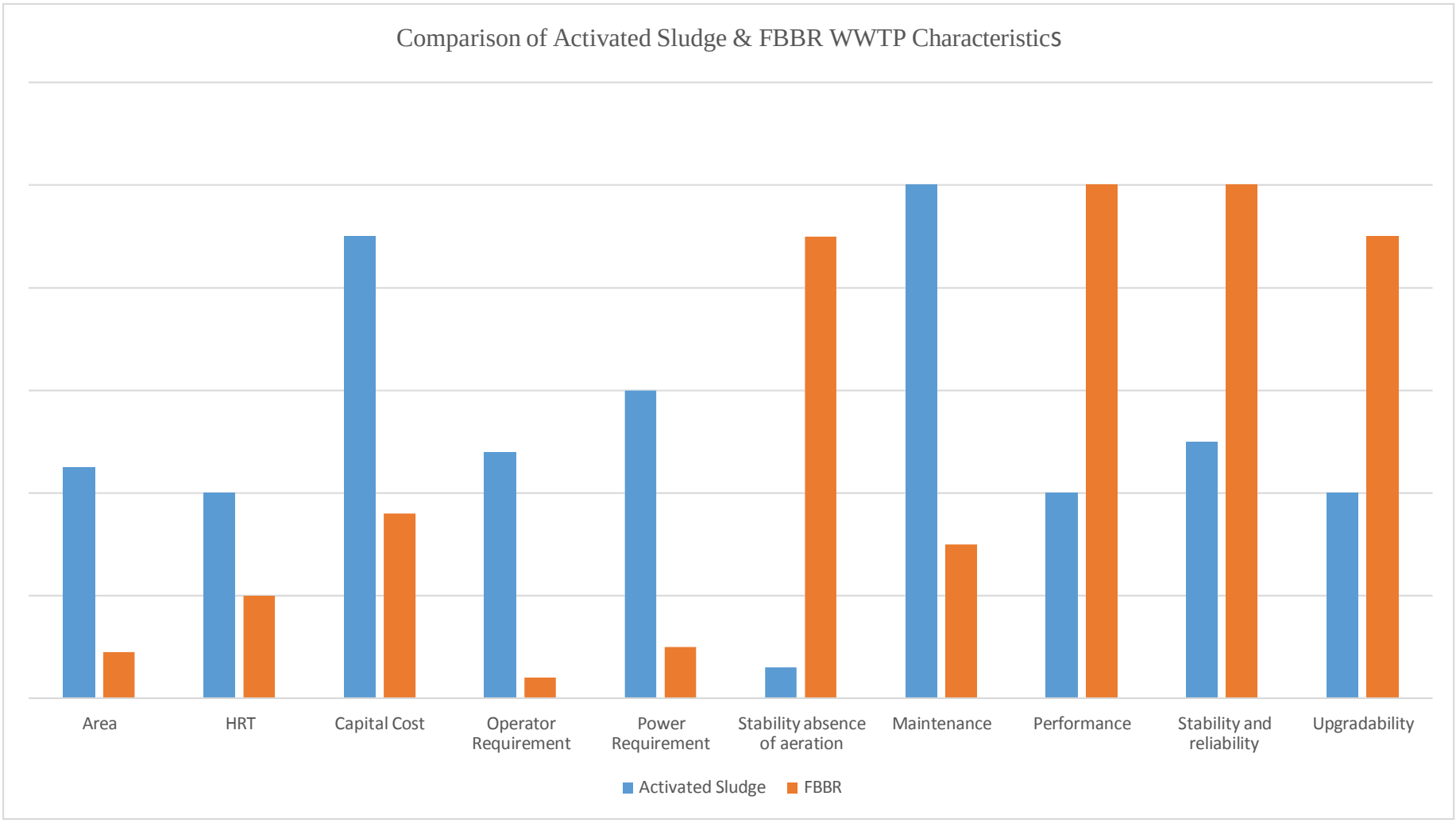
| | **MBR** | **MBBR** | **FBBR** |
|---|---|---|---|
| Effluent water quality | Superior | Acceptable for irrigation | Acceptable for irrigation |
| Sensitivity to shifting of complex or toxic substances | Good | Medium | Medium |
| Overall costs | High | Medium | Low |
| Energy consumption | High | Medium | Low |
| Handling of an electrical shutdown | Up to 24 hours without problems | Up to 10 hours, Afterwards bacteria will from bio-cakes* | Good handling |
| Susceptibility to a grease leak | Very sensitive. Membrane needs to be cleaned well/ replaced | Very Sensitive* | Leaked oil with float upwards and is easy to remove. |
| Required Space | Low | High | High |

*Material has to be changed, the plant will need a ten-day restarting –time
(green=advantage, white= normal, red = disadvantage

# Comparison of Activated Sludge & FBBR Waste Water Treatment Systems

| # | Description | Activated Sludge | FBBR (Fixed Bed Biofilm Reactor) |
|---|---|---|---|
| 1. | Area Requirement | 225 $m^2$ | 45 $m^2$ |
| 2. | Hydraulic Retention Time (HRT) | 18-20 Hrs | 8-10 Hrs |
| 3. | Capital Cost | • Very High due to several tanks, equipment , piping etc. | • Low due to minimal tankage, equipment and piping. |
| 4. | Operator Requirement | • Estimated to require 1 skilled operator / shift up to 24 hrs / day coverage - to control & operate the plant, MLSS, SV & SVI tests will need to be performed each shift. | • 1 Semi Skilled operator for 2 Hrs for Day.<br>• No testing Required |
| 5. | Power Requirement | • Very High due to roots type blowers, RAS & WAS line pumps etc.<br>• 24 Hrs Aeration Required and microbial colonies begins to destroy after 2-3 hours without aeration. | • Low due to high efficient Side Channel Blowers & Minimal equipment.<br>• 20 Hrs Aeration required and can sustain without aeration for 4-5 Days. |
| 6. | Maintenance | • Extensive maintenance required for mechanical equipment, piping etc. | • Very low maintenance due to minimal of moving parts. |
| 7. | Technology | • Traditional extended aeration plant requires large area, high energy consumption but, more significantly, difficult to control. Susceptible to changes in flows and loads, sludge bulking and<br>• MLSS wash-out. | • State of the art package plant comprising intense aerobic biological treatment for BOD removal & nitrification, de-nitrification, anaerobic sludge storage and reduction and complete sterilization.<br>• Robust & Very stable to flow and load variations |

| | | | |
|---|---|---|---|
| 8. | Performance | • Performance of the system depends on,<br>- Daily testing of the Aeration tank(s) MLSS &SV will be required with adjustments made to RAS (Return Activated Sludge) and WAS (Waste Activated Sludge) according to those results. | • The Smart Eco FBBR design provides for a very high level of BOD removal, Nitrification can also achieved. Whereas the proposed FBBR STP will not only meet and exceed the current standards but also will achieve anticipated future standards.<br>• As standard, the FBBR units also provide for denitrification for Nitrogen removal. With the optional addition of ferric dosing. Phosphorous removal can also be achieved. |
| 9. | Stability & Reliability | • If operated well and consistently, it should perform to design, provided that the influent does not vary markedly or exceed design parameters and that toxic shock events are not experienced. Sludge bulking and MLSS wash-out leading to failure is always a concern. Mechanical issues with Roots type blowers, similarly are a concern. | • Very robust due to a massive and diverse bacterial population accommodated within the protected spaces inside the fixed bed bio media.<br>• Bacterial populations are self-regulated according to food supply (BOD, NH3) and are always in excess to requirements.<br>• In the event of a toxic occurrence, the bacteria on the outside of a biomass section may die but, in so doing, adsorb some of the toxin thereby diluting it. Consequently, inner sections of the biomass receive non- lethal concentrations of the toxin and rapidly develop resistance to it. |
| 10 | Upgradability | • Difficult, essentially a whole additional plant would need to be built | • Easily Upgradable to higher capacities |
| 11. | Additional Equipment | • Pressure sand filter, activated carbon & in-line hypochlorite dosing for sterilization. Chlorine damage to vegetation is a possibility if effluents used for irrigation | • As standard FBBR STP has a Saran mesh filter on top of the final Plate Settler (clarifier) to maintain TSS below 15 mg/l, each FBBR unit also has a chlorine disinfection unit and<br>• Chlorine contact tank to achieve complete sterilization as well as the volatilization of excess chlorine. |


Comparison of Activated Sludge & FBBR WWTP Characteristics
Area
HRT
Capital Cost
Operator Requirement
Power Requirement
Stability absence of aeration
Maintenance
Performance
Stability and reliability
Upgradability
Activated Sludge
FBBR

# Fixed bed biofilm reactor system (FBBR)

## AET turnkey solutions for BOD and ammonia removal

Retrievable FBBR system unit

Component 1: Fill media

Component 2: Aeration diffusers

FBBRs (fixed bed biofilm reactors) are used in various wastewater treatment applications for BOD and ammonia removal. The product consists of two main components: Plastic fill media and aeration diffusers. Biofilm microorganisms settle down on the fill media surface and digest organic waste in water (BOD) under consumption of oxygen. After all BOD is removed the microorganisms facilitate the oxidization of ammonium NH4+ to NO3- (Nitrate).

AET supplies various types of fill media and aeration diffusers differing in materials, surface area and dimensions to meet our customers individual demands.

The FBBR system consists of individual, retrievable cage units to allow easy installation, maintenance, andupgrades. Ifneeded, AET canalso supply complementary airdistribution piping, FRP tankage, blowers, monitoring equipment and more.

Design examples:

Single FBBR cage unit

FRP tankage incl. FBBR for smaller flows

System advantages:

- Fine bubble strip diffusers for efficient oxygen supply of attached Biofilm growth
- Turndown rate of 16:1 and better SOTE% compared to disc or tube aeration reduces energy costs
- VFDs for automated blower operation and biofilm scouring possible
- Retrievable system andindividual ball valves per FBBRunitensure easy maintenance
- Modular cage construction allows easy FBBR expansion if needed
- Polypropylene fill media ensures long life span of media and reduces brittleness and chipping compared to PVC fill media
- Vertical flow design fill media provides maximum surface area of 38sft/cft but reduces risk of clogging

Applications:

In comparison to activated sludge, FBBRs are less sensitive for volatile flows, interrupted aeration or grease leaks which makes them a good fit for industrial applications such as:

- Food and beverages
- Meat processing
- Dairy
- Lagoon bypasses
- Chemicals
- Leachate
- Pharmaceutics
- Energy
- Pulp and Paper

Furthermore, FBBRs are an easy andeffective upgrade for existing activated sludge basins. By adding the FBBR units into an activated sludge basin additional biomass will grow on the media surface increasing the total sludge volume by up to 50%. The combination of activated sludge and FBBRs is also known as IFAS (integrated fixed film activated sludge).

# HEWi$^{Tube}$ Lamella Clarifier Series

## Boosting the sedimentation efficiency


The application of inclined settling planes to increase the sedimentation performance is an unchallenged technology; it's applied in numerous plants worldwide covering hundreds of applications.

**HEWi$^{Tube}$** modules equalize the flow and facilitates the phase separation of particles, flocs or sludge.

Depending on the task, we provide designs with different angles, lamella spacings and chevron types for a controlled pathway of down-sliding sludge.

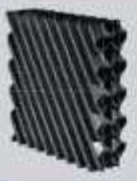
**HEWi$^{Tube}$** modules are customized to fit into round or rectangular tanks. The modules are made of rigid Polypropylene and can be placed directly into the tank sitting on a supporting structure.

AET also provides additional customized package components such as support structure and **HEWi$^{Tube}$** effluent launders for the best benefit of our customers. For remote projects we offer a local self-assembly option in order to reduce logistics and labour cost.

**Features:**

- **High settling efficiency**
- **Proven technology**
- **Made of rigid PP**
- **Up to 70°C temperature resistant**
- **Self-supporting structure**
- **Blue colour for potable water application**
- **High mechanical strength**
- **Easy installation of modules**
- **Circular or rectangular tanks**
- **Onsite Self-assembly option**
- **Optional components**
- **Proven technology**

## HEWi[Tube] Lamella series

| Water and waste water application | | | | |
|---|---|---|---|---|
| |  |  |  |  |
| **model** | **LS50** | **LS84** | **LS60** | **LS38** |
| **Typical Application** | Potable water<br>Rainwater treatment<br>Process water<br>Humus tanks | Primary sedimentation<br>Activated sludge<br>Combined sewer overflow | Effluent Polishing<br>Potable water<br>Humus tanks | Effluent Polishing<br>Aquaculture<br>Rainwater treatment |
| **made** | Polypropylene | Polypropylene | Polypropylene | Polypropylene/PVC |
| **Angle** | 45°-90° STD 55°/60° | 45°-90° STD 55°/60° | 60° | 60° |
| **Channel** | Equidistant chevron | Equidistant chevron | Trapezoidal flutes | Trapezoidal flutes |
| **Specific surface*** | ~13 m2/m3 (55°)<br>~11 m2/m3 (60°) | ~7 m2/m3 (55°)<br>~6.3 m2/m3 (60°) | 11.5 m2/m3<br>(average) | 15 m2/m3<br>(average) |
| **Hydraulic radius** | 17mm | 25mm | 12mm | 17mm |
| **Certification** | KTW / NSF | KTW / NSF | | |
| **Color(s)** | Black<br>Blue (KTW/NSF) | Black<br>Blue (KTW/NSF) | Black | Black |
| **Std dimension** | | | | |
| **Length (mm)** | 300 - 1500 | 300 - 1500 | 800 - 2400 | 800 - 2400 |
| **Width (mm)** | 300 - 1500 | 300 - 1500 | 300 - 600 | 300 - 600 |
| **Height (mm)** | 500 - 2000 | 500 - 2000 | 900 | 600 |

*) vertical projected surface = effective settling surface

## Design Guideline for HEWi[Tube] Lamella settlers

Most engineers are using Hazen's law as design approach for the settling efficieny.

Hazen's law links the settling velocity [$V_S$] of the target particle with the flow rate [Q] and the installed vertical projected surface [$A_P$].

The Hazen-velocity ( $V_H = Q/A_P$ ) is the most important design parameter.

Particles with a settling velocity that is equal or faster than the Hazen-velocity will be removed.

| Typical Design Hazen Velocity | | |
|---|---|---|
| **Feed water** | **Hazen** | **Product HEWi[Tube]** |
| **Potable water** | 0,6 – 0,9 m/h | LS50 / LS60 |
| **Primary settling** | 0,9 – 1,2 m/h | LS85 |
| **MBBR effluent** | 0,4 – 0,5 m/h | LS50 |
| **Trickling filter effluent** | 0,5 – 0,8 m/h | LS50 |
| **Polishing** | 0,6 – 0,8 m/h | LS50 / LS60 |
| **Aqua culture** | 0,4 – 0,8 m/h | LS50 / LS38 |

FACTSHEET

# 5 Reasons Why Wastewater Treatment Plants Convert from Chlorine to UV

Municipal Wastewater

Throughout the past few decades, growing awareness of the long-term public safety and environmental costs of chlorine wastewater disinfection has led to the adoption of inherently safer alternatives, such as UV. In fact, the first UV wastewater disinfection system in the U.S. was installed back in 1982 and now roughly 50% of the wastewater in North America is treated with UV. This includes new plants as well as existing ones that have converted from chlorine.

UV is the most effective, safe and environmentally friendly way to disinfect wastewater. Unlike chemical approaches to water disinfection, UV light provides rapid, effective inactivation of microorganisms through a physical process. When bacteria, viruses and protozoa are exposed to germicidal wavelengths of UV light, they are rendered incapable of reproducing and infecting. The process adds nothing to the water but UV light, and therefore, has no impact on the chemical composition or dissolved oxygen content of the water.

There are many reasons why plants make the switch from chlorine to UV – here are five of them.

## 1. *Footprint/Contact Time*

With chlorine disinfection systems, sizable contact chambers are required to allow sufficient contact time – typically about 30 minutes – for the chlorine to attack bacteria and other pathogenic microorganisms in the wastewater.

However, since the retention time for UV is measured in mere seconds or fractions of a second, a typical wastewater treatment plant actually reclaims additional space after converting from chlorine to UV.

Recent innovations in UV have led to much more modular and compact systems. The TrojanUVSigna™, for example, is designed to fit into an existing chlorine contact tank, often without any major modifications to the channel depth or width.

This TrojanUVSigna installation can treat 20 MGD (875 l/s) in only 250 $ft^2$ (23 $m^2$).

Stringent tolerances on concrete channel walls are not required, making chlorine contact tank and UV channel retrofits simple and cost-effective. Retrofits can accommodate existing water level profile and head loss.

## 2. *Costs*

Municipalities and wastewater treatment plants often hire engineering firms to conduct a comparative analysis of disinfection alternatives.

If a new treatment plant is being constructed, the analysis is relatively quick and straightforward. Many new wastewater treatment plants in North America install UV disinfection systems because the safety and cost benefits are so compelling.

For existing treatment plants, there is more variability in costs since there is already treatment equipment in place. The cost to expand or upgrade the equipment to meet current regulatory requirements is what must be calculated.

- Capital Expense: This includes the physical installation of equipment, or in the case of an existing facility, the upgrade/ expansion of the current processes. The initial capital expense of the disinfection alternatives is relatively straightforward to quantify. Capital expenditures are required for contract management, design engineering, land and equipment purchase, and construction and installation. The required capital expenditure will vary based on the size of the facility and scope of the upgrade. Cost estimates are prepared following an engineering evaluation to allow direct comparison between disinfection options.

- Operating Expense: The annual operating expenses can be more challenging to estimate since there are many contributing factors, variable components and some hidden costs. Costs to operate a chlorine disinfection system can be grouped into several categories, including chemical supply, labor, training and certification, emergency response planning and administration. For UV disinfection, the bulk of operating costs are attributed to electricity and replacement lamps.

## At-a-glance Cost Comparison

| Ongoing Expense | Chlorine Gas | Sodium Hypochlorite | UV Disinfection |
|---|---|---|---|
| Disinfection/ Dechlorination Chemical Supply | **$$$**<br>Purchase and delivery of chlorine gas cylinders. | **$$$$$$**<br>Purchase and delivery or on-site generation of hypochlorite. | **None**<br>No chemical supply is required. |
| Electricity | **$**<br>Relatively low power requirements for chlorine gas disinfection. | **$**<br>Power is required for operating chemical feed pumps and aeration equipment (if applicable). | **$$$$**<br>Electricity is required to power the UV lamps. |
| Replacement Parts | **$**<br>Replacement parts are minimal with chemical disinfection systems. | **$**<br>Replacement parts are minimal with chemical disinfection systems. | **$$$**<br>Replacement parts associated with UV disinfection systems consist primarily of UV lamps. |
| Operator Labor | **$$$$$$**<br>Labor required for changing chlorine cylinders, maintaining lead detection and emergency equipment, maintaining on-site chemical distribution and storage equipment. | **$$$**<br>Labor required to maintain pumps, generators, storage tanks, water conditioning equipment, de-scaling equipment, on-site chemical distribution piping. | **$**<br>Labor includes replacing UV lamps periodically and ensuring that quartz sleeves that house the UV lamps are kept clean. |
| Leak Response Requirements | **$$$$$$**<br>Costs for responding to and repairing leaks are very high. | **$$$**<br>Since hypochlorite is less toxic than chlorine gas, costs in this area are reduced. However, there are costs associated with containment and leak protection of the hazardous chemical. | **None**<br>UV lamps contain a very small amount of mercury. Leak response and emergency preparedness plans are not required, however, local guidelines must be adhered to. Trojan offers a complimentary recycling program in which used lamps are picked up and shipped to an approved recycling facility. |
| Administration for Ensuring Regulatory Compliance | **$$$$$$**<br>Time-intensive administration for compliance with regulated risk management plans, emergency response plans and community right-to-know programs. | **$$$**<br>Although sodium hypochlorite is exempt from "hazardous" designation, it is unstable and corrosive. As such, procedures must be in place to ensure proper transportation, handling, storage and spill protection. | **$**<br>Administration costs for UV are low. No special safety programs or risk mitigation plans are required. |
| Training | **$$$$$$**<br>Employees must be trained on process safety management, risk management plans, and evacuation procedures in addition to routine operation of the system. | **$$$**<br>Training programs must be in place to ensure chemicals are properly transported, stored and handled. | **$**<br>UV equipment is simple and straight-forward to operate. No special training or certification is required for operators. |

## 3. *Safety*

Chlorine gas is typically delivered to wastewater treatment plants in large cylinders mounted on trucks or trains. It is a highly toxic chemical that must be transported and handled with extreme caution. Training programs, certifications and emergency preparedness must be in place and routinely practiced, and a seemingly minor incident or lapse of attention can have significant safety implications and costs. Even a small leak can result in thousands or millions of dollars spent on evacuations, system upgrades, inquiries and insurance claims.

Sodium hypochlorite is a diluted liquid form of chlorine. It is corrosive and harmful if ingested or inhaled. It too must be handled and stored with caution, and containment and leak protection equipment must be in place.

In contrast, UV disinfection systems are straightforward and inherently safe to operate. Operation of a UV treatment system requires no special training or certification, beyond the manufacturer's start-up training program. Standard maintenance tasks typically include changing out the UV lamps, cleaning the quartz tubes that house the lamps (though many UV systems now have automatic sleeve cleaning), and routine monitoring of treatment performance.

## 4. *Disinfection By-products*

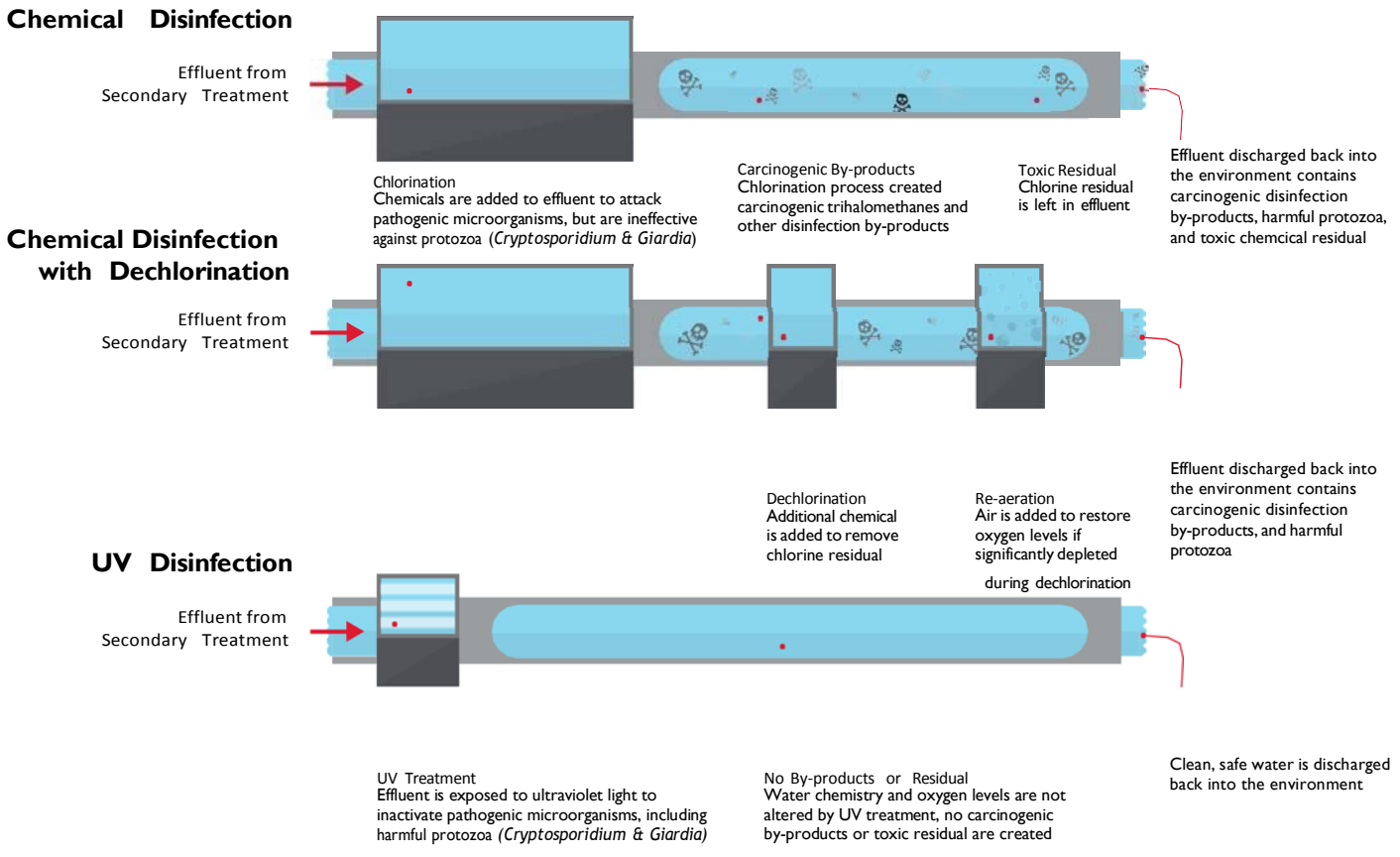
There are a number of organic and inorganic constituents found in wastewater. When chlorine is added to wastewater, the chemical alters and binds to the organic matter, forming what is called a disinfection by-product (DBP). The quantity of DBPs created is a function of the amount of organics in the water and the amount of chlorine added.

Disinfection by-products are known to be dangerous and, as such, have been studied in depth over the past few decades. Of most significant concern are the DPBs proven to be cancer-causing. Regulations in place today center around limiting the formation of these DBPs, particularly trihalomethanes and haloacetic acids. Even in small concentrations, these by-products have been proven to be carcinogenic.

Treatment plants must continuously attempt to balance the amount of chlorine added, and subsequent DBPs produced, with the need to adequately destroy the microorganisms in the wastewater. Regulations are in place simultaneously limiting concentrations of DBPs and bacterial levels, contributing to the complexity and cost of chemical-based disinfection systems.

## 5. *Dechlorination*

In response to the dangers posed by chlorine disinfection, regulators have imposed increasingly stringent limits on the levels of residual chlorine that can be released into receiving waters. For some wastewater treatment plants, this has prompted the need for an additional process – dechlorination – to remove residual chlorine in the effluent before it can be returned to the environment.



The dechlorination process typically involves the use of sulfur dioxide ($SO_2$), a corrosive gas that can cause eye and throat irritations at small concentrations, and potentially more dangerous effects at higher exposure levels. As a result, it too requires special safety provisions for handling, storage, and emergency response training. Increasingly, sodium bisulfite ($NaHSO_3$) is being used as an alternative to sulfur dioxide.

In this final step, gaseous sulfur dioxide is injected into the wastewater in a dechlorination basin. To adequately eliminate residual chlorine, it must be thoroughly mixed, and requires contact time with the effluent of approximately one minute.

Precise dosing of sulfur dioxide is essential to achieve the desired result. Overdosing can result in the formation of sulfites, and lower the dissolved oxygen content and pH level of the effluent. If too much oxygen is depleted, the water must be re-aerated prior to discharge.

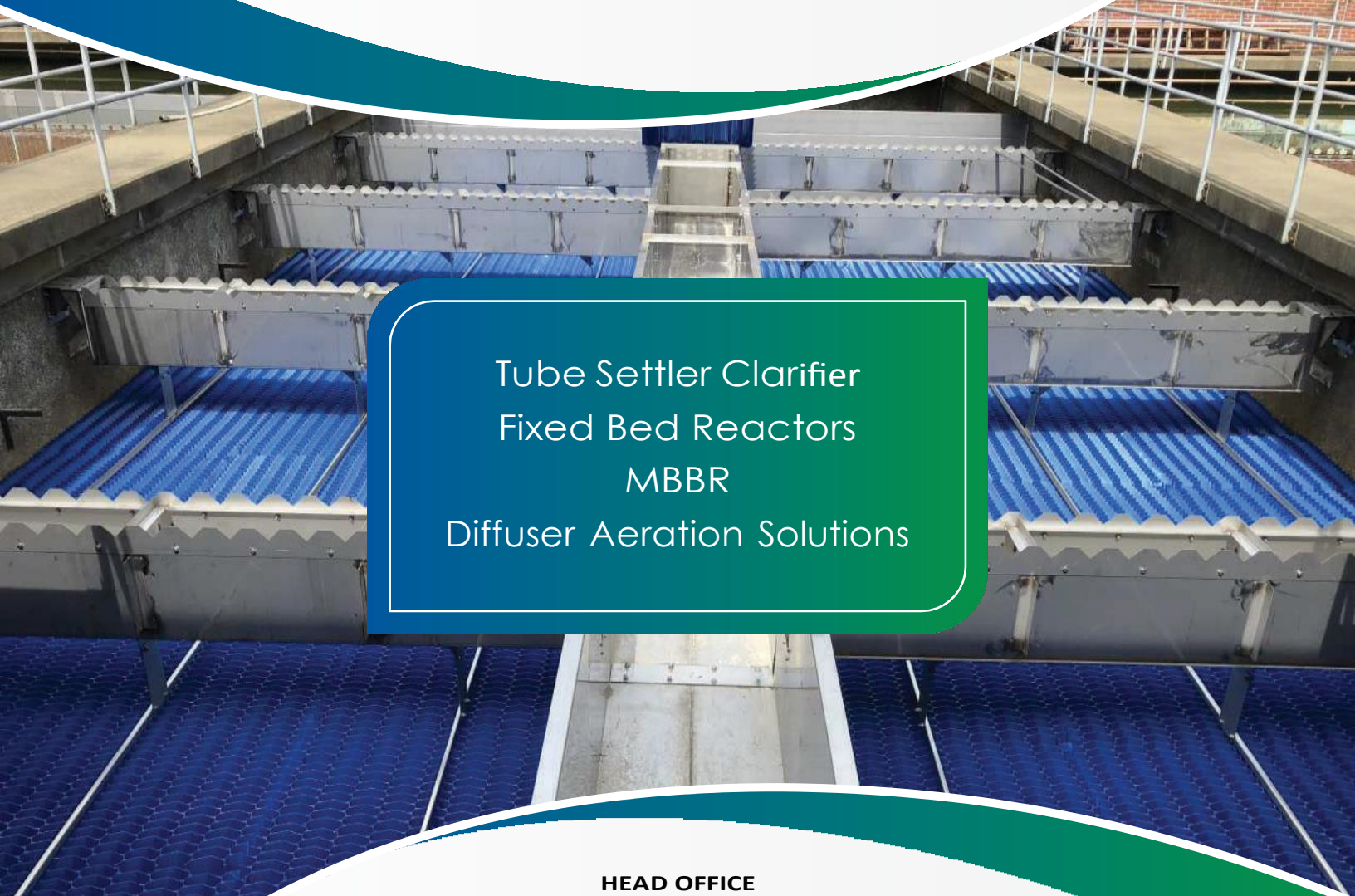
## *Let's Discuss Chlorine Conversion*

We hope this article has answered some of the questions you had about converting from chlorine to UV disinfection. As mentioned earlier, thousands of wastewater treatment plants have converted to UV and are now enjoying the benefits that this environmentally responsible disinfection method has to offer. In fact, with the world's largest municipal UV installation base, we here at Trojan have been involved in several of these chlorine conversion projects.

Are you ready to start evaluating your options? Would you like us to prepare an economic evaluation based on a net present value analysis? To get started, simply visit trojanuv.com/contactus and let us know more about your plant.

**AQUA EQUIP TECHNOLOGIES LLC**

**INTERNATIONAL CONSTRUCTION CONSORTIUM (PVT) LIMITED (ICC)**



# Tube Settler Clarifier
# Fixed Bed Reactors
# MBBR
# Diffuser Aeration Solutions


**HEAD OFFICE**

**Aqua Equip Technologies LLC**

2101 Starkey Rd, Largo, FL 33771, USA

Telephone: +1 727 238 2504

Email: info@aqua-equip.com

www.aqua-equip.com

**SRI LANKA OFFICE**

**International Construction Consortium (Pvt) Limited (ICC)**

# 70, S. De. S. Jayasinghe Mawatha, Kohuwala, Nugegoda, Sri Lanka

Telephone: +94 11 4400600 / Fax: +94 11 4400230

Email: icc@icc-construct.com

www.icc-construct.com

# COMPANY BACKGROUND

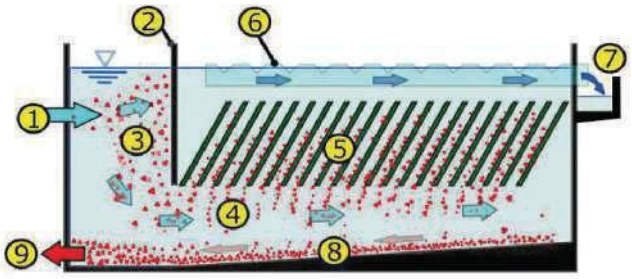
**Aqua Equip Technologies LLC (AET**) is a manufacturer and consulting firm for tube settler, biofilm attached growth and aeration diffuser systems. We are working together with the lead manufacturers for drinking water and wastewater components in the United States to always supply our customers with state of the art technologies.
AET assembles at three different locations in the US tube settler clarifier, fixed bed and diffuser solutions. The head office in Largo, FL is our engineering and design center whereas our assembly partners in Houston, TX and Denver, CO manufacture our product lines.

Our mission is to contribute with all efforts to the improvement of water quality worldwide and to raise awareness for the true value of water.

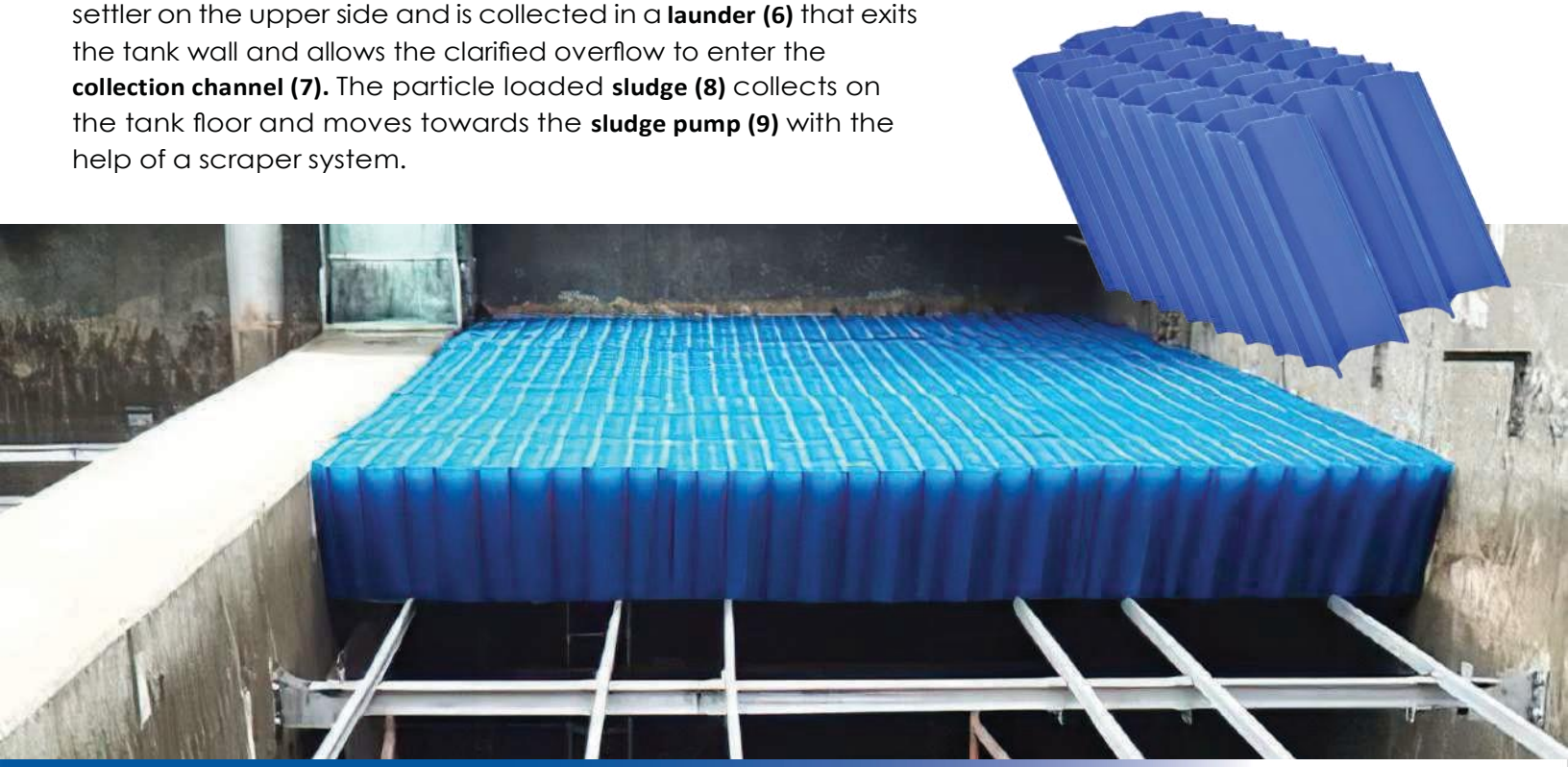
## GLOBAL PARTNERSHIP:

AET has global partners which provide local expertise and design support:

## LAMELLA CLARIFIER



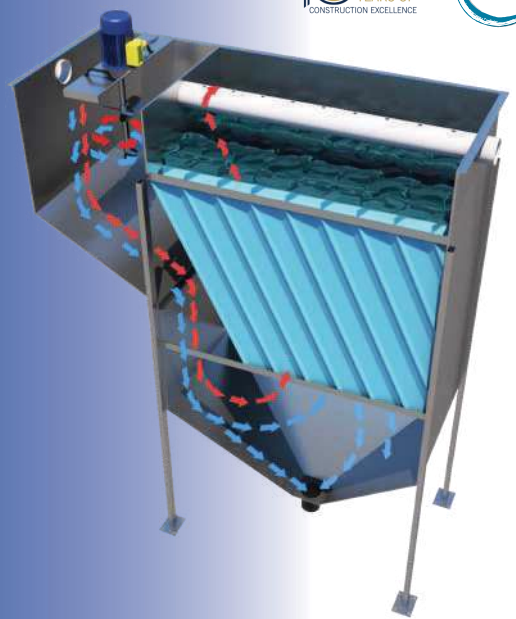

Hybrid settlers are build in a variety of configurations. Different functional zones can be identified in typical lamella settling tanks. The **Influent (1)** flows into a **buffer wall (2).**
Energy gets dissipated in the **inlet zone (3).** From here the flow continues to the **underflow section (4)** where it is evenly distributed to the **hybrid settler (5).**
Particles collect on the lower hybrid settler plane and collectively slide down due to the inclination. Clarified water leaves the hybrid settler on the upper side and is collected in a **launder (6)** that exits the tank wall and allows the clarified overflow to enter the **collection channel (7).** The particle loaded **sludge (8)** collects on the tank floor and moves towards the **sludge pump (9)** with the help of a scraper system.



## TUBE SETTLER STANDALONEMODULAR TANKS

### TCT and TRT series

- Standalone, mobile tube settler tank unit
- All in one clarifier solution
- Available in round and rectangular tank shape
- Available materials are stainless steel, FRP and PE
- Standardized system with various sizes
- Treatment capacity from 15 to 400gpm
- Optionally with mixing chamber
- Easy and fast setup
- Connect multiple TCTs/TRTs in parallel or in series also with AET compact FBBR systems



## FIXED BED REACTORS | MBBR

Wastewater treatment systems using biofilms that grow attached to a support media can be either an alternative or an improvement to the widely used suspended growth activated sludge process. When the system is operated with a single pass and without return sludge it is called FBBR (Fixed bed Biofilm reactor) or MBBR (Moving bed bio reactor). Especially for industrial pretreatment FBBRs are a good and advantageous alternative to activated sludge processes. If the system is operated with return sludge it is called IFAS (Integrated Fixed- Film activated sludge). IFAS systems are an easy and effective way to upgrade an existing activated sludge process by increasing the sludge amount (MLSS) in the aeration basin by up to 50%.

## DIFFUSED AERATION SOLUTIONS

Trickling filters with volcanic rock media have been introduced some hundred years ago. Thanks to the development of structured, durable plastic media some problems of the past have been overcome. Currently, modern trickling filter technology is receiving increased attention due to convincing advantages.

### LIGHTWEIGHT CONSTRUCTION

Less load on support structure and filter shell compared to volcanic rock.

### HIGHT REACTOR UTILIZATION

Plastic media has a 97% void ratio available for process needs, whereas volcanic rock carries ~ 40% dead volume.

### OUTSTANDING ENERGY-EFFICIENCY

Up to 60% less electricity demand compared to similar activated sludge systems.

### LOW MAINTENANCE / EASY TO OPERATE

Simple machinery without blowers and complex air

# DIFFUSED AIR AERATION

Aerobic micro-organisms in the Activated sludge process require air for the digestion of organic matter. Depending on the application specifics either fine bubble or coarse bubble diffusers are used to discharge the required air below the water surface. Next to conventual activated sludge plants aeration diffusers are also used in SBR (sequencing batch reactor), CSR (Continuously sequencing reactors) and BNR (Biological nutrient removal) systems.

## TYPES OF DIFFUSER AERATION

1. *Fixed Grid Aeration*
2. *Retrievable diffuser systems*
3. *Activated Sludge Systems*

*Fixed Grid Aeration*

*Retrievable diffuser systems*

*Activated Sludge Systems*


**HEAD OFFICE**

**Aqua Equip Technologies LLC**

2101 Starkey Rd, Largo, FL 33771, USA

Telephone: +1 727 238 2504

Email: info@aqua-equip.com

www.aqua-equip.com

**SRI LANKA OFFICE**

**International Construction Consortium (Pvt) Limited (ICC)**

# 70, S. De. S. Jayasinghe Mawatha, Kohuwala, Nugegoda, Sri Lanka

Telephone: +94 11 4400600 / Fax: +94 11 4400230

Email: icc@icc-construct.com

www.icc-construct.com

# Waste Water Treatment Plant Installations Done By ICC Smart Eco Solutions

| | Project | Year of Installation | Type | No of Units | Capacity- m3/day | Remarks | Images |
|---|---|---|---|---|---|---|---|
| 1 | Jungle Beach Hotel ,Trincomalee. | 2012 | Modular MBBR PE 300 @230 L\|P\|D | 1 | 70 | Completed |  |
| 2 | Malabe Housing. | 2012 | Modular MBBR PE 780 @230 L\|P\|D | 4 | 180 | Completed |  |
| 3 | Orchid 1 Condominiums, Malabe. | 2017 | Modular MBBR PE 200 @230 L\|P\|D | 1 | 45 | Completed |  |
| 4 | Orchid 2 Condominiums, Malabe | 2019 | Modular MBBR PE 400 @230 L\|P\|D | 2 | 90 | Completed |  |
| 5 | Chena Huts Hotel ,Yala. | 2015 | Modular MBBR PE 200 @230 L\|P\|D | 1 | 45 | Completed |  |
| 6 | Wild CoastTented Lodge ,Yala. | 2019 | Modular MBBR PE 300 @230 L\|P\|D | 1 | 70 | Completed |  |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7 | ICC Labor Camp, Rathmalana. | 2019 | Modular MBBR<br>PE 200 @230<br>L\|P\|D | 1 | 45 | Completed |  |
| | | | | | | | |
| 8 | Anasa Wellness Resort, Bandarawela. | 2020 | Modular MBBR<br>PE 300 @230<br>L\|P\|D | 1 | 70 | Completed |  |
| | | | | | | | |
| 9 | Ocean Front Condominiums, Galle. | 2021 | Modular FBBR<br>PE 300 @150<br>L\|P\|D | 1 | 45 | Completed |  |
| | | | | | | | |
| 10 | Faculty of Technology, University of Colombo, Homagama. | 2021 | Modular FBBR<br>PE 300 @230<br>L\|P\|D | 1 | 70 | Completed |  |
| | | | | | | | |
| 11 | Mont Clifford Luxuary Apartments, Homagama. | 2021 | Modular FBBR<br>PE 400 @150<br>L\|P\|D | 1 | 60 | Completed |  |
| | | | | | | | |
| 12 | Faculty of Healthcare Sciences, Eastern University of Sri Lanka, Batticaloa. | 2021 | Modular MBBR<br>PE 800 @230<br>L\|P\|D | 2 | 200 | Completed |  |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | IT Hub,Malabe. | 2022 | Modular FBBR<br>PE 530 @150<br>L\|P\|D | 1 | 80 | Completed |  |
| | | | | | | | |
| 14 | University of Jayawardhanapura Faculty of Humanities | 2022 | Modular FBBR<br>PE 5000 @ 30 L\|P\|D | 1 | 150 | Completed |  |
| | | | | | | | |
| 15 | University of Sabaragamuwa – P2 | 2022 | Modular FBBR<br>PE 3500 Day only<br>@ 50 L\|P\|D | 1 | 50 | Completed |  |
| | | | | | | | |
| 16 | SLIIT - Kandy | 2023 | Modular FBBR<br>PE 600<br>@ 50 L\|P\|D | 1 | 300 | In Progress |  |
| | | | | | | | |
| 17 | University of Sabaragamuwa –P1 | 2023 | Modular FBBR<br>PE 6000 | 1 | 1000 | In Progress |  |
| | | | | | | | |


**ICC SMART ECO SOLUTIONS**

# 57, S. De. S. Jayasinghe Mawatha, Kohuwala,
Nugegoda, Sri Lanka

www.icc-construct.com

smarteco@icc-construct.com