Treatment of Nitrogen and Phosphorus Point and Non-point Source Pollution with Algal Turf Scrubber® Technology- Case Studies and Potential for NC

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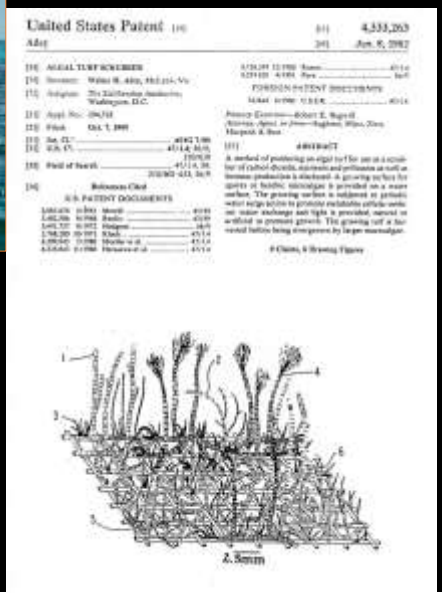
Biohabitats Incorporated

HydroMentia WATER TREATMENT TECHNOLOGIES

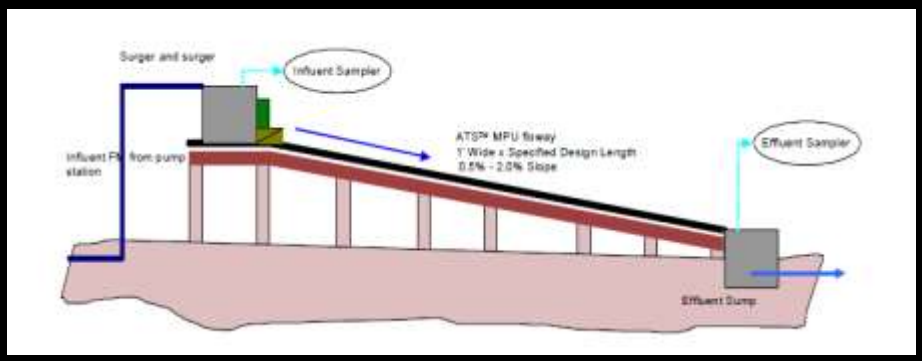
What is an Algal Turf Scrubber®?

- Uses native algae to remove nitrogen and phosphorus, while adding dissolved oxygen to source water
- Once algae is established, it is regularly harvested and processed, and as it regrows, new biomass maintains the accelerated growth phase, which extracts nutrients at higher rates
- With favorable conditions, algae grows and nutrients are continuously recovered and removed from the source water

Algal Turf Scrubber® Early Stage Development
1970s – 1990s Dr. Walter Adey
6 Process Patents



Basic ATS™ Pilot Floway Design Components



ATS – Algal Floway Community

Patterson ATS™ (1995-1996) Stanislaus County, CA
0.2 MGD x 500’

Medium Scale ATS

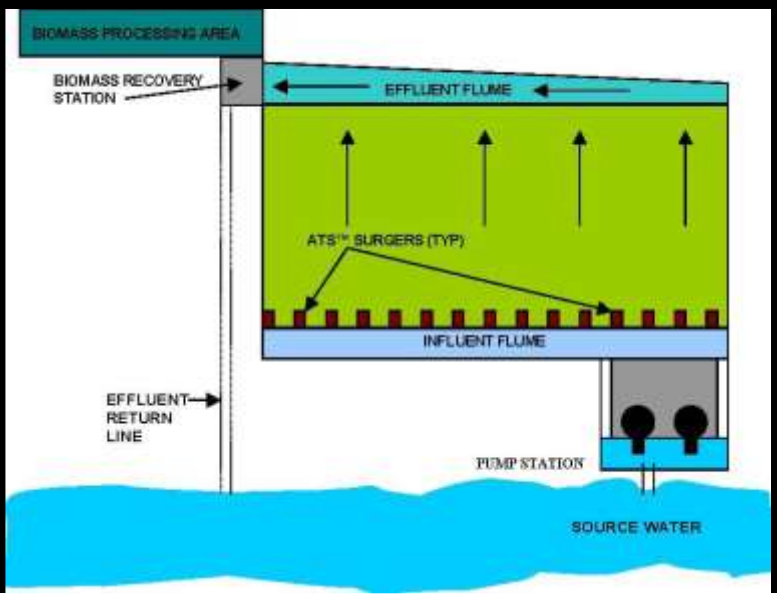
Egret Marsh ATS™
Indian River County, FL
10 MGD x 575' (2010-Ongoing)

Large Scale ATS

The ATS technology has been implemented at the very large scale in Florida and Texas by a commercial company named HydroMentia, headquartered in Ocala, Florida. Biohabitats is partnered with HydroMentia on scaling up further systems.

HydroMentia

Large Scale Algal Turf Scrubber® Design



Algal Turf Scrubber® Design
System Inflow

Water is surged down the sloped floway in a pulsing motion.
The pulsing surge stimulates algal growth.

Algal Turf Scrubber® Design
Algal Turf Floway

The algal turf biomass is recovered on a 7-14 day cycle using HydroMentia's proprietary harvest design. The recovered algal biomass contains excess nutrients removed from the water.

Algal Turf Scrubber® Design
Biomass Production

Algal turf or dense mats of simple algae are cultivated on the surface of the floway. As the algae grow, they remove nutrient pollutants (phosphorous and nitrogen) from the water.

Algal Turf Scrubber® Tractor Mounted Scraper

The algal turf biomass is recovered on a 7-14 day cycle using HydroMentia's proprietary harvest design. The recovered algal biomass contains excess nutrients removed from the water.

Algal Turf Scrubber® Design
Centralized Biomass Recovery

Harvested algae is conveyed by the water via a concrete flume to a centralized recovery facility.

Algal Turf Scrubber® Design
Centralized Biomass Recovery System

Algal Turf Scrubber® Design
Centralized Biomass Recovery

The harvested algae is removed from the water with a Flex Rake.

Algal Biomass Products

Biofuel Production and Bioplastics

Sandia Labs Texas A&M

Compost/Organic Fertilizer and Potting Media

Livestock Feed

Algal Based Growing Media

100CA/0PB 50CA/50PB 0CA/100PB

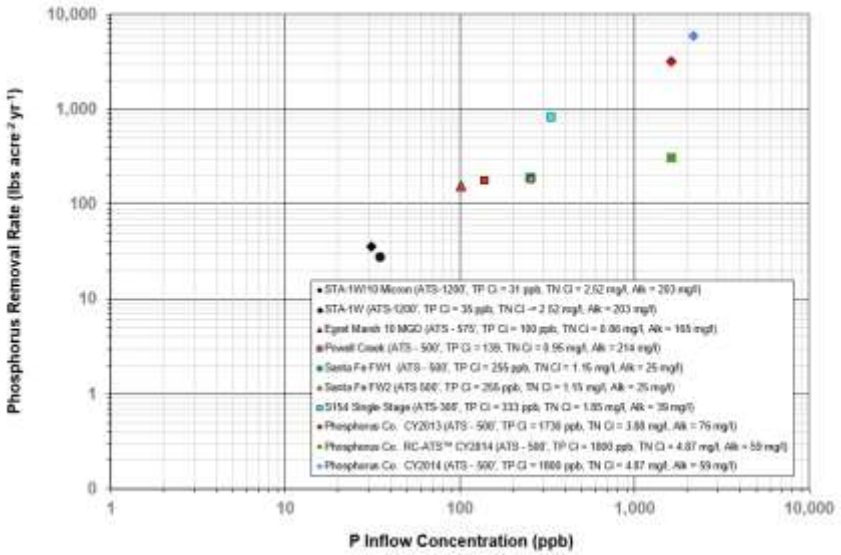
Peat-based (PB) substrate amended with composted algae (CA) at 10% increments by volume. From left to right, 100% CA to 100% PB to the far right. Plant number 6 (yellow tag) from either direction is 50/50 CA/PB.

Algal Turf Scrubber® Projects-Case Studies

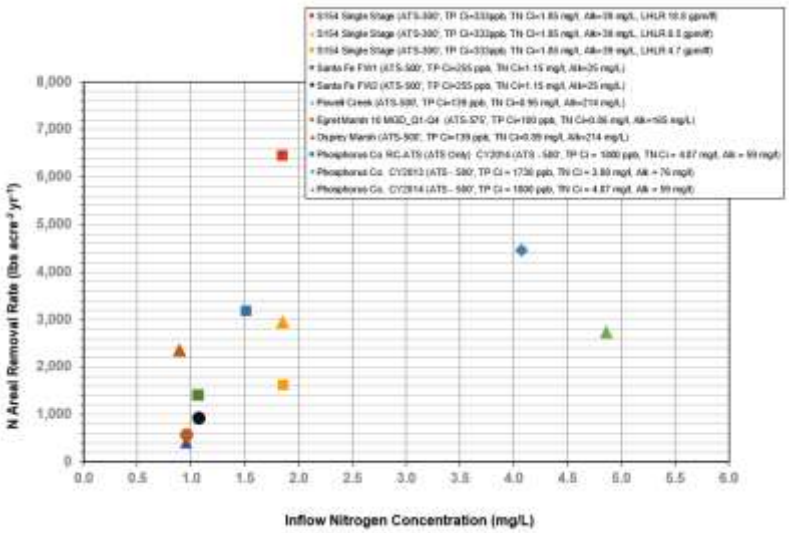
Algal Turf Scrubber® Systems - History

1. EAA ATS™, Palm Beach County, FL (1992)
1. Patterson ATS™, Stanislaus County, CA, (1993-1994)
2. HMI Aquaculture ATS™, Okeechobee County, FL (1999-2003)
3. Fall River ATS™_ABES, Fall River, TX (2000 – 2003)
4. S-154 ATS™ with WHS™ Pre-treatment, Okeechobee County, FL (2003-2004)
5. S-154 ATS™ (LHLR 4.7 gal/min-ft), Okeechobee County, FL (2004)
6. S-154 ATS™ (LHLR 8.5 gal/min-ft), Okeechobee County, FL (2004)
7. S-154 ATS™ (LHLR 18.9 gal/min-ft), Okeechobee County, FL (2004)
8. Egret Marsh ATS™, Indian River County, FL (2005)
9. Taylor Creek ATS™, Okeechobee County, FL (2007 – 2009)
10. Lake Lawne ATS™, Orange County, FL (2009)
11. Powell Creek ATS™, Lee County FL (2009)
12. STA-1W ATS™, Palm Beach County, FL (2009)
13. Spring Creek ATS™_CER, Lee County, AR (2009)
14. Susquehanna River ATS™_CER, Lancaster County, PA (2009)
15. Gloucester Point ATS™_VIMS, Gloucester, VA (2009 – 2010)
16. Santa Fe ATS™, Alachua County, FL (2009 – 2010)
17. Egret Marsh ATS™, Indian River County, FL (2010)
18. Dalton WWTF ATS™, Murray County, GA (2010 - 2011)
19. USDA ATS™, Indian River County, FL (2010 - ongoing)
20. NYCDEP ATS™, Queens County, NY (2010 - 2012)
21. South Canal ATS™, Indian River County, FL (In Design)
22. Phosphate Mining Company, Polk County, FL (2012)

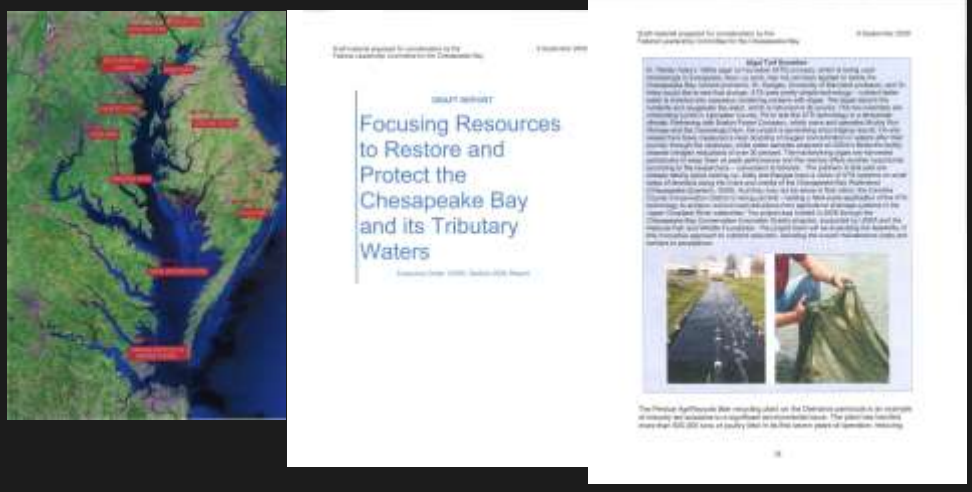
Algal Turf Scrubber® Relationship of Phosphorus Inflow Concentration and Removal Rates



Algal Turf Scrubber® Relationship of Nitrogen Inflow Concentration and Removal Rates



ATS™and Chesapeake Bay



ATS ™ Pilot locations around Chesapeake Bay and the draft technical report supporting Executive Order 13508 directing Chesapeake Bay cleanup. The cleanup includes ATS ™ as an emerging technology in the effort.

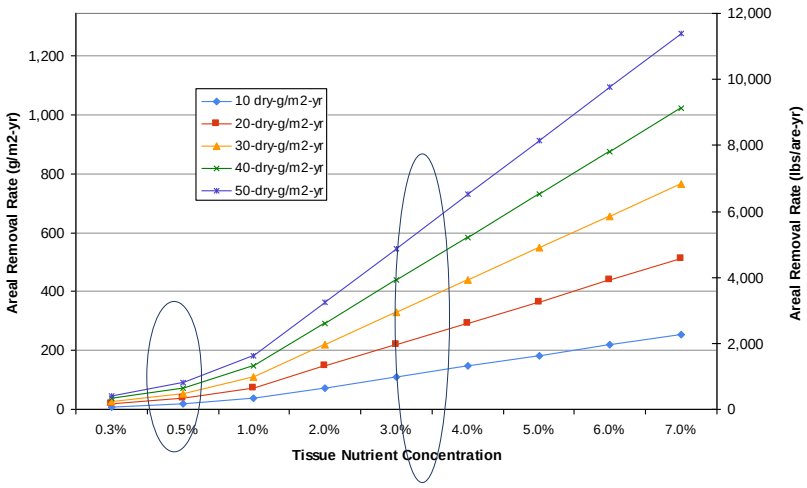
Areal Nutrient Uptake Rates for an ATS in the Chesapeake Bay Region

	Lower Boundary Estimate lbs / acre / year	Upper Boundary Estimate lbs / acre / year
Nitrogen	214	3900
Phosphorus	43	390

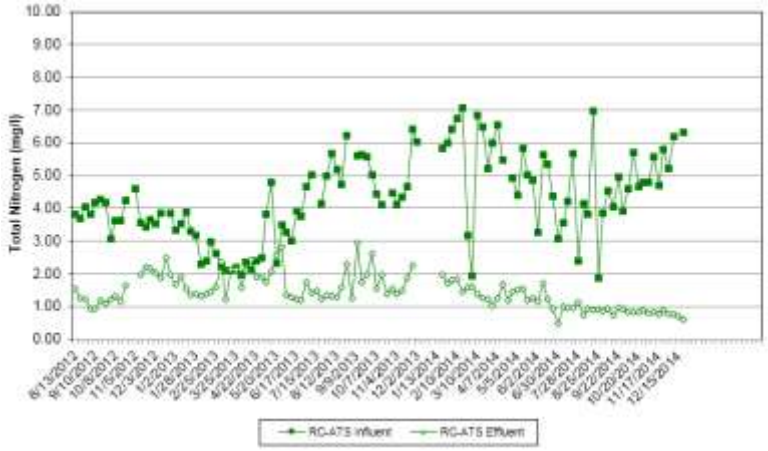
Averages from data collected from ATS studies on outdoor raceways operated for at least one annual cycle.

System Location	Water Treated	%N	%P
Lancaster, PA	Susquehanna River	2.5	0.3
Beltsville, MD	Dairy Manure	5.9	0.8
Bridgetown, MD	Ag Drainage Ditch	2.0	0.3
Gloucester, VA	York River	1.3	0.2
Reedville, VA	Great Wicomico River	2.5	0.2

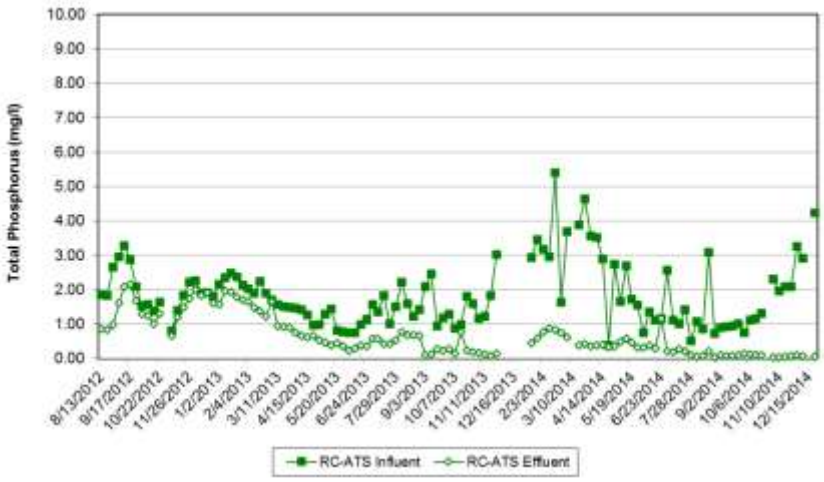
Nutrient Areal Removal Rates (ARR) based on Algal Productivity (dry-g/m2-yr) and Tissue Nutrient Concentrations



Algal Turf Scrubber® Potential for High Level Total Nitrogen Reduction – Recycle Mode



Algal Turf Scrubber® Potential for High Level Total Phosphorus Reduction – Recycle Mode



Nitrogen and Phosphorus Load Reduction in North Carolina

QUESTIONS?

Good Information Summary Paper on ATS Technology

Adey, W.H., Patrick C. Kangas and Walter Mulbrey. 2011. Algal Turf Scrubbing: Cleaning Surface Waters with Solar Energy While Producing a Biofuel. Bioscience, Vol. 6, No. 6.