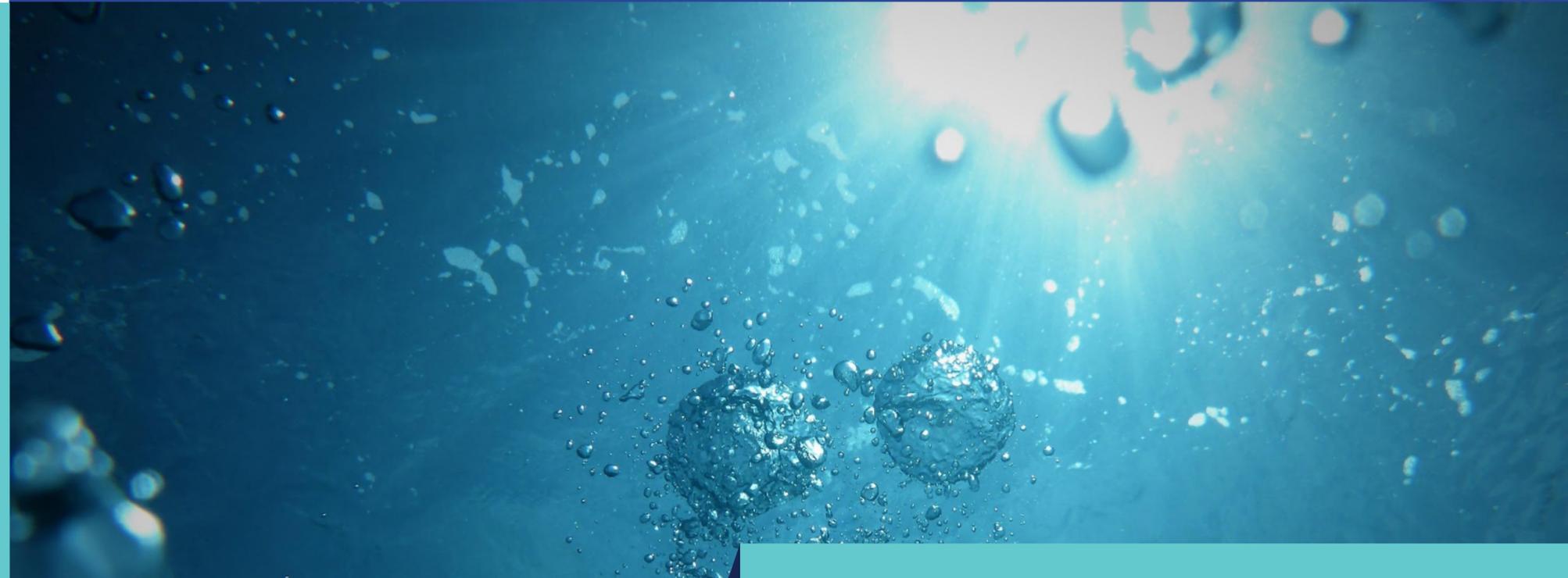


Remove nutrient pollution from water and return it as fertilizer



www.waterwarriorsinc.com

Water Warriors' technology removes nutrient pollution from water and returns it to the land as fertilizer. It is focused on making the world's water supply safer and cleaner through innovative, new products designed to revolutionize how water professionals remove harmful nutrients from water.



PROBLEM

The world's water supply is facing excess phosphorus pollution that is making our drinking water unsafe and destroying our environment. Existing treatment methods to remove phosphorus from water are either too expensive, too complex, require chemical dosing or are not capable of solving the problem.

SOLUTION

Poseidon Pellets adsorb harmful nutrients, such as phosphorus, from water. Once saturated, the pellets are so environmentally friendly they can be reused as a nutrient-rich, slow-release soil amendment.

- ▶ **Headquarter Location:**
Lexington, KY United States
- ▶ **Date Founded:**
September 2016
- ▶ **Money Raised to Date:**
\$0 Self-Funded
- ▶ **Team Size to date:**
3
- ▶ **Countries operating in:**
United States, United Kingdom, Australia

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Pilot description

Proof of concept to demonstrate the effectiveness of high-capacity water treatment pellets (“Poseidon Pellets”) to remove phosphorus from water.

Water Warriors will receive wastewater from The Coca-Cola Company with a low pH (2.5 range) and high concentration of phosphorus (8,000 mg/L to 35,000 mg/l range).

► Pilot KPIs

- 1) Reduce the phosphorus concentration to below 15 mg/L.
- 2) Increase pH level to 5 or above for wastewater.

► **The current phosphorus discharge limit is 20 mg/l or below.**

Problem

The Coca-Cola Company produces 600,000 gallons of high-strength phosphorus wastewater annually at a facility in Atlanta, GA. Due to the high concentrations of phosphorus and low pH levels, the liquid cannot be treated onsite and is currently being hauled away by a tanker truck on a weekly basis.

► Pilot Location:

Atlanta, United States

► Funding Provided:

\$35,343 USD

Solution

Water Warriors’ Poseidon Pellets will simultaneously raise the pH and remove phosphorus from water allowing the wastewater to be treated onsite while achieving the set phosphorus limit of 20 mg/l. This will save The Coca-Cola Company the trucking expense as well as avoid costly fines and surcharges for not meeting the phosphorus discharge limit.





Pilot goal

Demonstrate the effectiveness of Poseidon Pellets to reduce the phosphorus concentration and raise the pH allowing the wastewater to be treated onsite.

Confirm this treatment can take place within a specific period of time to keep up with the flow rates at the facility.

Determine if the pellet capacity for phosphorus adsorption is enough to be incorporated within current facility processes.

▶ KPI achievement:

- ▶ pH level of the influent raised from 2.5 to above 7 during testing period.
- ▶ Influent phosphorus level decreases from 12,000mg/l to below 15 mg/l.

Conclusions and findings

- ▶ Poseidon Pellets can raise the pH level to 5 or above and reduce phosphorus concentration to a manageable level to achieve 15 mg/l (with an additional polishing step).
- ▶ Potential pellet capacity is estimated to be 167 mg/g, according to the U.S. EPA lab testing conducted with Coca-Cola's wastewater.
- ▶ At the conclusion of Phase I of the pilot (June 2022), 2,000lbs of pellets treated 1,000 gallons of water and reached an estimated 63% capacity.
- ▶ The pilot confirmed a polishing step will be necessary to reduce phosphorus below 15 mg/l with untreated wastewater concentrations ranging between 8,000 mg/l to 35,000 mg/l.
- ▶ The 6 sample batches demonstrated the same phosphorus reduction behavior: more than 99% of the phosphorus was removed within the first 48 hours of exposure time to Poseidon Pellets. Most of the removal took place in 30 minutes with an average of 88% reduction in 30 minutes.

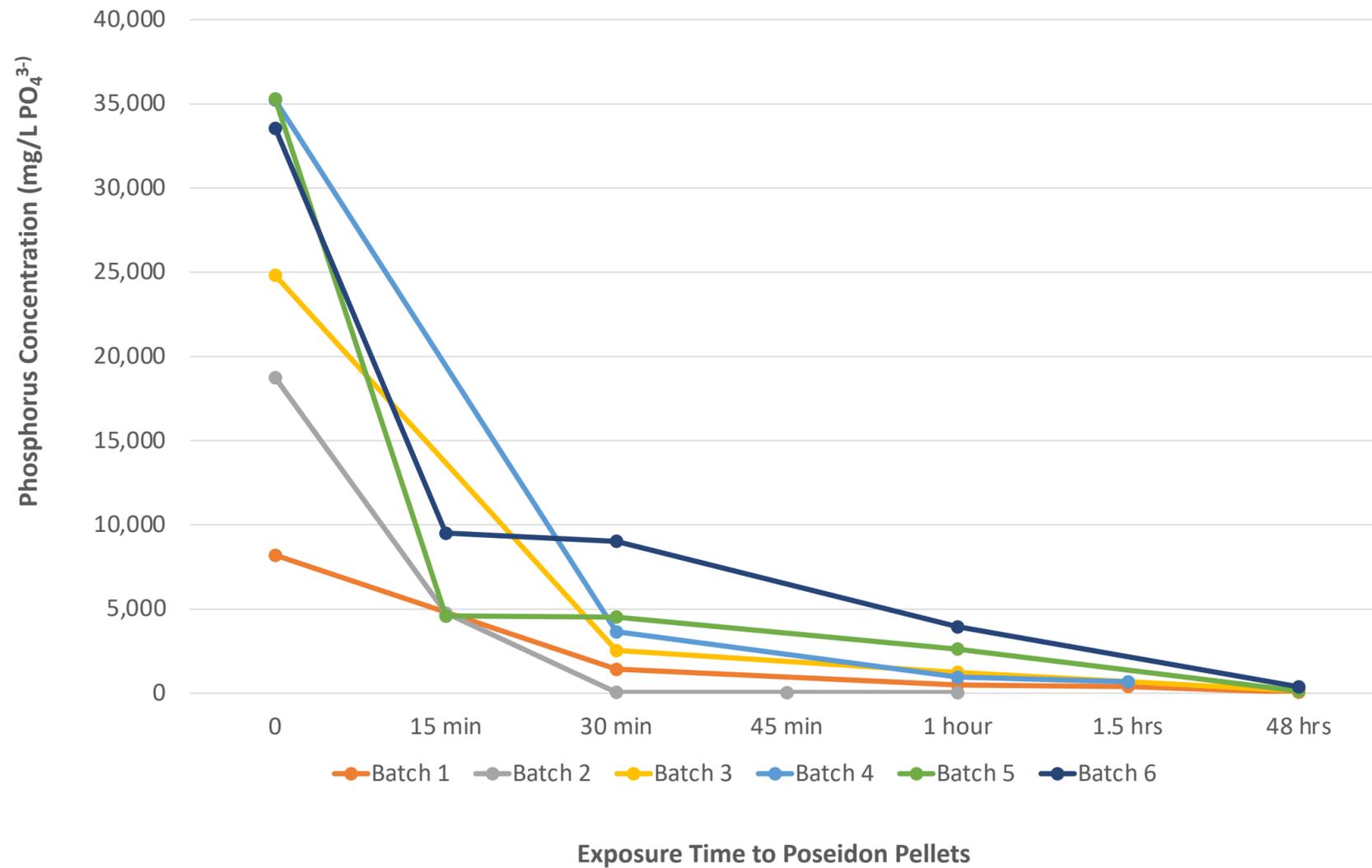


- ▶ Pilot setup with Coca Cola waste water exposure to Poseidon pellets



Pilot Findings

Phosphorus Concentration Reduction in 48 hour exposure to Poseidon Pellets



BATCH	Inlet P Concentration (MG/L)	Exit P Concentration (MG/L)	Percent Reduction of P (%)	Poseidon Pellet Accumulated Capacity
1	8.200	50	99,4%	4%
2	18.740	40	99,8%	11%
3	24.811	140	99,4%	20%
4	35.222	170	99,5%	34%
5	35.288	130	99,6%	47%
6	33.555	380	98,9%	63%



Pilot Timeline 2022

EPA Testing:

- Lab experiments conducted at U.S. EPA to determine phosphorus concentration in the Coca-Cola wastewater.
- Adsorption experiments with Poseidon Pellets to understand capacity and volume of pellets needed for the pilot.

2nd Batch Experimentation:

- Additional 150 gallons of Coca-Cola wastewater were transferred into the tank with the original 2,000 lbs. of Poseidon Pellets
- Samples taken and sent to the U.S. EPA for analysis.
- 99% phosphorus concentration removal achieved in less than 1 hour (reduced from 18,740 mg/l to 40 mg/l)
- An accumulation of 350 gallons treated

Phase I Completed:

- Poseidon Pellets demonstrated effective phosphorus concentration reduction to levels that allow wastewater to be treated onsite at the facility.
- A polishing step is recommended to achieve the phosphorus discharge goal of 15 mg/l.

January

February

April

May

June

July

1st Batch Experimentation:

- Installed 2,000 lbs. of Poseidon Pellets in a 1,000 gallon tank.
- 200 gallons of Coca-Cola wastewater were transferred into the tank.
- Samples taken and sent to U.S. EPA for analysis.
- 99% phosphorus concentration removal was achieved reducing (reduced from 8,200 mg/l to 50 mg/l.)

3rd – 6th Batch Experimentation:

- Additional 650 gallons of Coca-Cola wastewater were transferred into the tank with the original 2,000 lbs. of Poseidon Pellets
- Samples taken and sent to the U.S. EPA for analysis
- 99% phosphorus concentration removal achieved in less than 48 hours
- Poseidon Pellets show there is more capacity remaining and further phosphorus removal is possible.

Phase II:

- Additional 650 gallons of Coca-Cola wastewater were transferred into the tank with the original 2,000 lbs. of Poseidon Pellets
- Samples taken and sent to the U.S. EPA for analysis
- 99% phosphorus concentration removal achieved in less than 48 hours
- Poseidon Pellets show there is more capacity remaining and further phosphorus removal is possible.



Next Steps

- ▶ **Test theoretical pellet capacity**
- ▶ **Optimize the phosphorus removal process with polishing**
- ▶ **Develop the process method and design.**
- ▶ **Develop business case to install in full scale operations**
- ▶ **Determine cost effective by-product upcycling**

Phase II pilot

1. Run tests to polish the phosphorus through a secondary treatment system to lower levels down to 15 mg/l or below
2. Retrofit 2 totes to be used for the polishing phase.
3. Supply 1,000 lbs of 2nd Gen Poseidon Pellets.
4. Supply 1,200 lbs. of Poseidon Pellets - Phosphorus sorption media (PSM).
5. Samples will be collected at 4 sample points:
 - initial untreated wastewater
 - exit of the main treatment tank
 - exit of tote #1 with Poseidon Pellets
 - final exit after tote #2 with 2nd Gen Poseidon Pellets to polish the phosphorus and biochar as a sediment remover.
6. Tests will be analyzed at the U.S. EPA.
7. Toxicology testing will be conducted by a 3rd party lab

Phase II KPIs

- ▶ 600 Gallons Treated
- ▶ Validate/Invalidate current theoretical pellet capacity of 167 mg/g
- ▶ Measure phosphorus adsorbed in lbs.
- ▶ Measure for each batch:
 - volume of liquid
 - contact time
 - inlet and exit phosphorus levels in mg/l
 - Phosphorus concentration reduction in %
- ▶ Pellet price will be determined per pound. This will correlate pounds of pellets needed to remove one pound of Phosphorus while raising the pH to an acceptable/neutral level.



Additional use cases for Poseidon Pellets:

▶ **Municipal and Industrial Wastewater:**

Reduce phosphorus to 1 mg/l or below. The pellets are chemical free and can be reused as fertilizer. This is an important reuse of a limited resource. (The Coca-Cola Company Pilot Category)

▶ **Sustainable Aquaculture:**

Solve the excess phosphorus runoff in fish farms therefore contributing to the overall health of the farm.

▶ **Waterways Restoration:**

Reduce nutrient pollution in most waterways. We don't sink or push the problem downstream -- we remove the harmful nutrients.

▶ **Stormwater Management:**

Poseidon Pellets can be customized for almost any stormwater containment system. Our dual application methods solve small to extremely large needs for phosphorus removal.

▶ **Phosphorus Runoff:**

Ideal solution for nonpoint runoff of from animal waste.

Companies Water Warriors has also worked with:

- WPL
- Rockdale, Wisconsin WWTP
- Curtis, Wisconsin WWTP
- Phoslock Environmental Technologies (PET)
- City of Orlando, Florida
- Riverance



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Awards and Accelerators



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