Salinity SOLUTIONS		DOC No.	100051
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PROJECT	Somerset Council P Removal	TITLE	Sampling and Pre-treatment Trial 2024

SUMMARY

The report contains an analysis of the importance of pre-treatment and consistent sampling of wastewater effluent, for the continuous production of P credits. Key findings from this study are:

- Wastewater effluent quality fluctuates significantly, so pre-treatment process needs to be robust for delivering a suitable feedwater supply to the HyBatch™ process
- UF as a proposed pre-treatment technology was suitable, this allowed for 3 weeks of continuous operation consistently removing over 96% of Total-P from the waste stream, as well as recovering 95% of treated wastewater.
- Seasonal fluctuations in Fivehead wastewater quality still needs to be explored, this can be achieved within a 12-month period, including the installation of a 25 m^3/day system for 6 months before installing a larger capacity system. The installation of the smaller system allows P credits to be generated instantly.
- A commercial model was developed to include the 6-month trial of a smaller unit, with precautions of tankering costs of the waste product, a safety factor on the amount of downtime for cleaning/membrane changes.

Please note this report is a condensed summary of the original sampling and pre-treatment trial report

Abbreviations

SEC	Specific Energy Consumption
UF	Ultrafiltration membrane process
BRO/BUF 10	UF pilot unit supplied by PCI membranes
B1 module	Testing module part of the PCI BRO/BUF pilot unit
HyBatch™	Salinity's patented HyBatch™ Technology
MWCO	Molecular weight cut off
STT	Single tube tester (part of PCI BRO/BUF pilot unit)
TP	Total phosphorus
P-Credit	Phosphorus Credit
CIP	Clean-in-Place
RO	Reverse Osmosis

1 Introduction

In July 2023 a two-week field trial was provided by Salinity Solutions at Fivehead wastewater treatment works near Taunton, to establish the effectiveness of HyBatch™ technology for the removal of phosphorus as part of the nutrient neutrality challenge. It was demonstrated that over 96% of total phosphorus (TP) was removed by HyBatch™ and therefore the trial was deemed a success.

However, it was observed that high concentrations of organics and solids in the feedwater caused fouling of the HyBatch™ system and regular downtime was required for system cleaning. It was therefore recommended that a follow-up trial was required on Fivehead feedwater in order to identify an effective pre-treatment to allow the HyBatch™ system to operate optimally for sustained periods.

Alongside this technical validation, it was important to measure the concentration of TP in the feedwater to establish whether an adequate concentration was present for the generation of P credits.

Understanding TP levels, along with fluctuations in incoming water quality, is critical to optimizing the performance of the nutrient removal system. Ensuring reliable operation alongside a sufficient TP concentration will provide a dependable source of P-credits.

What was the problem?
It was discovered that there were significant fluctuations in physical parameters, ions, TP, organic and solid content of the Fivehead effluent. To consistently achieve higher recoveries of product water and removal of TP, a robust pre-treatment was required to reduce fouling and scaling potential in membranes.

How did we address the problem?
Alongside a pre-treatment assessment, it was decided to carry out sampling at Fivehead wastewater treatment works for an 18-week period**.** An extended sampling period is vital for obtaining reliable water quality data, assessing the correct pre-treatment and optimizing long-term performance.

It was judged that ultrafiltration (UF) would be an effective pre-treatment solution for HyBatch™ feed, significantly reducing organics and solids while enhancing system performance. To validate the efficacy of UF as a viable pre-treatment solution, we partnered with PCI and RSE, to test in three phases between October and December 2024. Additionally, to monitor the fluctuations in Fivehead effluent, an extensive sampling programme was followed between 3rd September 2024 and 31st January 2025.

The primary aims of the trial were as follows:

1. Demonstrate consistent total phosphorous (TP) removal, following the validation of a suitable pre-treatment solution
2. Characterise the fluctuations in water quality parameters
3. Confirm cost of a TP credit

2 UF performance

Phase 1- rejection characteristics of selection of UF membranes

Six UF membranes from PCI Membranes with MWCOs from 1000 kDa to 9000 kDa were tested using a Single Tube Tester to evaluate separation performance based on recovery, permeate production time, and water quality for a week. According to Phase 1 results we selected two UF membranes that showed the best rejection for solids and organics which were XP197 and PU608.

Phase 2- Operating parameters of UF membranes

As seen in Table 1 below, this phase tested the two selected membranes on the B1 filtration module from PCI, to determine optimal operating parameters and assess a membrane's ability to produce acceptable RO feedwater quality for a period of two weeks, once we had increased their recoveries to the membrane's limit. Also, this would help minimise waste volumes, which has a direct impact on the commercial viability of the UF-HyBatch™ system.

Table 1: Summary of performance results of the selected membranes in B1 module phase 2

Membrane type	Recovery range	Solids rejection	Organics rejection
XP197	80%-83%	38%	73%
PU608	87%-90%	93%	78%

Since recovery (higher recovery will minimise waste volumes), and superior UF permeate quality were critical for phase 3, PU608 was chosen to be the preferred UF membrane type for Phase 3 testing.

Phase 3- HyBatch™ performance

Hydraulic performance

The HyBatch™ performed well with a specific energy consumption (SEC) ranging from 1.07-1.4 kwh/m^3 and a water recovery ranging from 80-95%. Based on the data received from Element labs It can be concluded, that consistent removal of >96% of TP were achieved in Phase 3, with an inlet average of 1.6 mg/L in the HyBatch™ system.

A visual representation of the experimental layout in Phase 3 of the HyBatch™ system can be seen in Figure 1.

Figure 1: Experimental lab layout of HyBatch™ system for Phase 3

Sampling fluctuations

The variation observed between different water samples taken from Fivehead across different water quality parameters (between 2%-190%) is likely to be amplified during periods of extreme weather conditions/ seasonal fluctuations (See Annex A for TP trend).

For example, based on publicly available data, we anticipate fouling will be worse in the spring-summer period due to higher concentrations of certain water quality parameters (such as organics, TP levels). Similarly, rainfall is likely to have an impact on the water quality, possibly increasing TP concentrations and solids content due to more surface run off/wash off from fertilizers (containing phosphates) and vegetation/plant waste or leaching from soil. Hence, a longer sampling period, encompassing the worst period of spring-summer is recommended.

3 Conclusion

This report evaluated the performance of the HyBatch™ system for TP removal from Fivehead effluent, demonstrating its effectiveness in achieving ultra-low TP concentrations while minimizing the waste volumes at low energy consumption. By incorporating ultrafiltration (UF) as a pre-treatment step, we significantly improved membrane performance, reducing fouling and ensuring consistent feedwater quality. The pilot-scale experiments conducted over a three-week period in Phase 3 confirmed that the proposed system can reliably meet stringent discharge regulations while maintaining cost-effective and sustainable operation. The HyBatch™ system consistently achieved total phosphorus (TP) removal of over 96%, with an average recovery rate of 90–95%, thereby minimizing waste generation.

In addition to the consistent removal of TP (> 96%) at high recoveries of 95%, as per the membrane autopsy reports, it was found that the HyBatch™ system showed no signs of irreversible fouling/scaling and only a very thin layer of reversible/biofouling was found, along with some trace amounts of corrosion deposits, which can be handled easily with a simple CIP process.

Another exciting opportunity is the potential for phosphorus recovery from the HyBatch™ system's concentrate stream. In the short term, our focus remains on maximizing TP removal efficiency, but in the longer term, processes that could enable the onsite recovery of phosphorus in granular form should be explored. This approach not only aligns with circular economy principles but also presents a sustainable solution for phosphorus reuse, reducing dependency on conventional phosphorus sources and creating additional value from wastewater treatment.

Annex A

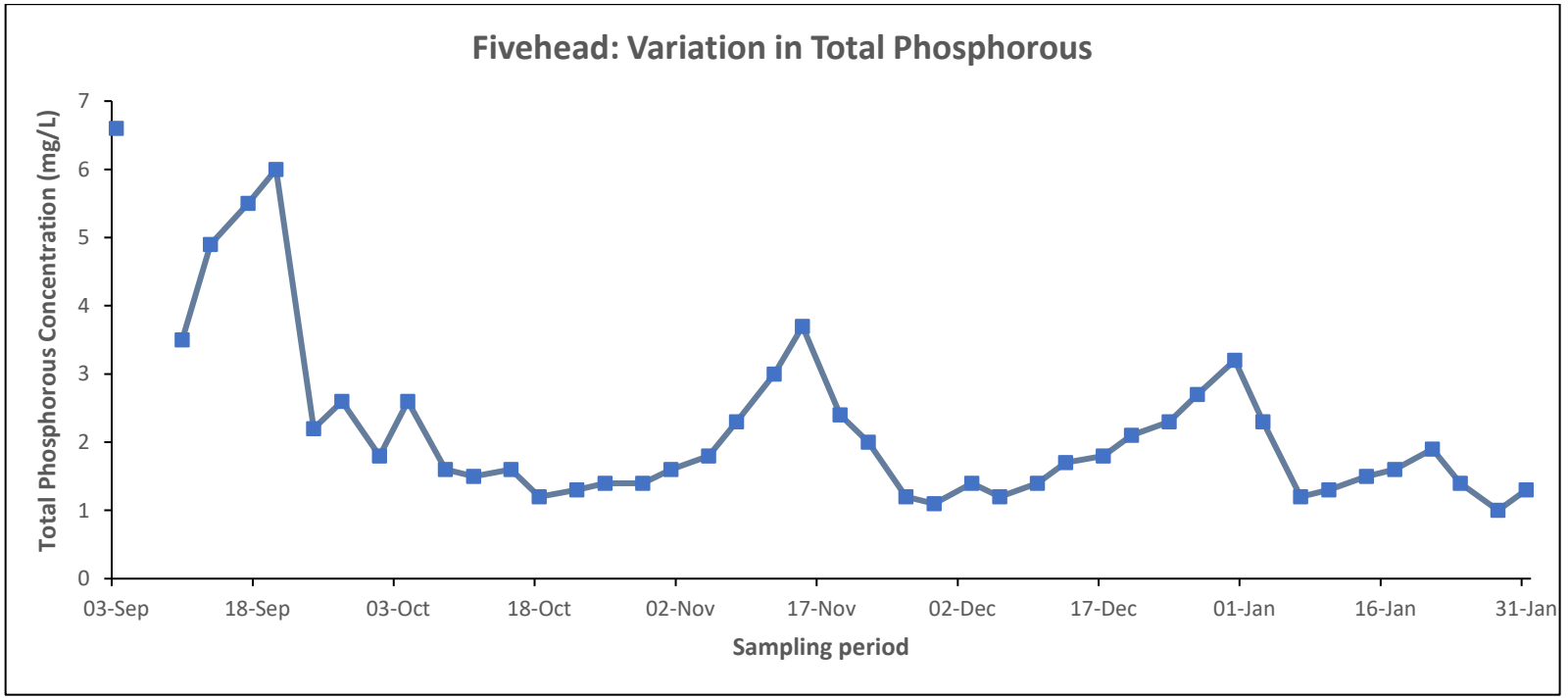

Figure G: Variation in TP concentration from 3rd September 2024 to 31st January at Fivehead