WHITE PAPER

SEEING GREEN: NUTRIENT RECOVERY SOLUTIONS CONTRIBUTE TO SUSTAINABLE CIRCULAR ECONOMY

A partnership between Evoqua and Ostara brings eco-friendly phosphorus recovery technology to wastewater plants

For today's wastewater plants, addressing nutrient content in discharge is a growing concern due to an increased focus on water quality issues and new environmental regulations around nutrient pollution. Wastewater operators are facing emerging requirements for the removal of phosphorus in particular, which can cause harm to the environment if left untreated. States like Colorado and Utah have recently implemented statewide effluent limits for phosphorus, with more likely to follow in the coming years.

For plant operators tasked with balancing operational expenditures, maintenance, and overall compliance, managing phosphorus recovery efforts may sound like a significant undertaking. But with today's nutrient recovery technology, treatment plants can efficiently improve water quality, meet discharge requirements, and convert phosphorus into an eco-friendly fertilizer.

Companies like Evoqua Water Technologies and Ostara are offering cutting-edge nutrient recovery technology that brings operational efficiencies, economic benefits and environmental rewards.

A Perfect Partnership

In the fall of 2021, Evoqua and Ostara announced their new partnership designed to combine Evoqua's extensive wastewater treatment technologies with Ostara's market-leading nutrient recovery solutions to ultimately help customers recover nutrients and convert them into marketable fertilizers.

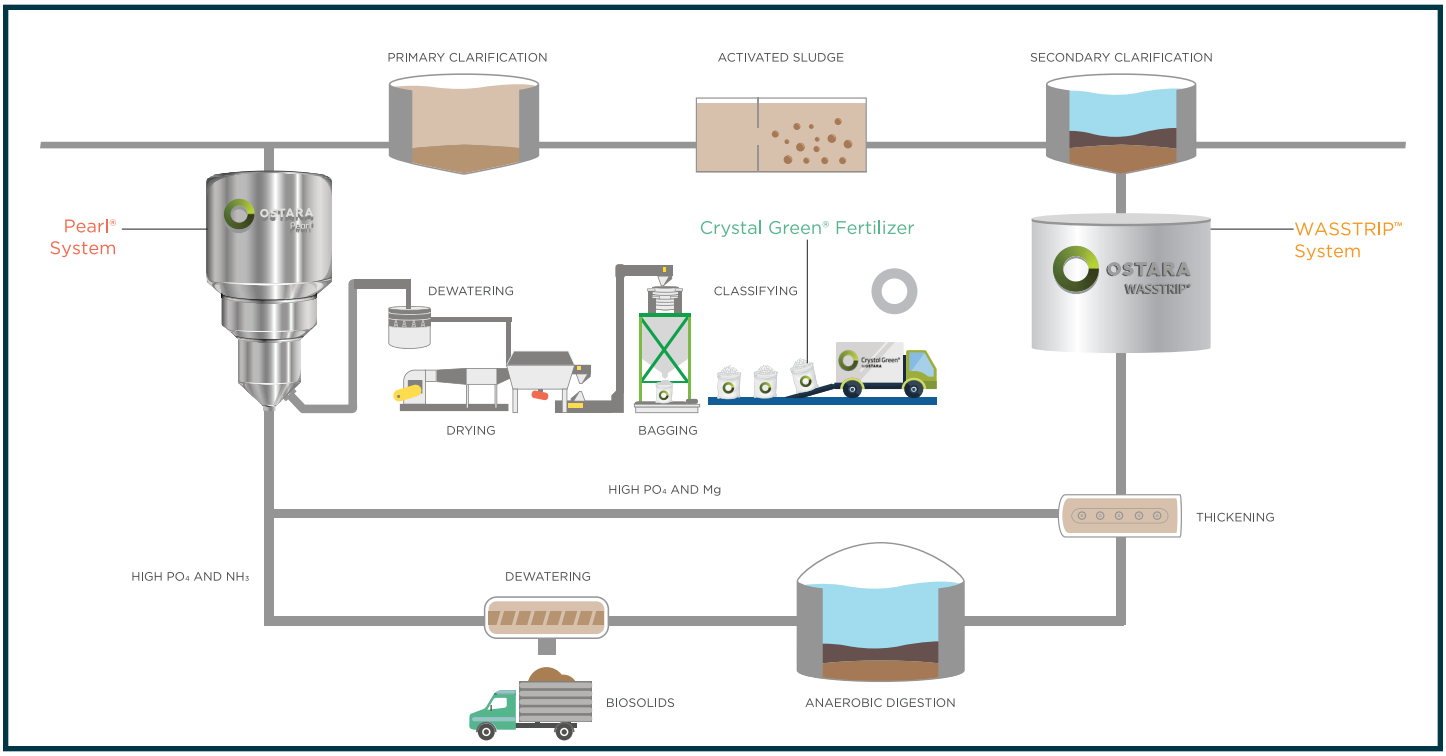
Evoqua brings a strong sales network, engineering skills and project management capabilities, while Ostara brings years of fertilizer management and core nutrient recovery process development to the table.

Ostara's Pearl® system recovers nutrients to create an eco-friendly fertilizer. Evoqua is leading sales and implementation efforts for the system through their partnership.

"This is a peanut butter and chocolate moment where you've got Evoqua capabilities and Ostara capabilities, they're even better together," said Matthew Kuzma, Vice President of Nutrient Recovery Systems at Ostara. "It really allows both parties to play off their strengths without overlapping or competing."

Casey Whittier, Product Manager at Evoqua, said this partnership helps to further Evoqua's goal of expanding its sustainable solutions. The collaboration has also allowed Evoqua to expand its nutrient removal capabilities into true nutrient recovery.

"Phosphorus removal is a big area that we play in with a number of technologies," Whittier said. "What we were missing and was a gap that this partnership helped to fill, was the phosphorus recovery side of things, making a sustainable product with the fertilizer offtake. For us, it was a really nice fit into our overall phosphorous solutions."



Ostara's nutrient recovery system breaks down into two main components: the Pearl system and the WASSTRIP™ system. The Pearl removes phosphorus from a treatment system, and the WASSTRIP system releases phosphorus upstream in facilities that use anaerobic digestion, turbo-charging the removal and recovery process. The end product is crystalline fertilizer granules that are bagged and sold as Crystal Green® fertilizer.

A Sustainable Solution

The partnership between Evoqua and Ostara has resulted in the offering of Ostara's Pearl® system, a fluidized bed reactor that harvests nutrients from wastewater and transforms them into a mineral fertilizer. The customizable treatment solution recovers phosphorus from pre-and post-digestion liquors through the controlled precipitation of crystalline struvite (magnesium ammonium phosphate). The system facilitates the growth of struvite with the addition of magnesium in a controlled pH environment.

Designed to complement the Pearl system, the WASSTRIP™ system brings added benefits for treatment plants that use anaerobic digestion by releasing phosphorus and magnesium from waste activated sludge upstream before they reach the digester.

Whittier explains that without the Pearl system and WASSTRIP system, sludge will release nutrients like phosphorus and nitrogen once they hit the digester. Those nutrients will then circle through the plant and eventually require removal via chemicals, and struvite will often form in the digester and pipes as a scale that poses maintenance problems rather than a usable product.

Kuzma compares the process to a sponge, where the phosphorus accumulating organisms in the liquid treatment process absorb the phosphorus like a sponge.

"Once you hold them under anaerobic conditions, it's like squeezing the sponge and it releases it back out," he said. With the WASSTRIP system, the sponge is squeezed early and nutrients are directed to the Pearl system reactor for controlled struvite formation.

Those crystallized struvite fertilizer granules are then available to be harvested, distributed and sold by Ostara as its Crystal Green® Fertilizer. The treated discharge exits the top of the Pearl reactor and returns to the plant with an up to 85 percent reduction in phosphorus and 40 percent reduction of ammonia nitrogen.

Kuzma explains that the Pearl system and WASSTRIP system help to solve the unintended consequences of

combined biological removal processes with anaerobic digestion.

"You have a growing adoption of bio-P processes that are more economically and environmentally sustainable. And you have increased adoption of anaerobic digestion for energy recovery, which is more environmentally and economically beneficial in the big picture," he said, "but when you put those two things together you end up with a struvite problem unless you proactively address it."

The Pearl with WASSTRIP system solve struvite problems head on, so facilities no longer need to choose between biological phosphorus removal and anaerobic digestion.

The Benefits of Phosphorus Recovery

Many broad industry trends are factoring into the recent push for wastewater nutrient recovery. For one, a rising need for nutrients from a growing and urbanizing population means it's crucial that nutrients do not go to waste and cause damage to natural ecosystems and human health.

Wastewater plants are looking to mitigate environmental impacts like eutrophication, whereby excess nutrients like nitrogen and phosphorus build up in waterways and cause toxic algae blooms.

The industry is also seeing growing adoption of anaerobic digestion, which has the benefit of renewable biogas production and also moves nutrients into a soluble phase where they are more readily available for recovery.

Kuzma emphasizes the importance of distinguishing the difference between phosphorus recovery and phosphorus sequestration, which produce different outcomes. Where recovery results in a renewable product, sequestration may not. Kuzma said some companies promote the concept of recovery while ultimately putting struvite into biosolids, which may not reduce eutrophication, offset phosphate mining or generate a renewable crystalline fertilizer product.

Phosphorus recovery ultimately contributes to a circular economy, solving the issue of nutrient pollution and nutrient waste at the same time. Plants can financially benefit from the sale of a phosphorus-based fertilizer while removing it from waterways.

Green Product, Green Outcome

A closer look at Ostara's Crystal Green fertilizer makes clear the many environmental and economic benefits of phosphorus recovery.

On the environmental side, each ton of fertilizer recovered means a greenhouse gas emissions reduction of 1-5 tons of carbon dioxide equivalent (CO_2e), depending

LCA Analysis Summary - impact per unit of crop yield

Percentage change in crop yield and environmental impact to produce 1 kg of crop when conventional fertilizers partially displaced by Crystal Green fertilizer

Impact Category		CROP	Potato	Potato	Corn (maize)	Canola (Rapeseed)
		LOCATION	Minnesota, USA	Koźle, Poland	Illinois, USA	Manitoba, Canada
	Units	CROP YIELD	+12%	+16%	+5.5%	+6.8%
Global Warming Potential	kg CO_2 equivalent		-10.60%	-15.60%	-4.40%	-5.90%
Eutrophication (freshwater)	kg P equivalent		-52.40%	-41.00%	N/A*	-54.40%
Phosphate Rock Extraction	kg P in phosphate rock		-46.50%	-31.60%	-26.00%	-18.10%

Notes: **GREEN** = CG has a lower impact (< - 5%) than MAP/DAP.
BLUE = CG has a lower impact (0 to -5%) than MAP/DAP.
RED = CG has a greater impact than MAP/DAP.

* The value is a negative number and cannot be meaningfully assessed as a percentage change. The change represents a benefit of more than one order of magnitude.

Life Cycle Analysis performed by Environmental Resources Management

Crystal Green fertilizer provides phosphate, nitrogen and magnesium throughout the growing season in response to crop demand. This ongoing access to nutrients helps crops reach yield potential while reducing soil tie-up and nutrient runoff.

upon factors like location and the crop grown.

Using the fertilizer also has a significant impact on freshwater eutrophication, with reduced phosphorus discharge and reduced phosphorus in biosolids. This effect can range from a 40 percent reduction of a negative environmental impact to a full conversion of a negative into a net positive impact, as determined by a recent third-party lifecycle analysis (LCA).

Recovery of Crystal Green fertilizer can also reduce the demand for phosphate rock mining by up to 46 percent (per the previously referenced LCA analysis). This is especially important since phosphate is a finite resource and mining can cause destruction to natural habitats.

From a business standpoint, Kuzma notes that the fertilizer helps reduce phosphorus runoff from the agricultural application side in addition to benefiting the wastewater plant operations, thus helping with both point source and non-point source nutrient challenges.

Ostara takes care of the commercial aspect of the process by buying the Crystal Green fertilizer from the wastewater plants so they can focus on what they do best, with Ostara then re-selling into the fertilizer market. The fertilizer brings wastewater facilities guaranteed revenue, as it is a demonstrated viable and marketable end product.

"Getting it into a form that's a crystalline mineral fertilizer allows you to transport it cost-effectively and store it stably to enter the true fertilizer market," Kuzma said. "The unique components of the fertilizer then really become repeatability, storability and consistency."

As market trends point wastewater treatment facilities in the direction of nutrient recovery, anaerobic digestion and biological removal processes, solutions from companies like Evoqua and Ostara can fulfill multiple goals at once. For plants looking to stay ahead of industry progress and meet compliance requirements while increasing profits, phosphorus recovery solutions are a worthy investment.

Click here to learn more about Evoqua's Nutrient Recovery Solutions or connect with a product expert!

ABOUT EVOQUA WATER TECHNOLOGIES:

Evoqua Water Technologies is a leading provider of mission critical water and wastewater treatment solutions, offering a broad portfolio of products, services and expertise to support industrial, municipal and recreational customers who value water. Evoqua has worked to protect water, the environment and its employees for more than 100 years, earning a reputation for quality, safety and reliability around the world. Headquartered in Pittsburgh, Pennsylvania, the company operates in more than 150 locations across ten countries. Serving more than 38,000 customers and 200,000 installations worldwide, our employees are united by a common purpose: Transforming Water. Enriching Life®.

evoqua WATER TECHNOLOGIES

CRYSTAL GREEN, PEARL, AND WASSTRIP ARE TRADEMARKS LICENSED BY OR THROUGH OSTARA NUTRIENT RECOVERY TECHNOLOGIES INC.