

Algal Turf Scrubbers: An Innovative Approach for Reducing Pollution in Municipal and State Waterways

Peter I. May, Ph.D., Larry Davis and Kelly Fleming
Green Mechanics Benefit LLC
Greenbelt , Maryland

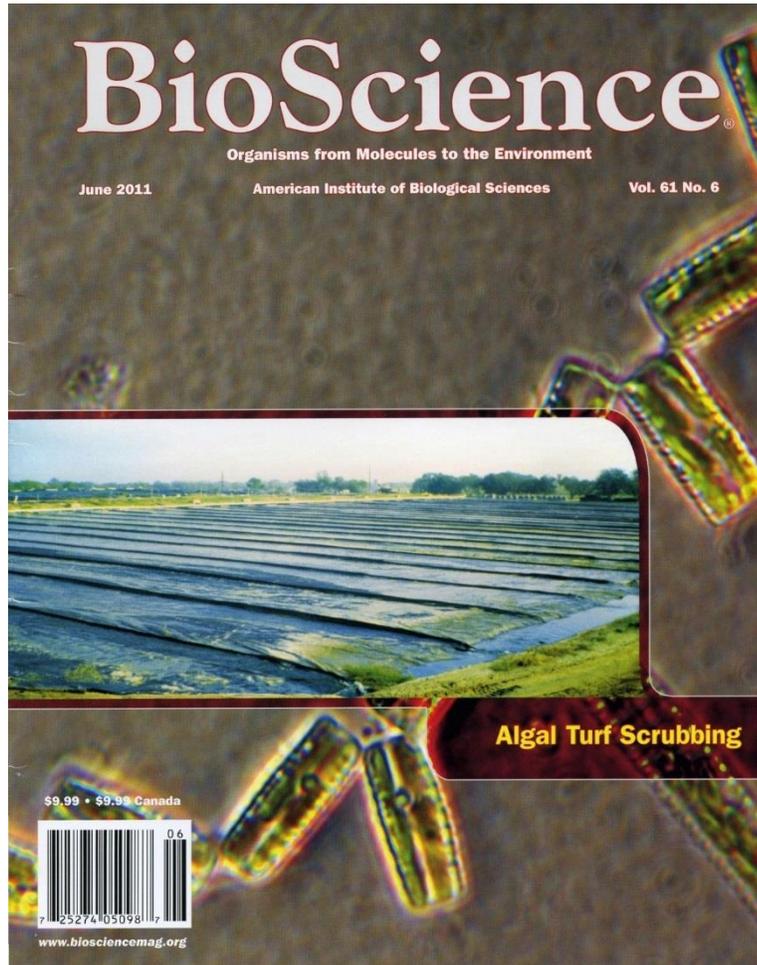
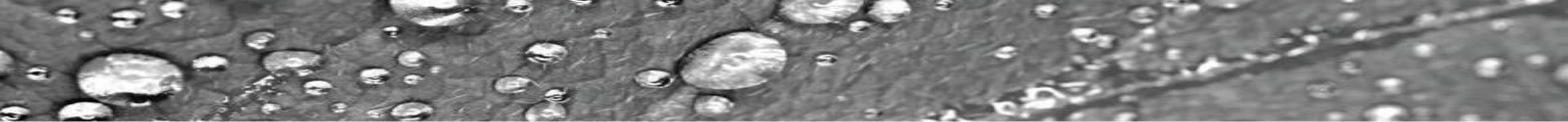
Robert A. Walker
Bladensburg Waterfront Park/Anacostia River
M-NCPPC, Department of Parks and Recreation, Prince George's County

Presentation to the Alliance for the Chesapeake Bay
Building Local Resilience: Innovative Approaches to Managing Stormwater,
Mitigating Flooding and Reducing Pollution

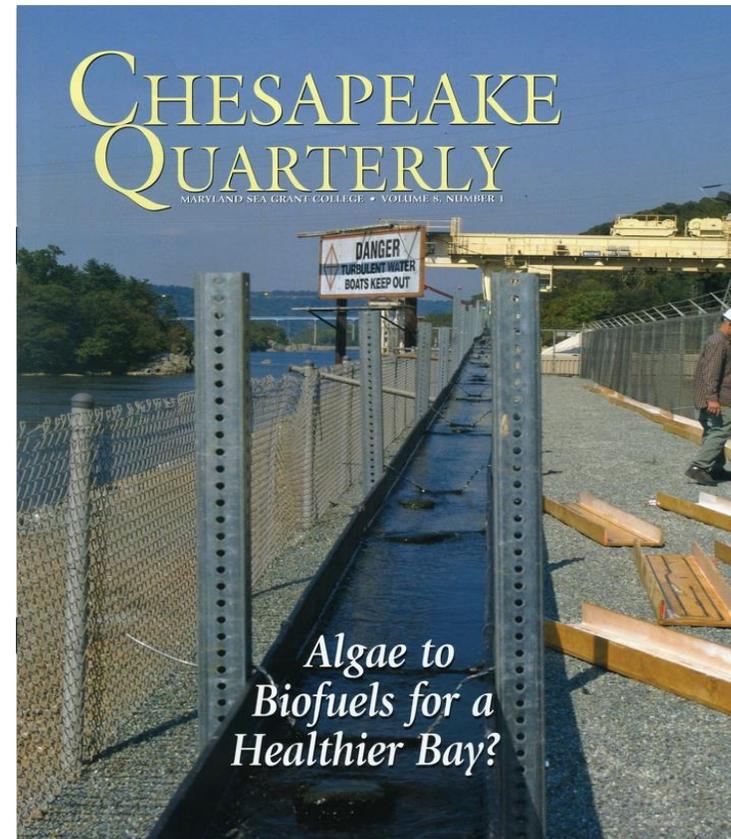


March 5th, 2026



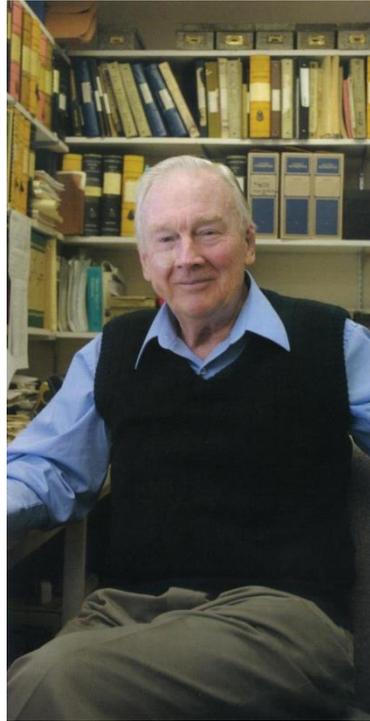


The Algal Turf Scrubber is well developed as an experimental and now EPA approved technology for improving water quality of polluted water sources, including: rivers, lakes, estuaries and wastewater.



Algal Turf Scrubber® Early Stage Development 1970s – 1980s

The inventor, Dr. Walter Adey, as head of the Smithsonian Marine Systems Lab developed the approach while studying algae growth on tropical coral reef surfaces.



United States Patent [19]
Adey

[11] 4,333,263
[45] Jun. 8, 1982

[54] ALGAL TURF SCRUBBER 4,236,349 12/1980 Ramus 47/1.4
4,259,828 4/1981 Pace 56/9

[75] Inventor: Walter H. Adey, McLean, Va.

[73] Assignee: The Smithsonian Institution, Washington, D.C.

[21] Appl. No.: 194,726

[22] Filed: Oct. 7, 1980

[51] Int. Cl.³ A01G 7/00

[52] U.S. Cl. 47/1.4; 56/9; 210/620

[58] Field of Search 47/1.4, 59; 210/601-632; 56/9

[56] References Cited

U.S. PATENT DOCUMENTS

| | | | | |
|-----------|---------|-----------------|-------|--------|
| 2,983,076 | 5/1961 | Merrill | | 47/59 |
| 3,402,506 | 9/1968 | Renfro | | 47/59 |
| 3,691,737 | 9/1972 | Hodgson | | 56/9 |
| 3,768,200 | 10/1973 | Klock | | 47/1.4 |
| 4,209,943 | 7/1980 | Moeller et al. | | 47/1.4 |
| 4,235,043 | 11/1980 | Harasawa et al. | | 47/1.4 |

FOREIGN PATENT DOCUMENTS

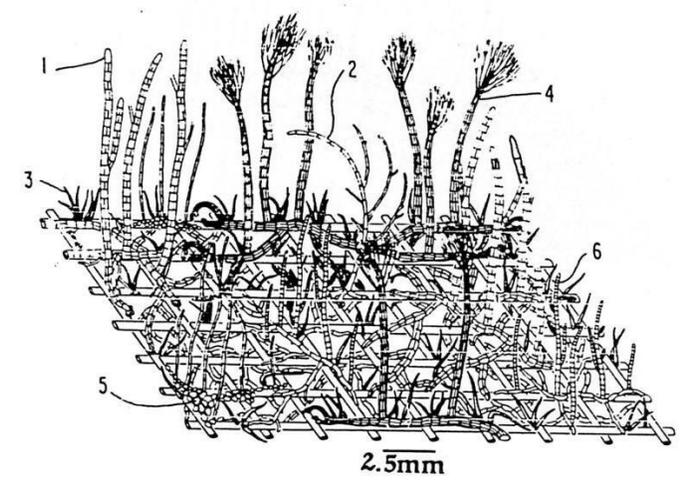
743644 6/1980 U.S.S.R. 47/1.4

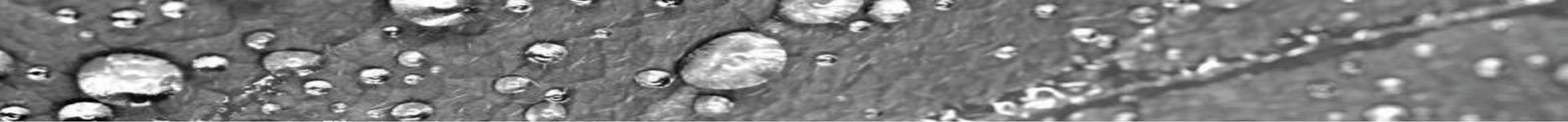
Primary Examiner—Robert E. Bagwill
Attorney, Agent, or Firm—Sughrue, Mion, Zirn, Macpeak & Seas

[57] **ABSTRACT**

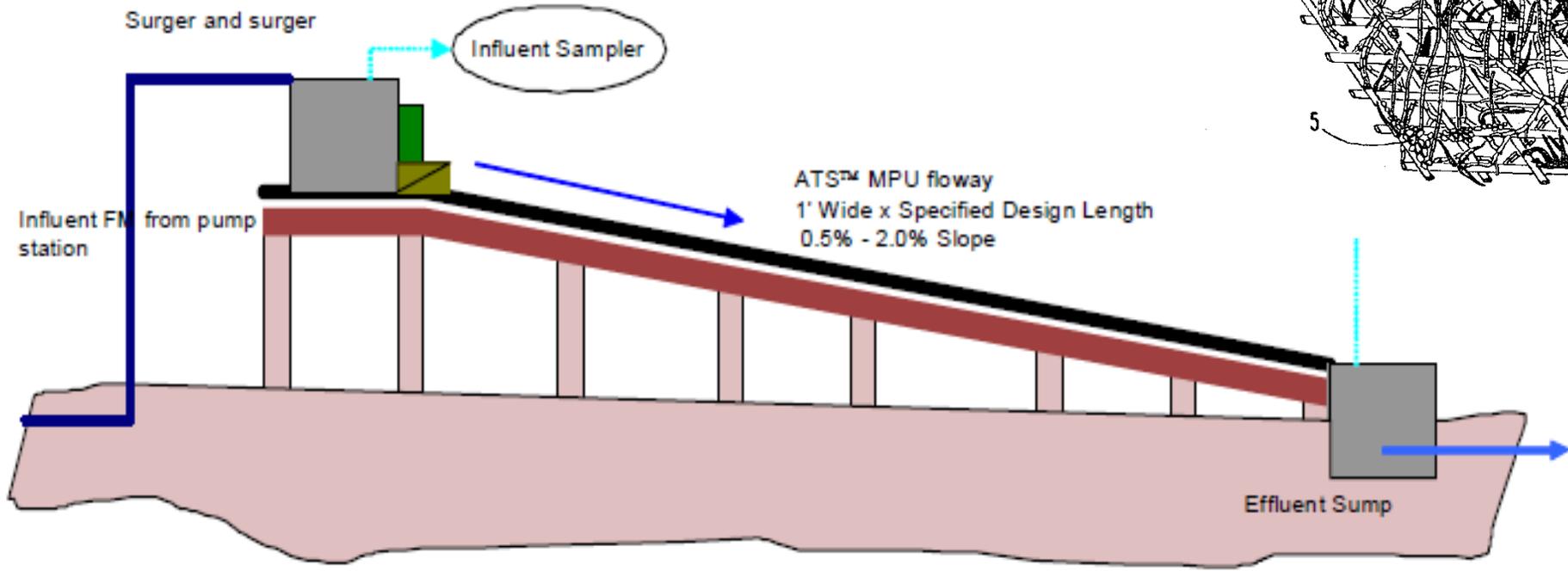
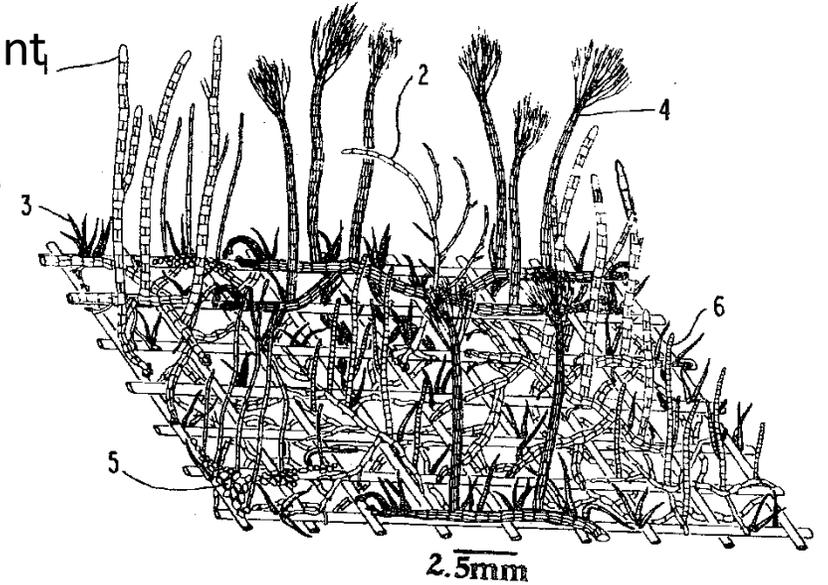
A method of producing an algal turf for use as a scrubber of carbon dioxide, nutrients and pollutants as well as biomass production is disclosed. A growing surface for spores or benthic microalgae is provided on a water surface. The growing surface is subjected to periodic water surge action to promote metabolite cellular-ambient water exchange and light is provided, natural or artificial to promote growth. The growing turf is harvested before being overgrown by larger macroalgae.

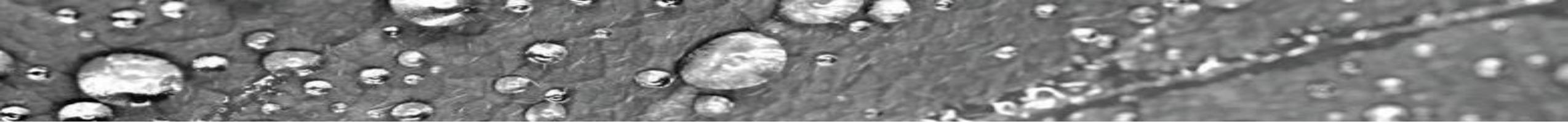
9 Claims, 6 Drawing Figures





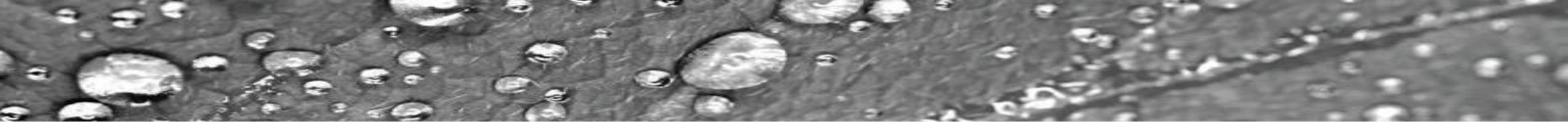
Basic ATS Components: Water Pump, Floway, Screen for Algae Attachment
The water pumped and gravity flowed over the screen under the sun stimulates algae to attach and grow taking up nutrients



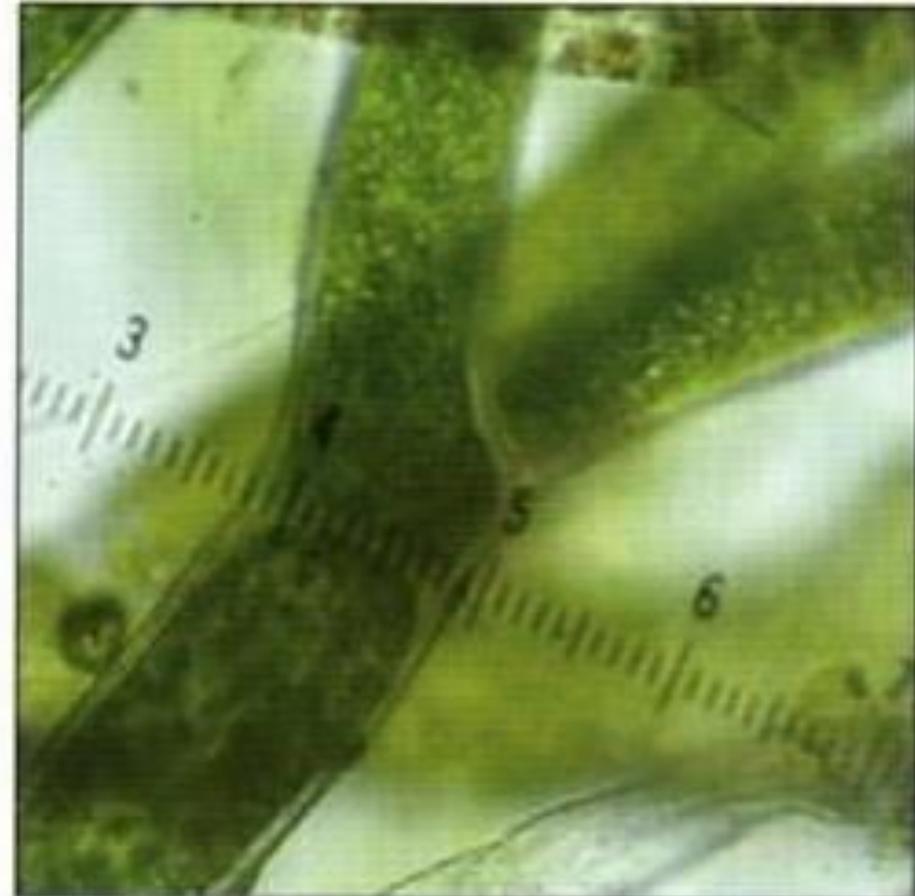
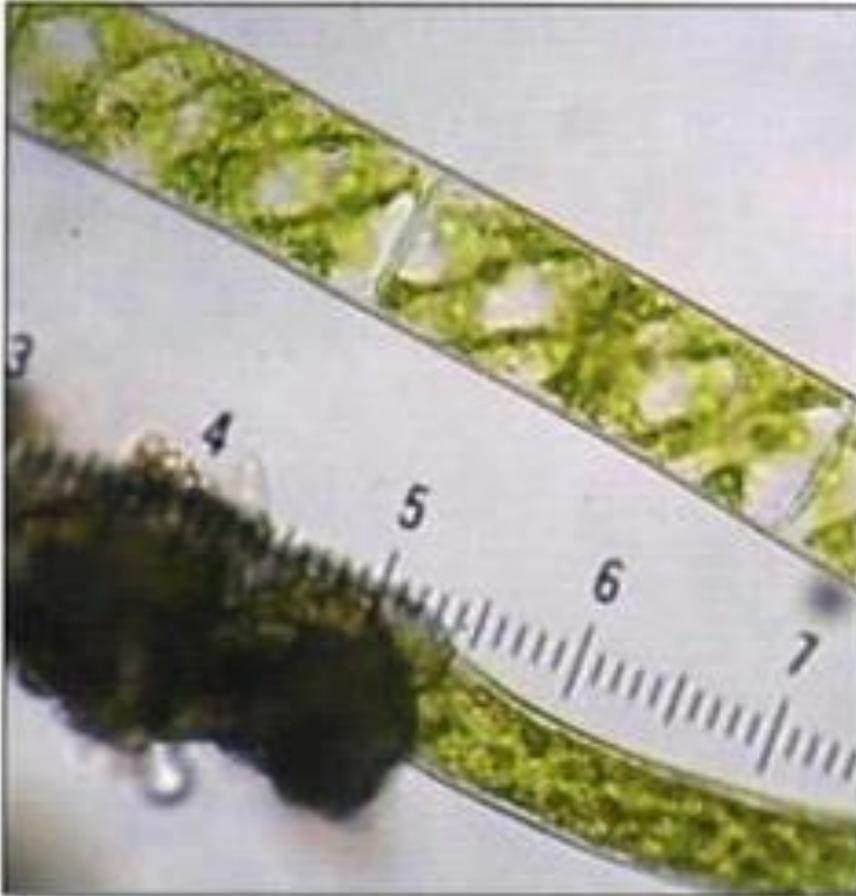


ATS™ – Algal Floway Community Changes based on Source Water and Seasons





Algae are fast-growing water organisms that absorb nutrients, release oxygen and can produce valuable natural fertilizers, soil ammendments or biochemical byproducts. . .



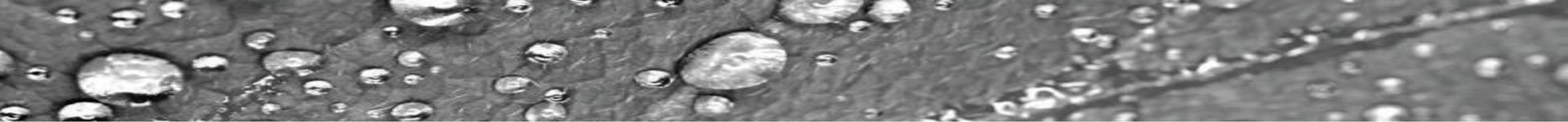
Controlled growth of algae is the driving force for water quality management in the Algal Turf Scrubber technology.

With the ATS technology we take advantage of the power of microalgae to take up nutrients and grow fast!

Pioneering modern ecologist H. T. Odum called this approach “ecological jujitsu” ...



Attached filamentous algal “turf” pulls nutrients and traps sediment from the inflowing water while pumping dissolved oxygen into the outflowing water.



Draft material prepared for consideration by the
Federal Leadership Committee for the Chesapeake Bay

9 September 2009

DRAFT REPORT

Focusing Resources to Restore and Protect the Chesapeake Bay and its Tributary Waters

Executive Order 13508, Section 202b Report

Draft material prepared for consideration by the
Federal Leadership Committee for the Chesapeake Bay

9 September 2009

Algal Turf Scrubber

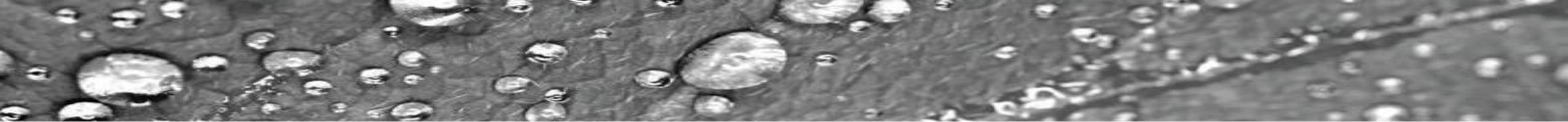
Dr. Walter Adey's 1980s algal turf scrubber (ATS) process, which is being used increasingly in Everglades clean up work, has not yet been applied to tackle the Chesapeake Bay nutrient problems. Dr. Kangas, University of Maryland professor, and Dr. Adey would like to see that change. ATS uses pretty simple technology – nutrient-laden water is diverted into raceways containing screens with algae. The algae absorb the nutrients and oxygenate the water, which is returned to its source. The two scientists are conducting a pilot in Lancaster County, PA to test the ATS technology in a temperate climate. Partnering with Exelon Power Company, which owns and operates Muddy Run Storage and the Conowingo Dam, the project is generating encouraging results. On-site researchers have measured a near doubling of oxygen concentration in waters after their journey through the raceways, while water samples analyzed at USDA's Beltsville facility showed nitrogen reductions of over 30 percent. The hardworking algae are harvested periodically to keep them at peak performance and the residue offers another opportunity according to the researchers – conversion to biofuels. The partners in this pilot are already talking about scaling up. Adey and Kangas have a vision of ATS systems on small strips of farmland along the rivers and creeks of the Chesapeake Bay Watershed (Chesapeake Quarterly, 2009). And they may not be alone in that vision, the Caroline County Conservation District is doing just that – testing a field-scale application of the ATS technology to achieve nutrient load reductions from agricultural drainage systems in the Upper Choptank River watershed. The project was funded in 2008 through the Chesapeake Bay Conservation Innovation Grants program, supported by USDA and the National Fish and Wildlife Foundation. The project team will be evaluating the feasibility of this innovative approach to nutrient reduction, including the overall maintenance costs and barriers to acceptance.



The Perdue AgriRecycle litter recycling plant on the Delmarva peninsula is an example of industry led solutions to a significant environmental issue. The plant has handled more than 500,000 tons of poultry litter in its first seven years of operation; reducing

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





US EPA's Chesapeake Bay Program Office
Expert Panel Report Recommendations
To Bay States for Algal Turf Scrubber
Implementation Guidance as an Approved
Best Management Practice (BMP) for
Water Quality Improvement

Nutrient and Sediment Reductions from Algal Flow-way Technologies

Recommendations to the Chesapeake Bay Program's
Water Quality Goal Implementation Team from the
Algal Flow-way Technologies BMP Expert Panel

Charles Bott, Mark Brush, Elizabeth Canuel, Matt Johnston, Pat Kangas, Sarah Lane,
Peter May, Walter Mulbry, Margaret Mulholland, David Sample, Kevin Sellner, and
Kurt Stephenson
October 21, 2015

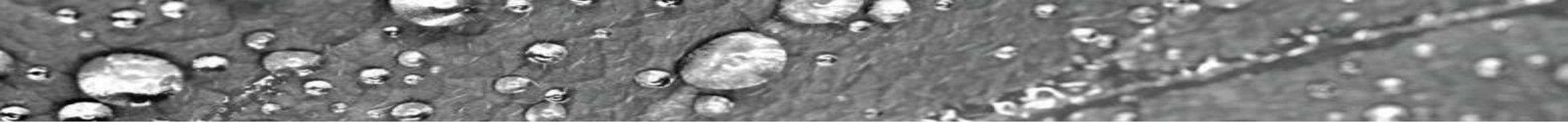


Port of Baltimore Algal Flow-way Installation (Courtesy of the Port of Baltimore)

The Port of Baltimore Pilot Algal Floway

- 61 m long x 2 m wide
- Lined with rubber membrane
- Nylon mesh screen
- Tipping buckets
- 0.5% slope
- Takes up N and P
- Removes sediment
- Harvested weekly
- Algae anaerobically digested to methane



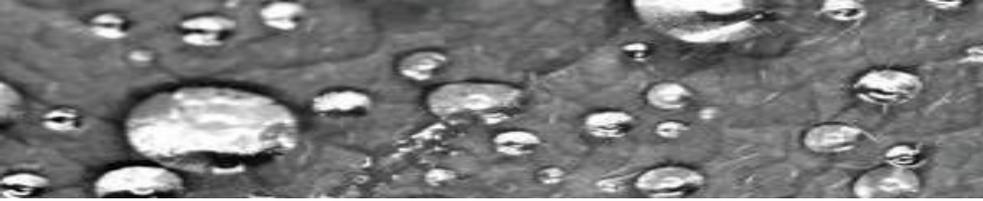


A Circular Farm Economy is a National Focus USDA 2/3/2022 Statement

- Nutrients / Fertilizers
- Carbon
- Energy
- Water Quality Improvement
- Soil Health Improvement
- Green Jobs

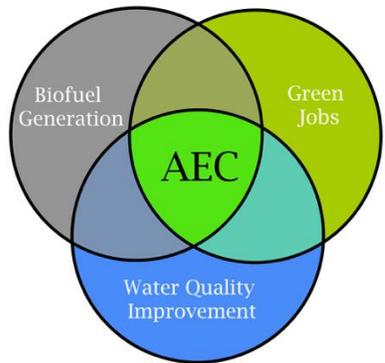
Algal Turf Scrubbers Can Be a Tool...

- Nutrient/Sediment Credit Trading
- Carbon Sequestration Credit Trading
- Farm Energy Production (Methane/Syngas)
- Free Fertilizers, Organic Soil Inputs
- Free High Protein Animal Feed



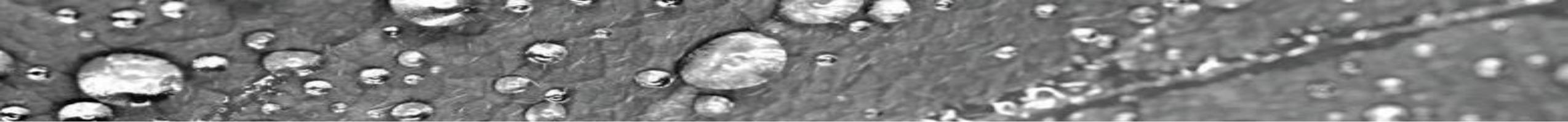
Farm Based ATS at
Bridgetown Farm on
Maryland's Eastern
Shore, solar powered,
drawing from a farm
drainage ditch.

UMD/AEC Project



Algal Ecotechnology Center
<http://www.enst.umd.edu/algae>





Large Scale ATS™

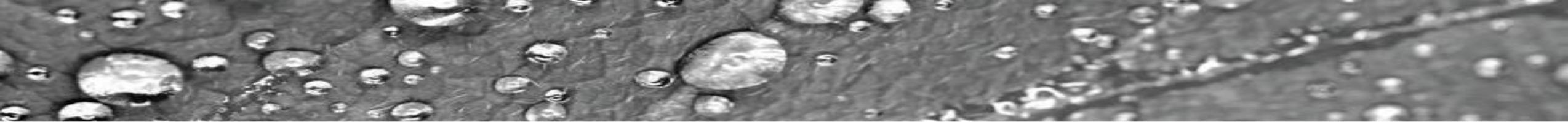
The ATS technology has been implemented at the very large scale in Florida and Texas by a commercial company named Hydromentia, headquartered in Ocala, Florida. Green Mechanics is partnered with Hydromentia on scaling up further systems, ideally in Chesapeake Bay's Watershed to support it's restoration.



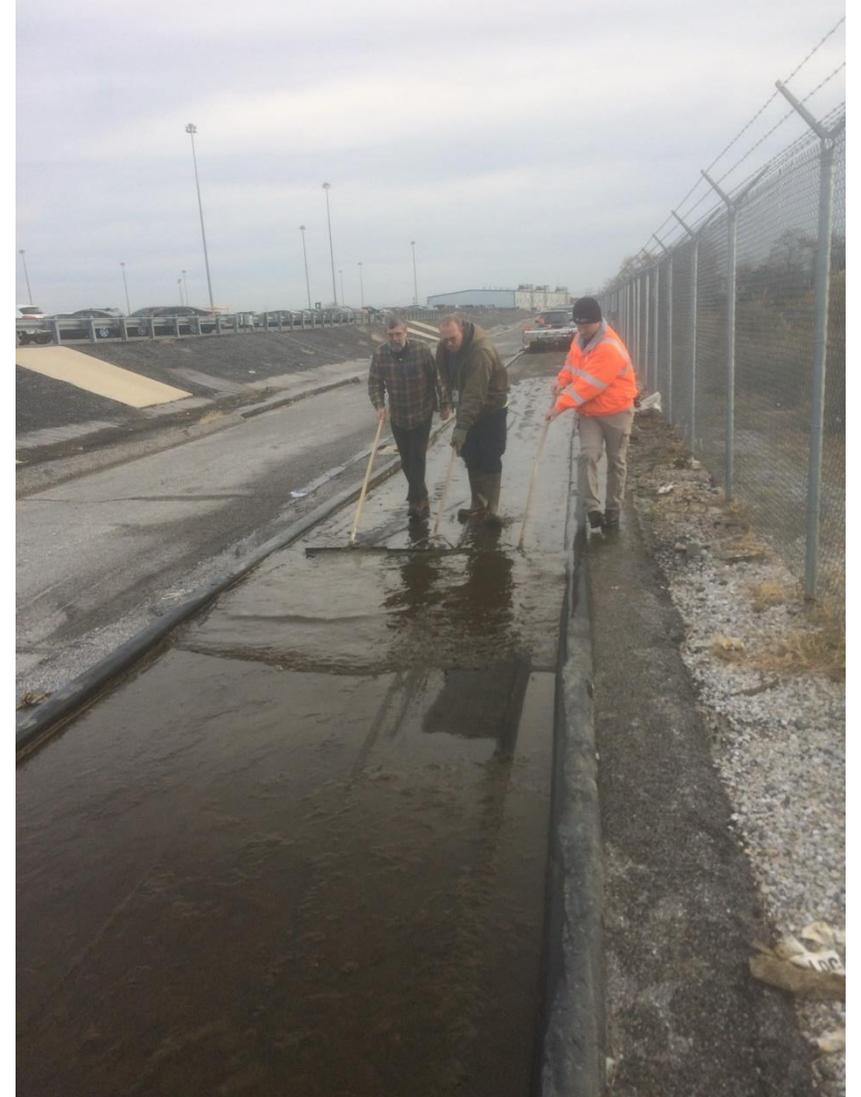
GREEN
MECHANICS



HydroMentia

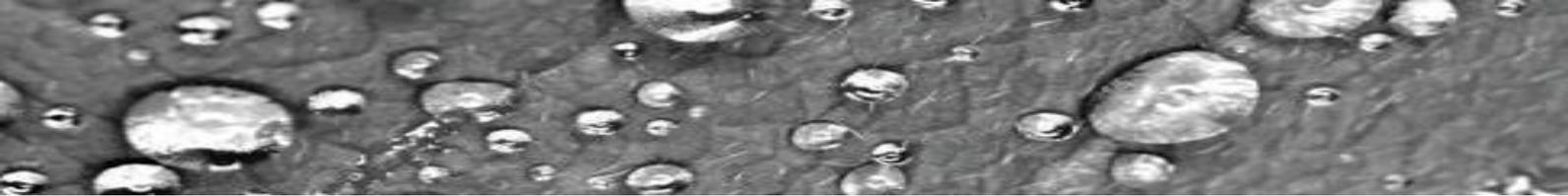


Two Pathways for Harvesting: Tractor vs Manual



Algal Ecotechnology Center
<http://www.enst.sumd.edu/algae>

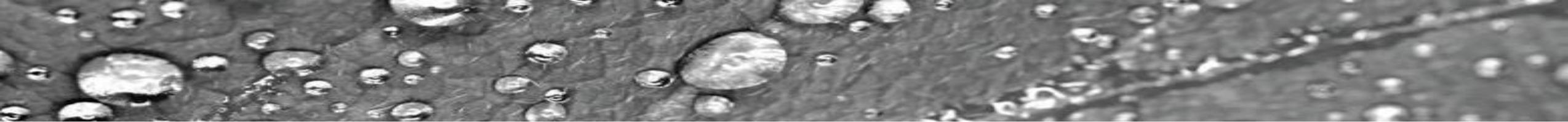




Farm Based ATS at
Bridgetown Farm on
Maryland's Eastern
Shore, solar powered,
drawing from a farm
drainage ditch. (UMD/AEC)

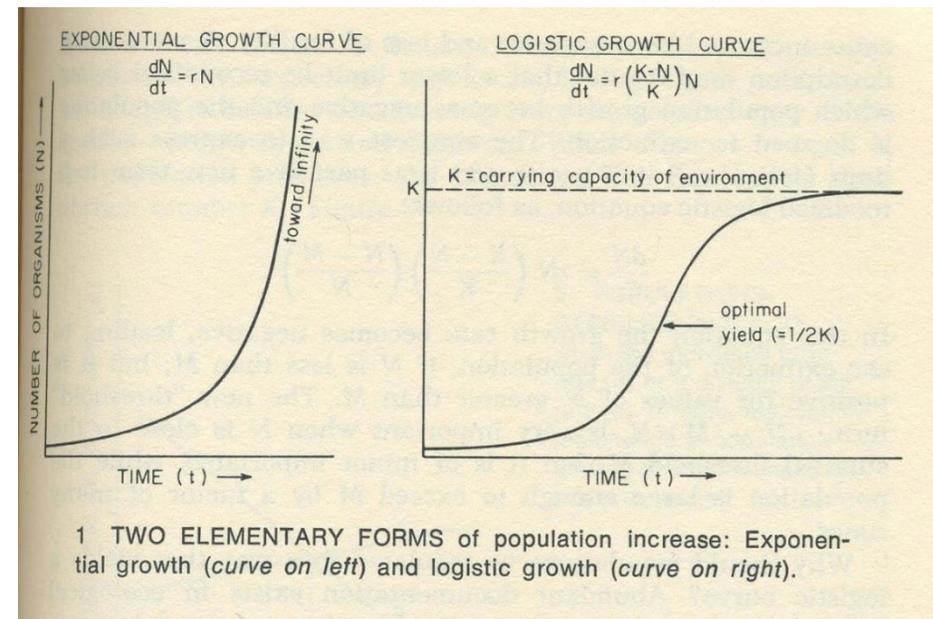
One hour harvest by hand,
5-10 minutes by machine





A key function in the ATS technology is harvesting the algae.

We can optimize productivity, and therefore nutrient uptake, by harvesting at the inflection point in the growth curve of the attached algae...and then the algae grows right back exponentially...



Thus, harvesting the ATS is like lawn mowing...

Operations and Maintenance

Larger Scale ATS Operations with Composting for Soil Ammendments



Potential Algal Biomass Products

Biofuel Production

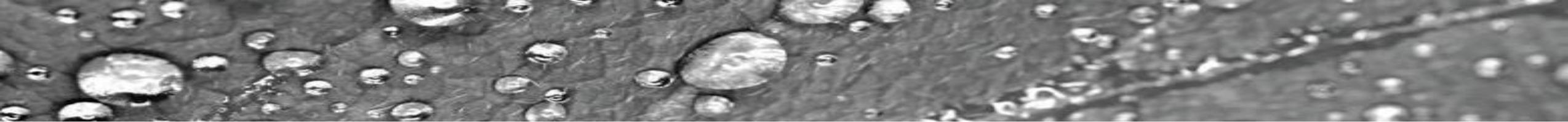
Omega 3s

Compost/Organic Fertilizer

Livestock Feed



One liter of biobutanol made from algae from a New York City Wastewater Treatment Plant Algal Turf Scrubber system

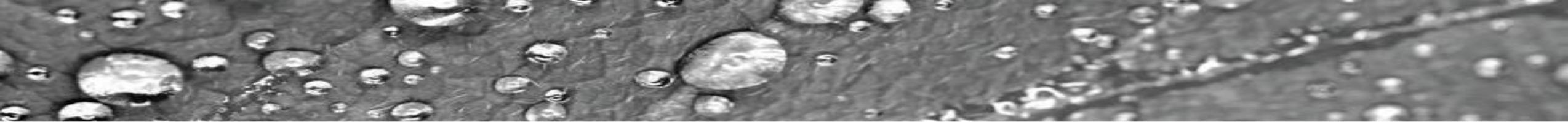


Algae end use at the Port of Baltimore ATS: Anaerobic Digestion to Microbial Fuel Cell

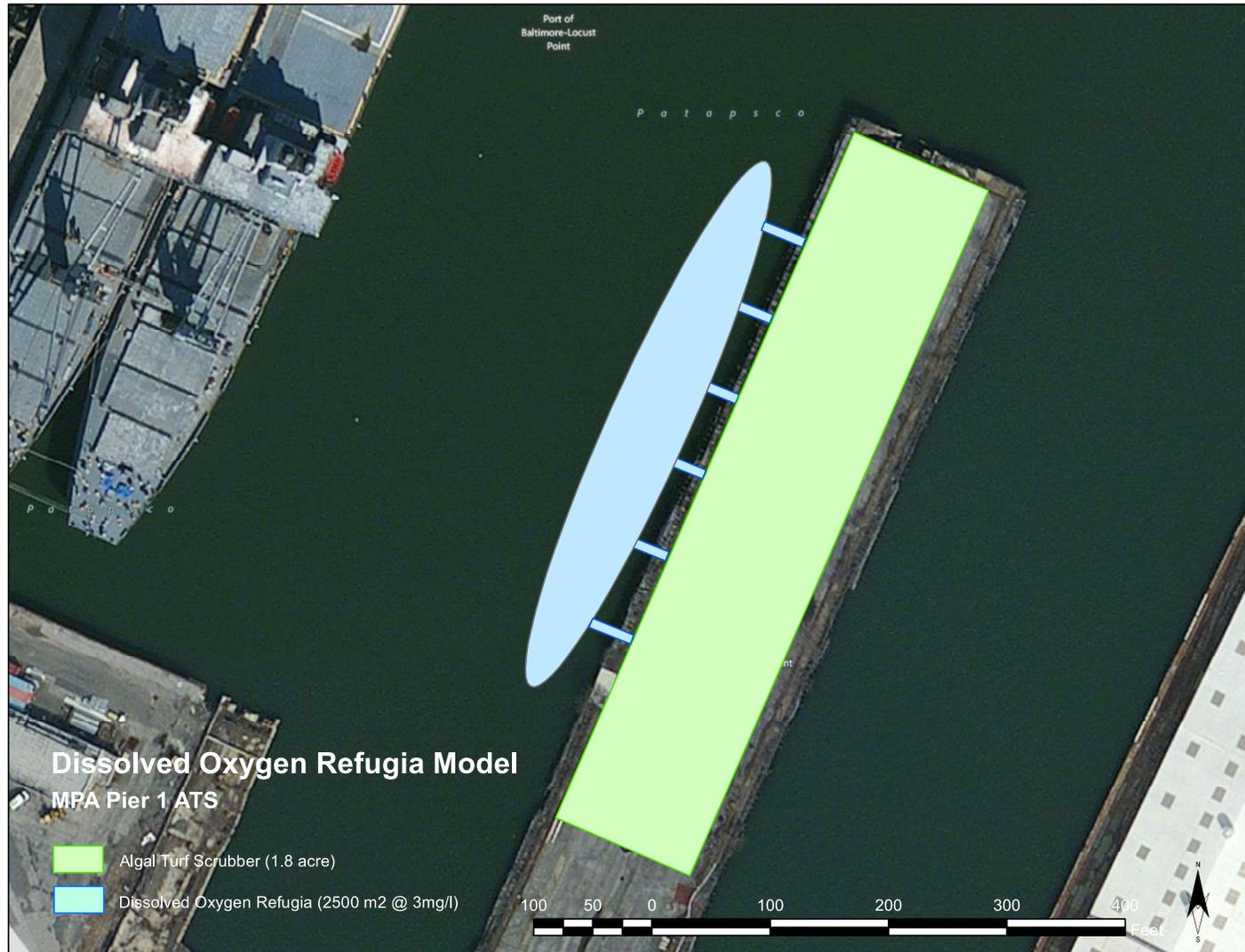
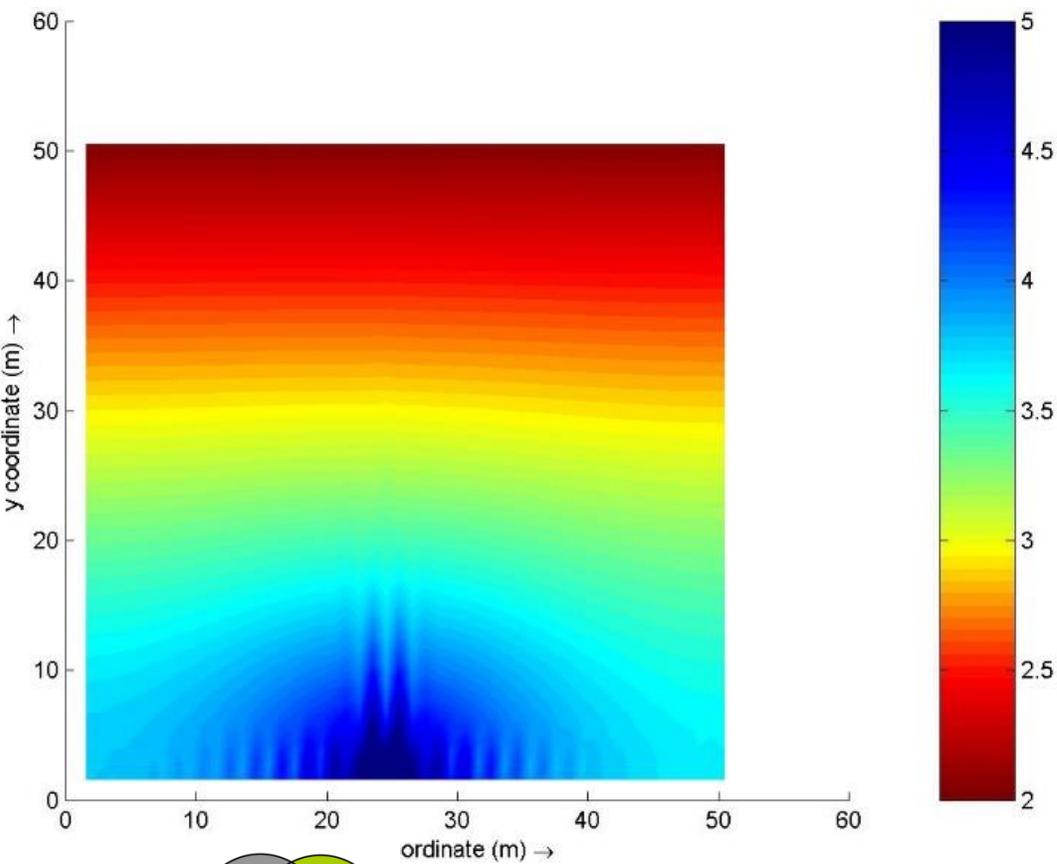
An ATS pilot at the Port of Baltimore with University of Maryland applied an experimental anaerobic digester to process the algae biomass into methane which was fed into a fuel cell to create electricity running lights at the system.

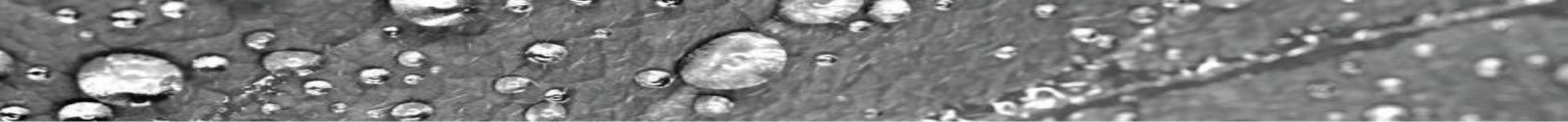


Algal Ecotechnology Center
<http://www.enst.umd.edu/algae>



Dissolved oxygen diffusion model results for DO refugia at Maryland Port Administration Pier 6. A UMD/AEC modeling study.





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 |

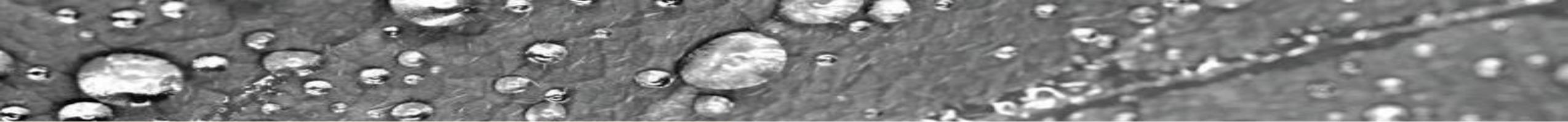
Comparison Data of Two Anacostia River ATS Operated Simultaneously in Summer and Fall of 2018

| Site | Weeks | ATS size m2 | Average Production Dry g/m2/day | TN lbs/ac/yr | TP lbs/ac/yr | Carbon lbs/ac/yr |
|----------------|-------|-------------|---------------------------------|--------------|--------------|------------------|
| Bladensburg MD | n=14 | 3.2 | 61.2 | 1098.5 | 143.9 | 7,107.1 |
| Washington DC | N=12 | 1.0 | 45.5 | 913.9 | 145.8 | 7,214.1 |

Anacostia River MD
Bladensburg
Waterfront Park ATS
Test Bed w/ UMD ENST
Students



Anacostia River DC
ATS Test Bed at AWS Pier
At Eastern Power
Boatclub Marina above
11st Bridge

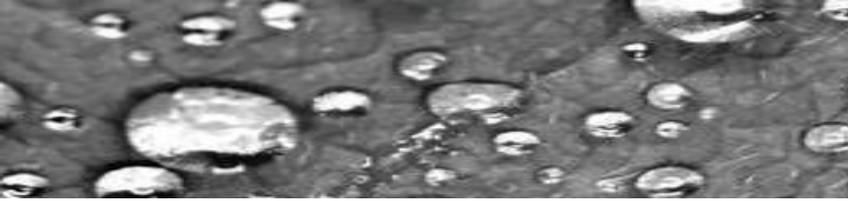


Anacostia River Bridge Impervious Acreages

| | |
|--|--------------------|
| Frederick Douglass / South Capital Street Bridge | 4.0 |
| 11 th Street Bridges (3) | 4.4 |
| Pennsylvania Avenue / John Sousa Bridge | 2.9 |
| East Capital Street / Whitney Young Bridge | 3.25 |
| Benning Road Bridge | 3.46 |
| New York Avenue / Route 50 Bridge | <u>1.06</u> |
| Total | 19.07 acres |

A One Quarter Acre ATS on Anacostia River would *Mitigate Total Nitrogen* for *ALL Bridges* with **21.05 acres** Of Urban Impervious Surface Runoff Impact

(Using 2018 AWS DC ATS / Eastern Powerboat Club Marina Data and the 2000 MDE Stormwater Manual)



Bladensburg Waterfront Park *current* new ATS flowways 2023-2026

Three 1meter x 15m
Algal Scrubber Flowways

Will mitigate *ALL* of park's
1.25 acre roadway/parking
for nitrogen

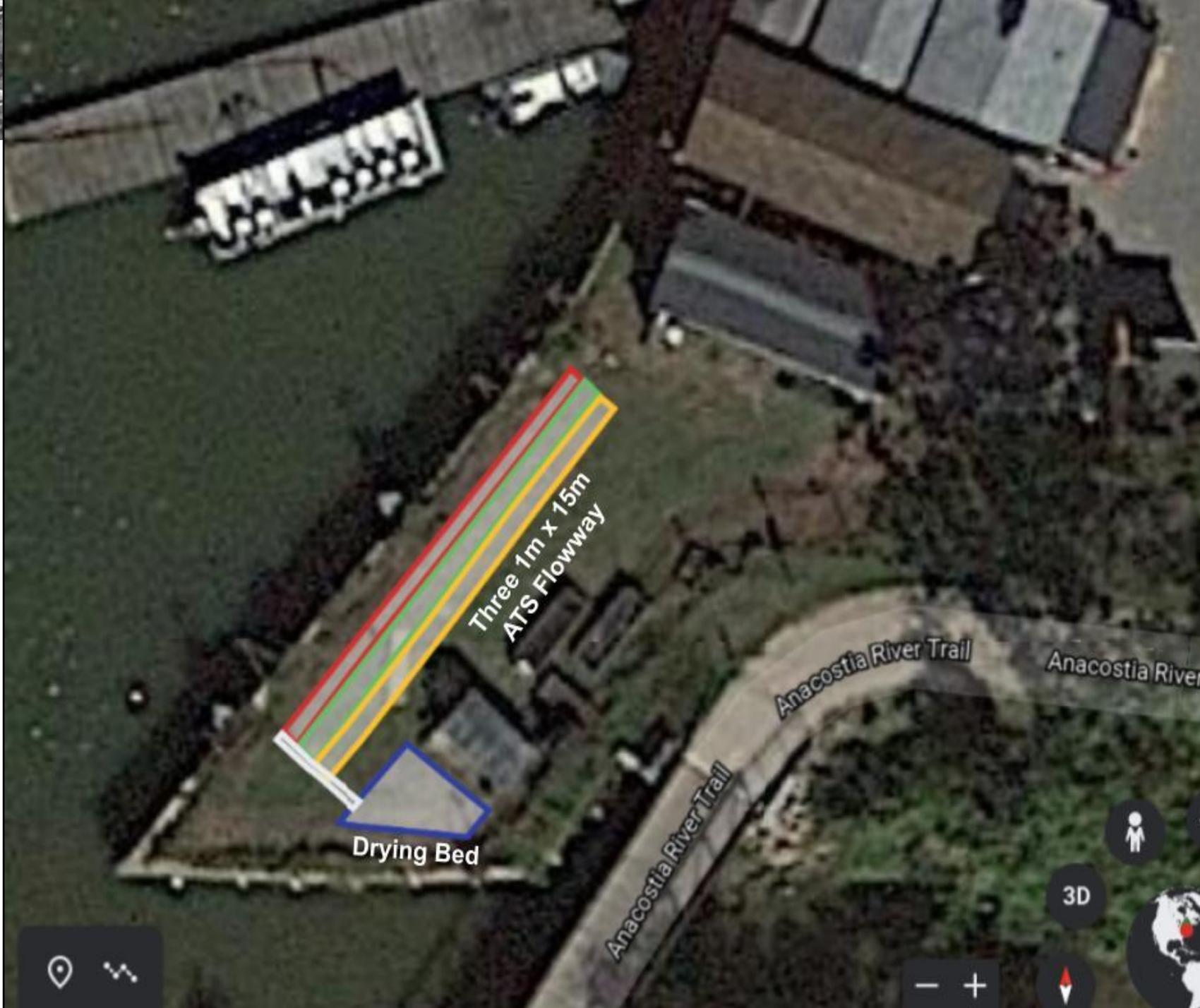
Built through a grant from
PG Parks to Green Mechanics

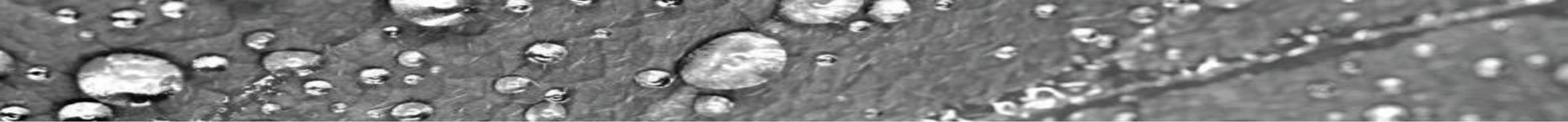


GREEN
MECHANICS



live more, play more



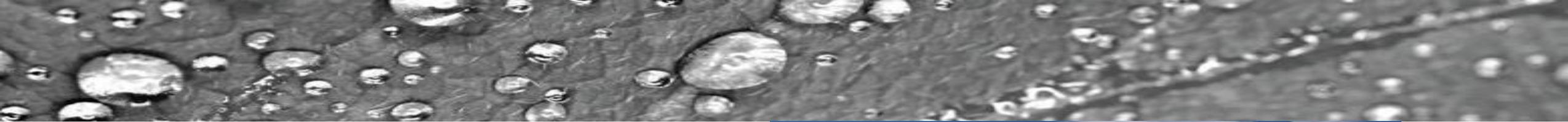


Three 15m x 1m Anacostia River pilot ATS built and operated in 2024 by Green Mechanics with a grant from Prince George's County Parks at Bladensburg Waterfront Park



Algae is squeegeed down the flowway into pipes that flow into drying beds where algae is weighed and calculated for nutrient and sediments

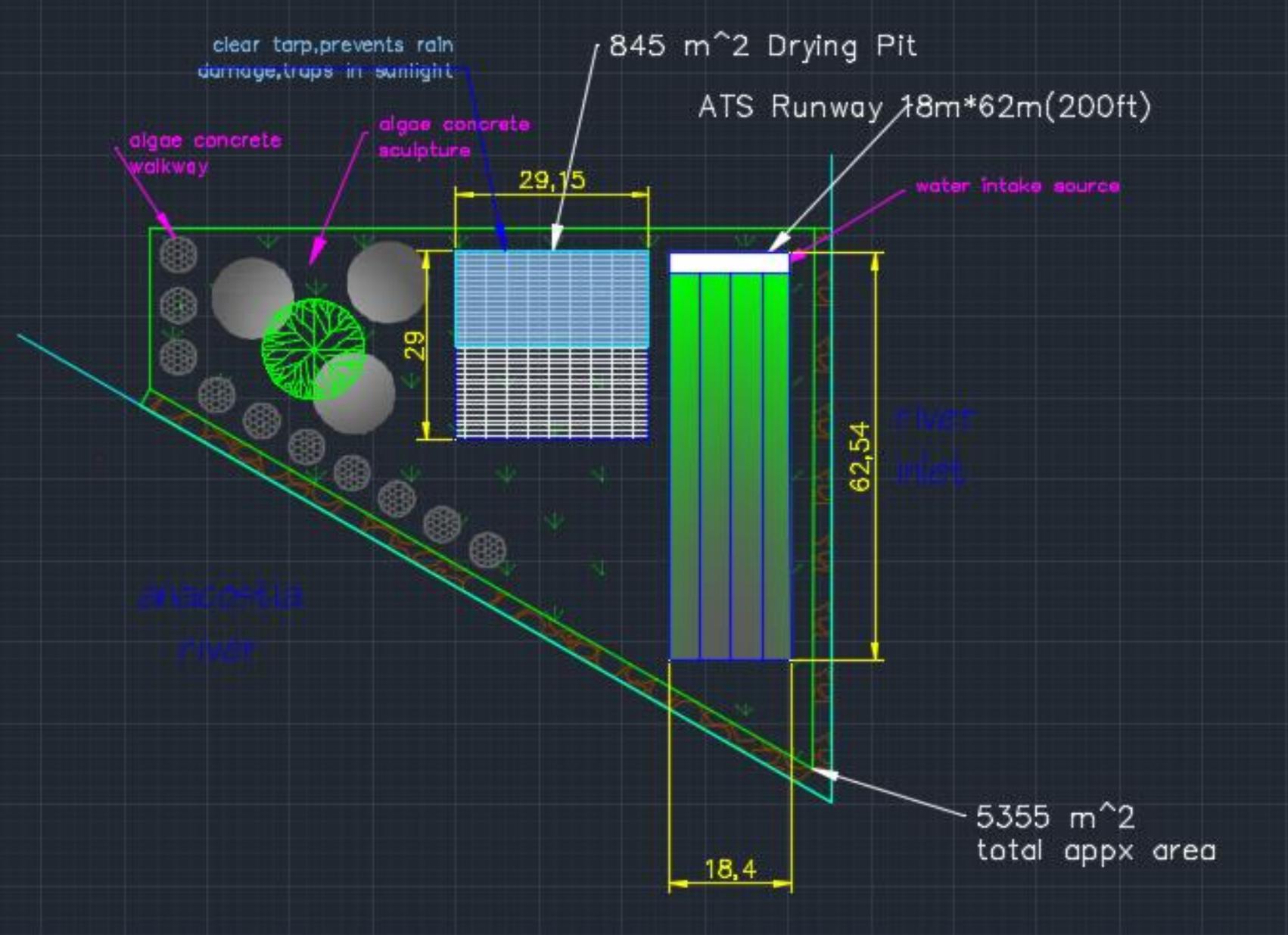
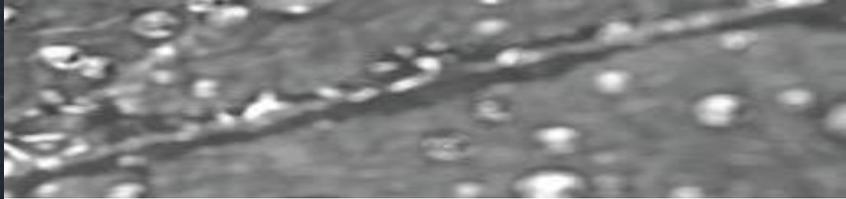




Prince George's Parks Bladensburg Waterfront Park on Anacostia River

A 1 acre scale-up ATS on land
owned by Maryland - National
Capital Parks and Planning
Commission (M-NCPPC) - would
receive TMDL credits





Bladensburg ATS DESIGN LAYOUT

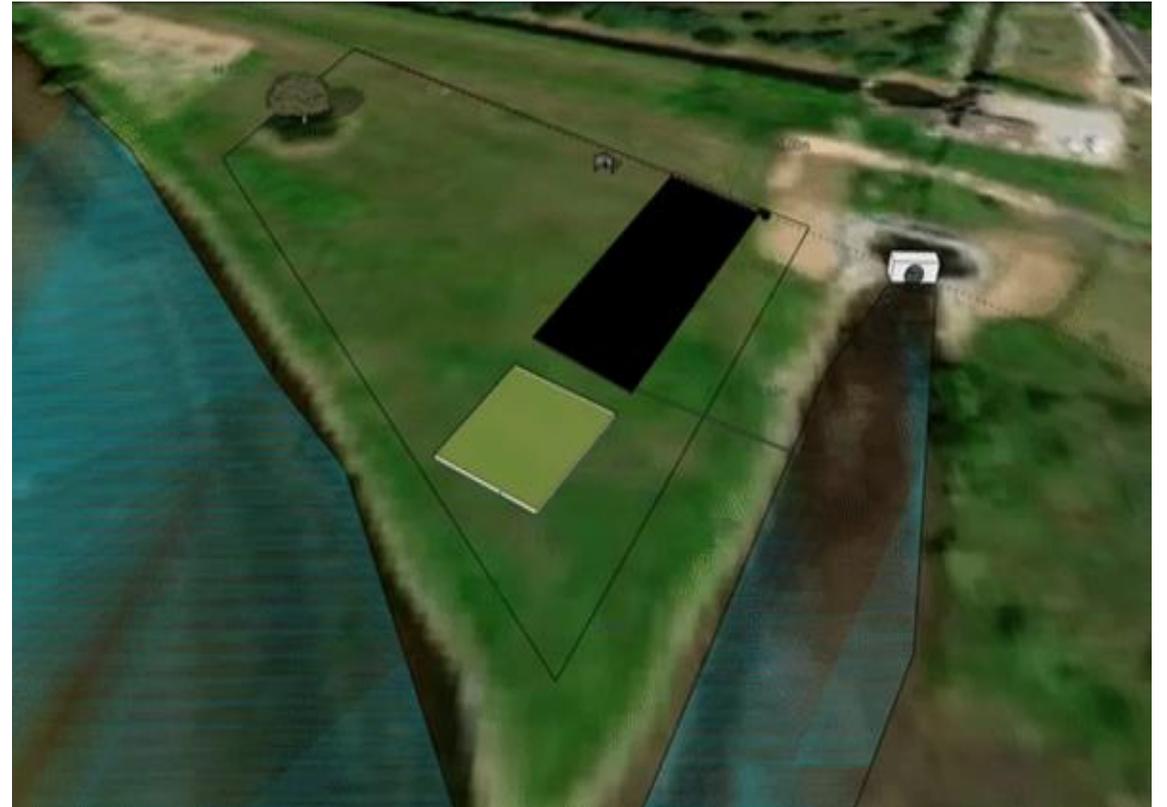
Outcome Goals: Environmental and Site

Improve total ecosystem health through:

The removal of nutrients and sediment

Carbon uptake for reuse or sequestration

Improve the dissolved oxygen concentration in receiving waters



GREEN
MECHANICS



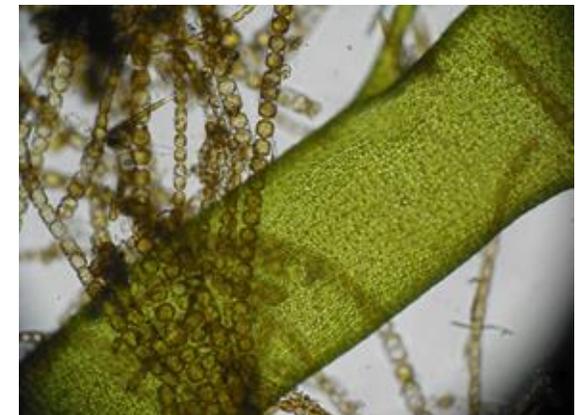
live more, play more

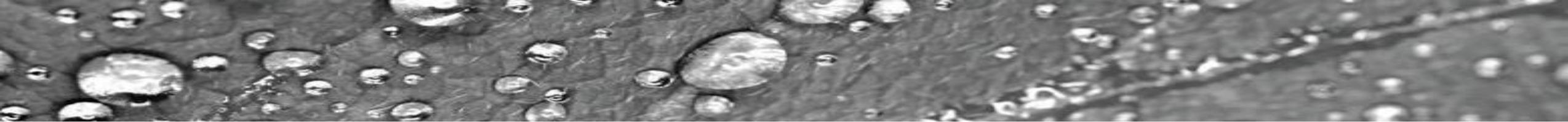
Total Maximum Daily Load (TMDL) Benefits

A one acre algae scrubber can provide up to 100 acres of impervious surface mitigation

for Nitrogen (based on 2018 Bladensburg UMD ATS biomass data)

| ----- Pollutant | ATS –BWP Amount Removed lbs/ac/yr (UMD 2018) | Urban Impervious Stormwater Inputs lbs/acre/yr (2020 MDE) | Equivalent Impervious Acres Treated acres/yr (2020 MDE) |
|---------------------------------|---|--|---|
| Nitrogen (lbs) | 1098.8 | 10.85 | 101.3 acres |
| Phosphorous (lbs) | 142.0 | 2.4 | 59.2 acres |
| Suspended Sediment (tons) | 41.88 | 0.46 | 91.0 acres |





Peter I. May: pimay@greenmechanics.co Kelly Fleming: kfleming@greenmechanics.co
Larry Davis: ldavis@greenmechanics.co Robert A. Walker: Roberta.walker@pgparks.com

Alliance for the Chesapeake Bay Municipal Leaders Visit to Bladensburg Waterfront Park ATS



GREEN
MECHANICS

Any Questions?



**Parks &
Recreation**
M-N-C-P-P-C

live more, play more