
APPENDIX C.2

IFAS



AnoxKaldnes™

Moving Bed Biofilm Reactor (MBBR)

Integrated Fixed-Film Activated Sludge (IFAS)

and ANITA™ Mox Deammonification

WATER TECHNOLOGIES

AnoxKaldnes™ MBBR and Hybas™ Processes

AnoxKaldnes™

is the global leader in MBBR and IFAS technologies. Veolia provides the most advanced MBBR and IFAS technologies supported by more expertise and with more installations (600+) than any other MBBR and IFAS system provider.

AnoxKaldnes™ MBBR

(Moving Bed Biofilm Reactor) is a biological wastewater treatment process that utilizes specialized polyethylene carriers (media) to create a large protected surface on which biofilm can attach. The media is mixed in the reactor, and the large surface area provides more treatment capacity in a smaller volume compared to activated sludge.

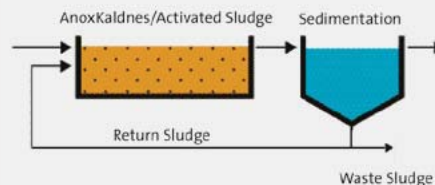
AnoxKaldnes Hybas™

(Hybrid Biofilm Activated Sludge) technology is an application of the IFAS process in which moving media is mixed into an activated sludge environment. The result is both fixed-film and suspended growth biomass working together and lending the strengths of each to the hybrid process. The Hybas process is excellent for retrofitting existing activated sludge plants to improve ammonia and nitrogen removal.

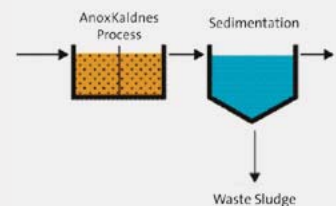
Advantages

- Simple and reliable operation
- Excellent for ammonia and total nitrogen limits ($\text{NH}_3\text{-N} < 1 \text{ mg/L}$, $\text{NO}_3\text{-N} < 1 \text{ mg/L}$)
- Smaller footprint than activated sludge
- Increase plant capacity for nitrification and/or denitrification
- Effective in cold water
- Accommodates a wide range of flow and load fluctuations
- Non-clogging media with a long lifespan
- Flexible design for almost any tank configuration

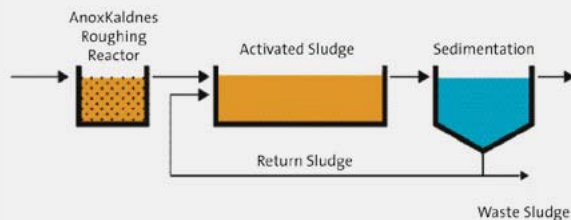
Hybas™ Technology



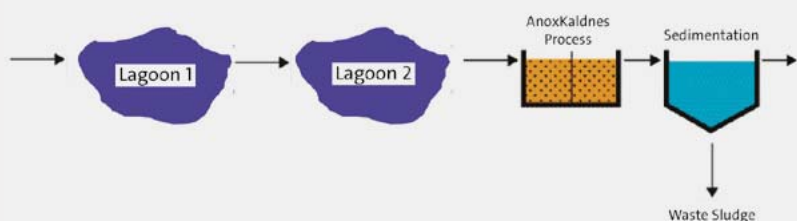
MBBR



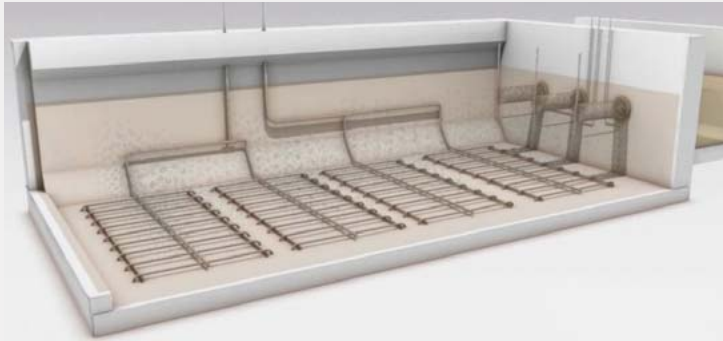
Biofilm Activated Sludge



LagoonGuard® MBBR



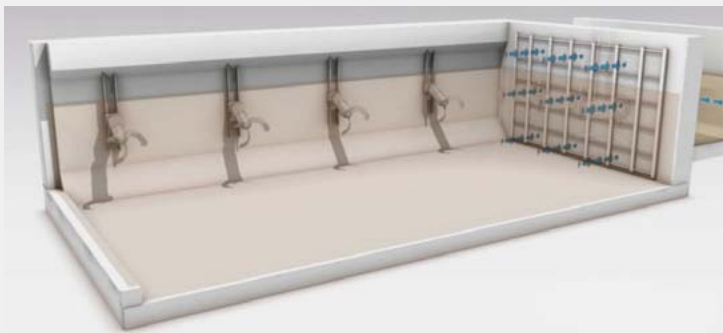
Air Grids and Media Retention Screens



Aerobic Applications

- AnoxKaldnes stainless steel air diffuser system is robust, non-clogging and maintenance free
- Diffusers provide oxygen for process needs and media mixing for optimal biological performance
- Cylindrical screens at reactor's effluent wall retain media while allowing treated water and suspended solids to pass through

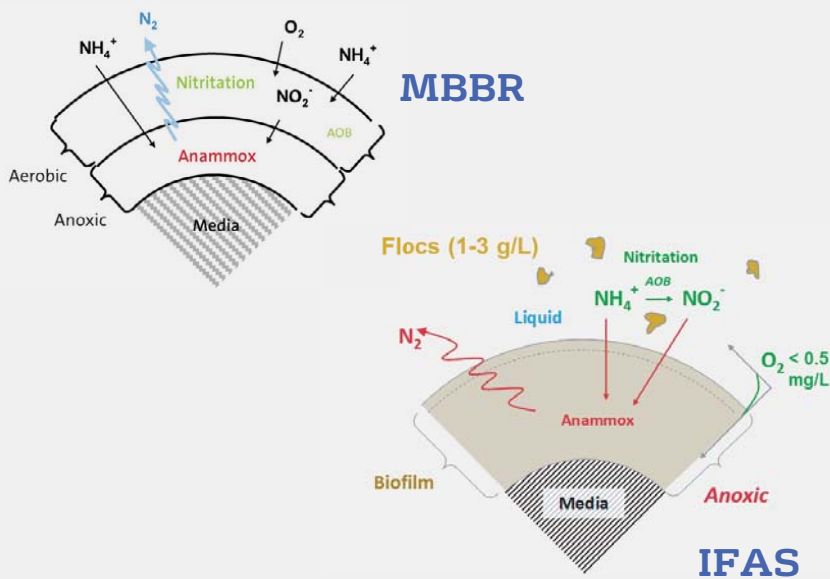
Mixers and Flat Screens



Anoxic Applications

- AnoxKaldnes stainless steel air diffuser system is robust, non-clogging and maintenance free
- Diffusers provide oxygen for process needs and media mixing for optimal biological performance
- Flat screens at reactor's effluent wall retain media while allowing treated water and suspended solids to pass through

ANITA™ Mox Deammonification



System Supplier Scope of Supply

- Complete process design with effluent guarantees and performance bonds
- Process equipment including media, screens, air grids, blowers, pumps, mixers and valves
- Field Instruments and process control
- Customized SCADA for the highest level of operations monitoring and control

The ANITA Mox process combines aerobic nitrification and anammox reactions simultaneously in a single reactor. With MBBR, the reactions take place in different layers of biofilm on the AnoxKaldnes media. With IFAS ANITA Mox, most of the nitrification reaction occurs in the suspended biomass, while the anammox reaction takes place on the carrier media. The MBBR and IFAS ANITA Mox platforms both provide a robust, stable process with simple operation, energy and chemical savings, and efficient ammonia removal.

AnoxKaldnes Technology Can Benefit A Wide Range of Plant Sizes



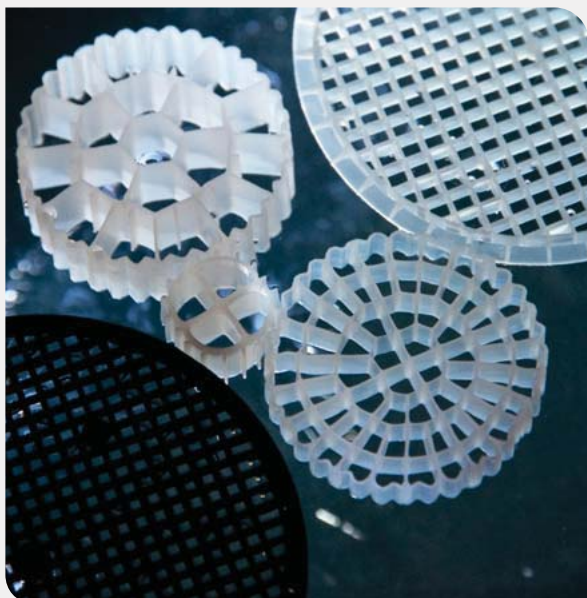
Cheyenne, WY ***AnoxKaldnes MBBR***

- In 2005, MBBR replaced trickling filters and was chosen because it is a biofilm process that is compatible with the existing clarifiers.
- Consists of two trains of two pre-anoxic and four aerobic reactors in series to treat 6.5 MGD and achieve BOD <10 mg/L and ammonia <2 mg/L, NO_x-N <9 mg/L.



Providence, RI ***AnoxKaldnes Hybas Technology***

- Ten parallel process trains with a treatment capacity of 77 MGD
- Existing aeration basins converted to a 4 stage process with one IFAS zone per train
- Pre-anoxic stage for denitrification using the influent BOD as a carbon source
- Aerobic Nitrification stage for BOD and Nitrification – IFAS Zone. 52% fill using AnoxKaldnes K3 media type. Total media surface area of 36.3 million square feet
- Post-anoxic stage for additional denitrification using an external carbon source
- Clarification stage for solids separation and collection



Winning Combinations

- *High rate clarification with ACTIFLO®*
- *Primary clarification with MULTIFLO*
- *Filtration with Hydrotech Discfilter*

A map of the contiguous United States with red dots indicating sampling locations for *Anoxia peruviana*. The dots are distributed across various states, including California, Nevada, Arizona, New Mexico, Texas, Colorado, Utah, Idaho, Montana, Wyoming, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Missouri, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, Virginia, North Carolina, South Carolina, Tennessee, Kentucky, Indiana, Michigan, Ohio, Pennsylvania, Maryland, Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, Maine, Alaska, and Hawaii. A legend in the bottom right corner identifies the species as *Anoxia peruviana* and the study as "TN R..." (likely Tennessee River).

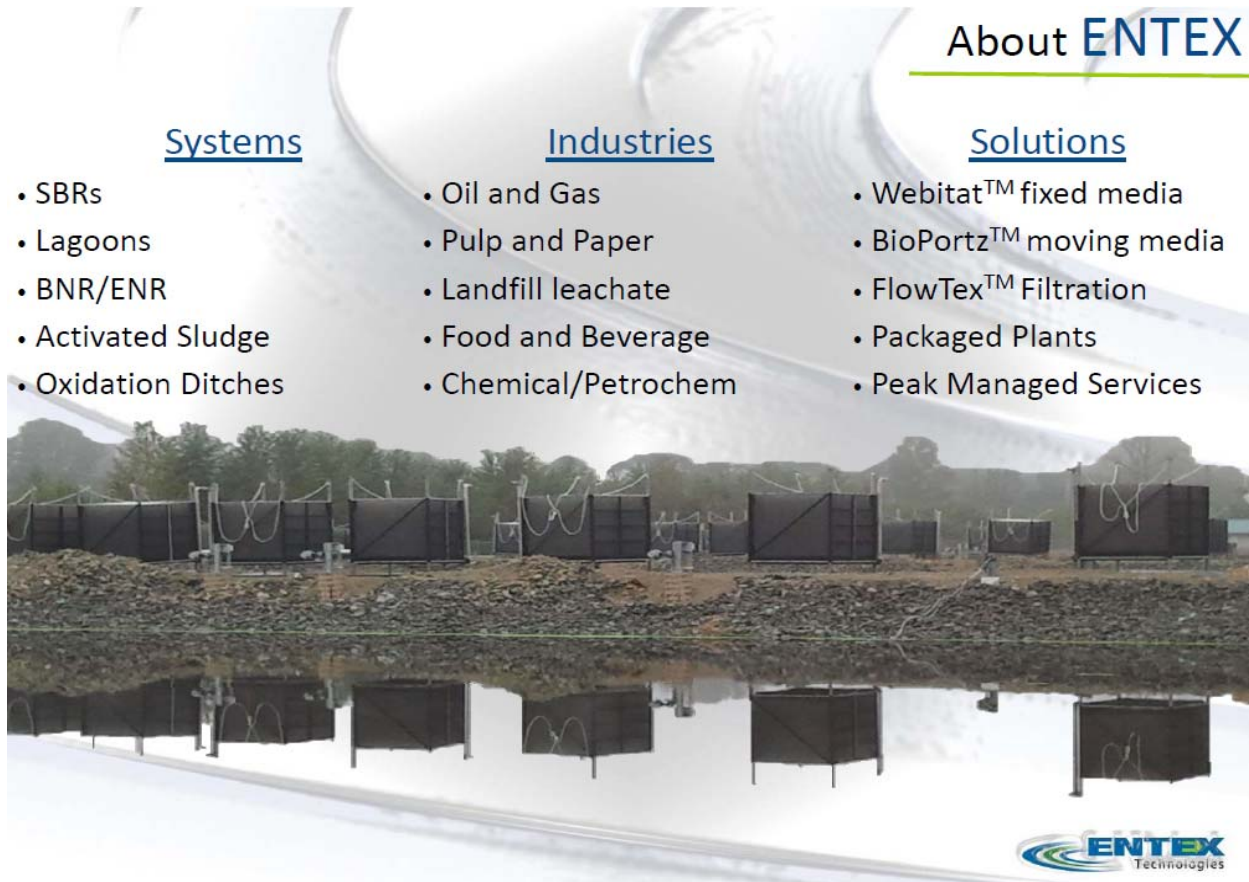
South Adams County, CO

About Entex

Entex offers an unequalled selection of advanced wastewater treatment solutions. Our solutions effectively address space constraints and budget concerns, as well as ever increasing demands for higher quality effluent and increased plant capacity. Technologies provided by Entex have been selected with confidence to treat more than 60 million gallons per day of design capacity.


Entex provides biological systems for carbon and nutrient removal, including phosphorus and nitrogen control. As a provider of both fixed media (BioWeb) and moving media (BioPortz) processes, Entex offers an unbiased design assessment. The Entex team has been involved in over 750 installations with over a combined 100 years of experience. Additionally, Entex offers a flexible suite of tertiary filtration systems that have been Title 22 approved by the State of California for reuse quality effluent. Entex's filtration systems are designed to further polish final effluent and reduce turbidity for reuse and irrigation purposes.

Entex provides the ability to upgrade treatment facilities to meet the needs of increased capacity and improved effluent discharge requirements, often without the need for additional treatment basins. These systems provide powerful solutions to the challenges facing wastewater treatment systems, offering extraordinary levels of performance typically at a substantially lower cost than conventional solutions.



About **ENTEX**

<u>Systems</u>	<u>Industries</u>	<u>Solutions</u>
<ul style="list-style-type: none">• SBRs• Lagoons• BNR/ENR• Activated Sludge• Oxidation Ditches	<ul style="list-style-type: none">• Oil and Gas• Pulp and Paper• Landfill leachate• Food and Beverage• Chemical/Petrochem	<ul style="list-style-type: none">• Webitat™ fixed media• BioPortz™ moving media• FlowTex™ Filtration• Packaged Plants• Peak Managed Services



About BioWeb™

Entex's BioWeb is a patented, high strength (+1,000 lbs), lock-knit polyester textile designed to enhance and stabilize microorganism colonization within biological wastewater treatment applications. By introducing a protected surface, microorganisms are allowed to immobilize and increase in concentration, thereby increasing the ability to degrade wastewater constituents and nutrients. Individual filaments form small ½-inch loops that extend from the textile, providing growth sites for biomass. Since the material is lock-knit, it will not unravel and will not dislodge during operation. Each BioWeb row is secured to a horizontal cross member at the top and bottom of the frame, ensuring the BioWeb will remain intact. Additionally, BioWeb is installed in a continuous sheet with 4-inches between vertical rows to allow a greater open area to reduce hydraulic drag. Flow is typically directed parallel to the vertical rows.



Intro to BioWeb Fixed Media

BioWeb fixed-media

- Lock-knit polyester (will not unravel)
- 16+ years in industry
- 1,000+ lbs break strength
- Optimized design for scour
- 30+ years projected lifespan

Frames

- Complete welded 304L SS
- Integrated scour aeration
- Custom engineered solutions

Installation

- Modules delivered fully assembled
- No onsite frame assembly required

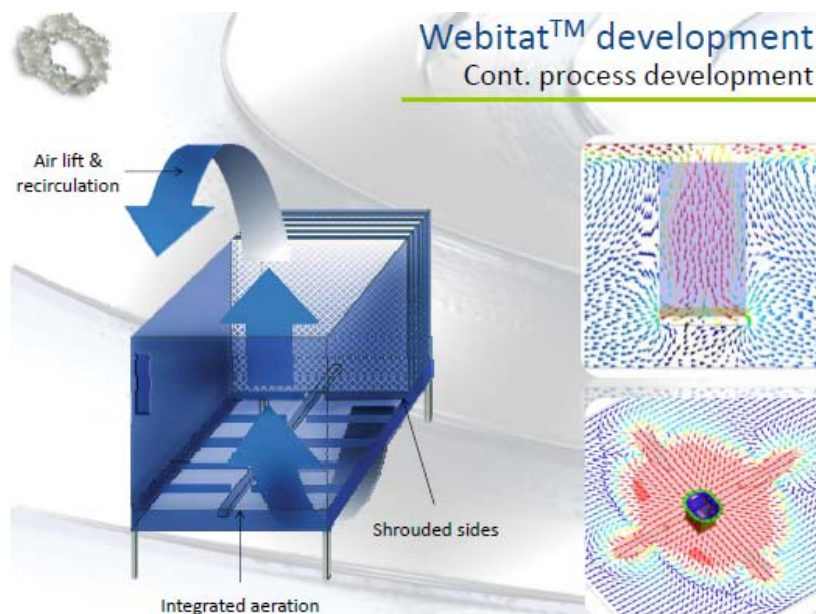


BioWeb Fixed media



About Webitat™

Entex's Webitat process utilizes BioWeb media and allows a proactive control of the attached biofilm thickness by incorporating an integrated aeration mechanism below each Webitat frame. This dedicated aeration ensures a high rate of shear and serves to create an air lift effect, enabling continuous circulation of influent substrate. As a result, substrate transfer and diffusion rates can be optimized. Each Webitat is shrouded to confine and direct the integrated aeration into the BioWeb media, increasing scour efficiency. The integral aeration flux rate can be controlled via dedicated Webitat process valving to provide proactive operation and process control. The enclosed Webitat module operates as its own high-rate biological reactor, enhancing mixing and biomass inventory. By regulating Webitat aeration, performance can be optimized to meet plant specific needs.



- Baseplate, for lagoon applications

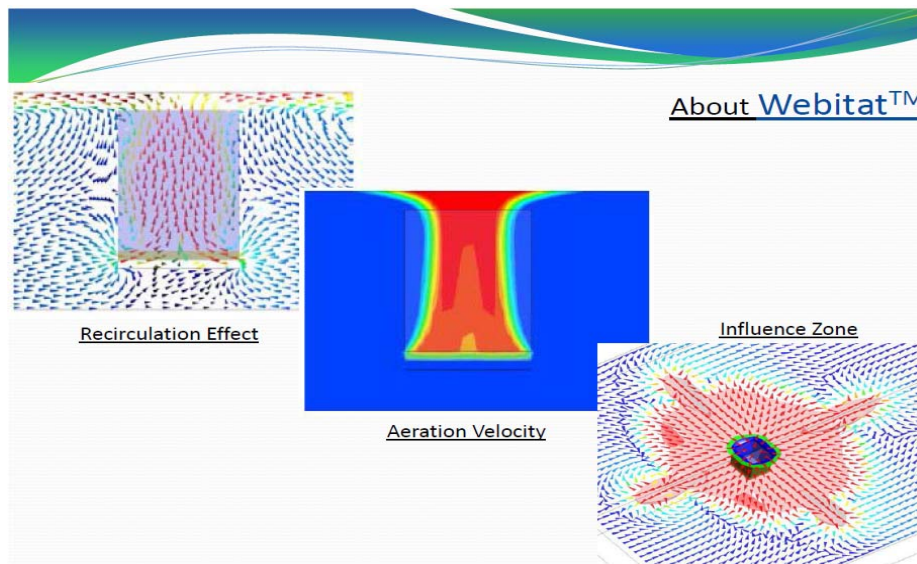
- Shrouded sides confine aeration pattern and create air lift pump, substrate is drawn into Webitat unit



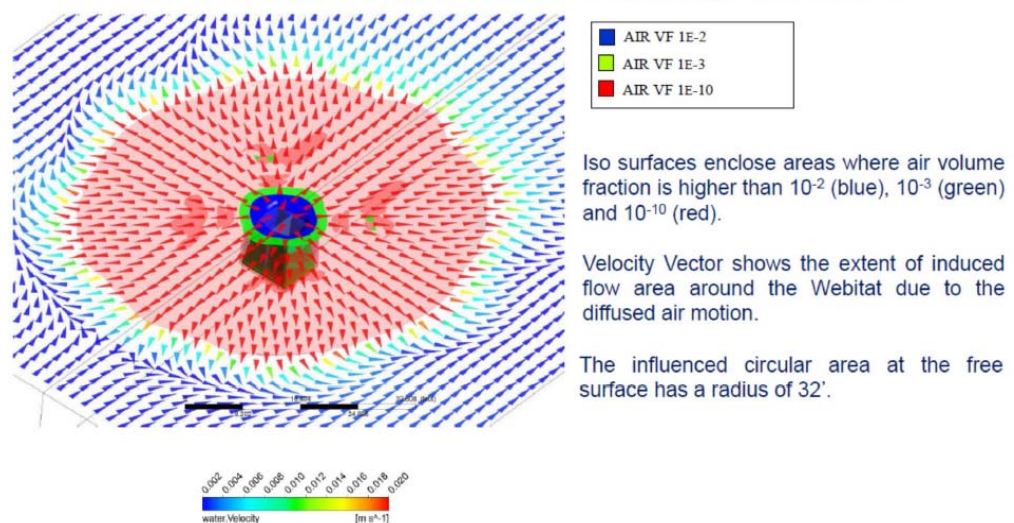
- Integral aeration

About Webitat cont...

Each Webitat module can be programmed to operate independent of other Webitat modules to allow additional process flexibility, aeration adjustment and mixing control. When operated in activated sludge systems, the Webitat aeration process minimizes bypass potential and forces substrate to be recirculated continuously. Complex CFD analysis has been performed to demonstrate the recirculation effects and mixing intensity of the Webitat aeration (see below). Under normal aeration rates, Webitat modules can recirculate in excess of 4 MGD per module and can impact liquid movement to negate bypass. This ensures conventional processes are well mixed.



Iso surfaces plot and velocity vectors

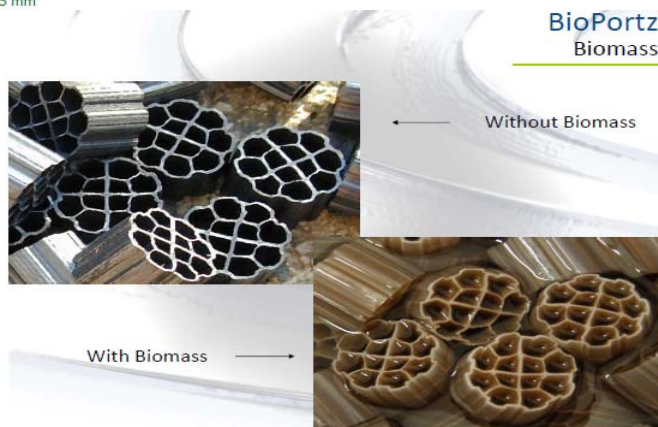


About BioPortz

BioPortz is a high density polyethylene (HDPE) extruded media designed to enhance and stabilize microorganism colonization within biological wastewater treatment applications. By introducing a protected surface, microorganisms are allowed to immobilize and increase in concentration, thereby increasing the ability to degrade wastewater constituents. Independently moving BioPortz carriers continually circulate through the treatment basin in a random motion, ensuring excellent oxygen and substrate transfer to the biomass. Because little or no additional tankage is typically required, BioPortz offers an effective solution for plants with limited room for expansion. Additionally, it is also an excellent solution for space efficient, high performance new treatment basins.

BioPortz moving media provides $589 \text{ m}^2/\text{m}^3$ of protected biological surface area for biomass growth. The attached biomass populations can more than double the effective MLSS concentration. The vigorous motion of the media through the basin provides a high shear, creating higher biological kinetics.

BioPortz media is approximately 18mm in diameter and 15 mm in cylinder length. This allows for a more open effluent media retention screen design, minimizing head loss and plugging or blinding potential. Entex's design incorporates a 10-mm slot width. Inlet screening is thereby less stringent and can be as large as 6-mm.



Resourcing the world

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APPENDIX C.3
MBR PRELIMINARY PROPOSAL
