PHORWater

Integral Management Model
for Phosphorus recovery
and reuse from Urban Wastewater

LIFE12 ENV/ES/000441

Laura Pastor Alcañiz
4th March 2015, Berlin
"Circular approaches to phosphorus: from research to deployment"

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LAGEP

INTRODUCTION

Consortium DAM, CALAGUA, and LAGEP

PHORWater LIFE+ project:

"Integral Management Model for Phosphorus Recovery and reuse from Urban Wastewater"

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INTRODUCTION

Scarcity of phosphorus (P)

↓

sustainable management of this resource in WWTP

The main objective of **PHORWater** is to demonstrate, at pre-industrial scale, the **viability and sustainability of the correct management of the P** in a WWTP obtaining **struvite by crystallization**.

INTRODUCTION

El Cidacos WWTP, Calahorra, Spain

INTRODUCTION

23.000 m³/day

EBPR (A2O Configuration)

Anaerobic digestion for primary and secondary sludge

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Project Plan and structure

B. Implementation actions	B.1 Integral management of the WWTP for optimal phosphorus recovery.
	B.2 Desing, contruction and start-up of the crystallization process.
	B.3 Implmetation on the Phosphorus recovery demonstration pilot plant. Struvite production.
	B.4 Validation of the obtained struvite as a fertiliser.
	B.5 Economical feasibility study.
C. Monitoring of the impact of the project actions	C.1 Effectiveness of the project actions. Project results monitoring.
	C.2 Project socioeconomical impact.
D. Communication and dissemination actions	D.1 Communication and dissemination of project results.
E. Project management and monitoring of the project progress	E.1 Project management.
	E.2 Networking activities.
	E.3 After LIFE Communication Plan

INTRODUCTION

Project Plan and structure

Action		Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
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INTRODUCTION

B1 Integral management of the WWTP for optimal P recovery

Performed to determine the type and extent of phosphate fixation throughout the plant and to enhanced the phosphorus recovery

Tasks:

- Characterisation of the water and sludge lines of the WWTP
- Mass balances performance
- Identification of the optimal WWTP operational configuration in order to minimize uncontrolled phosphorus and enhance phosphorus recovery
- Implementation of the optimal operational configuration
- Validation of the new WWTP configuration (correct functioning checking)

INTRODUCTION

B2 Design, construction and start-up of the crystallization process

Construction of a struvite crystallizer and its implementation at the WWTP

Tasks:

- Crystallizer and auxiliary elements design
- Control algorithm design and development
- Suppliers search and offers requests
- Phosphorus recovery plant construction and installation
- Validation of the installation (correct functioning checking)

RESULTS B1: Integral management of WWTP

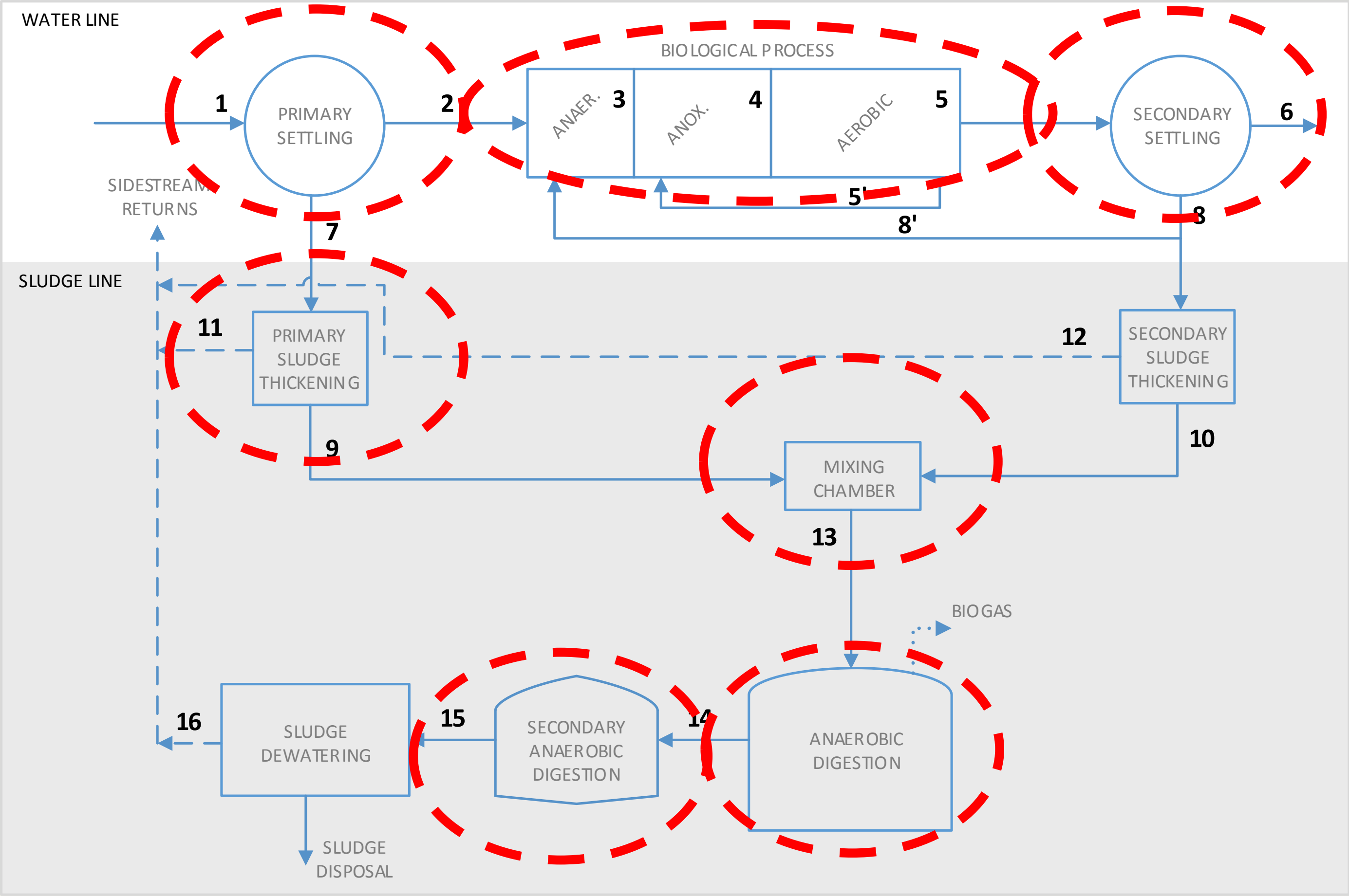
Characterization of the water and sludge line

- Five analytical campaigns carried out
  - To determine the P removal efficiency in the water line
  - To assess the precipitation processes in the sludge line

- Mass balances have been applied in the main elements of the WWTP

RESULTS B1: Integral management of WWTP

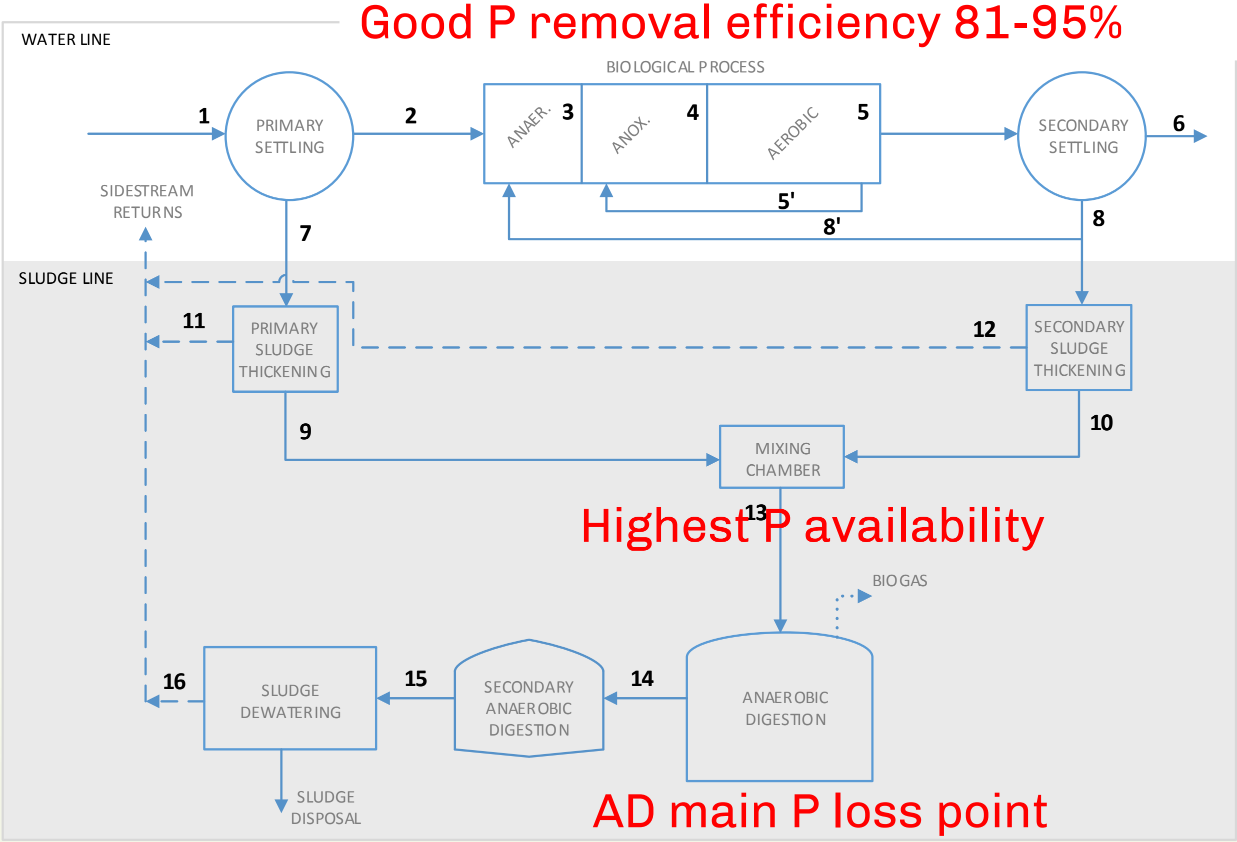
Characterization of the water and sludge line



RESULTS B1: Integral management of WWTP

Characterization of the water and sludge line

Good P removal efficiency 81-95%



Highest P availability

AD main P loss point (8-12 gP/kg sludge)

- Good P removal efficiency from water (81 to 95%)
- The main phosphorus loss point in the plant was the anaerobic digester (8-12 g of P per kg of sludge treated in the sludge line)
- Only between 20 and 32% of the P entering the sludge line could be available for its recovery.
- The highest P availability (i.e., the highest phosphate concentration) took place in the mixing chamber.

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RESULTS B1: Integral management of WWTP

Identification of the optimal WWTP configuration

- The release of P in the digester results from the organic matter degradation and from polyphosphate (Poly-P) hydrolysis.
- The organic matter degradation process that takes place in the anaerobic digester is a consequence of the sludge stabilization and cannot be reduced.
- However, the release of P from Poly-P hydrolysis in the digester can be reduced by enhancing its release in a previous stage before digestion.
- Optimal configuration:

ELUTRIATION OF THE MIXED SLUDGE CONTAINED IN THE MIXING CHAMBER

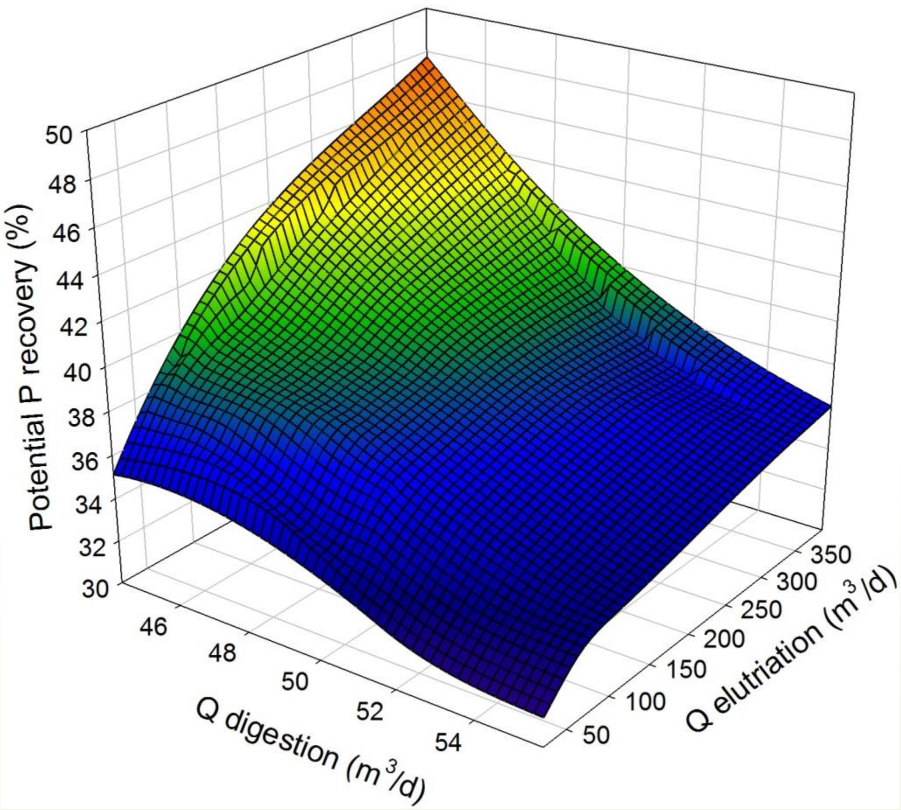
RESULTS B1: Integral management of WWTP

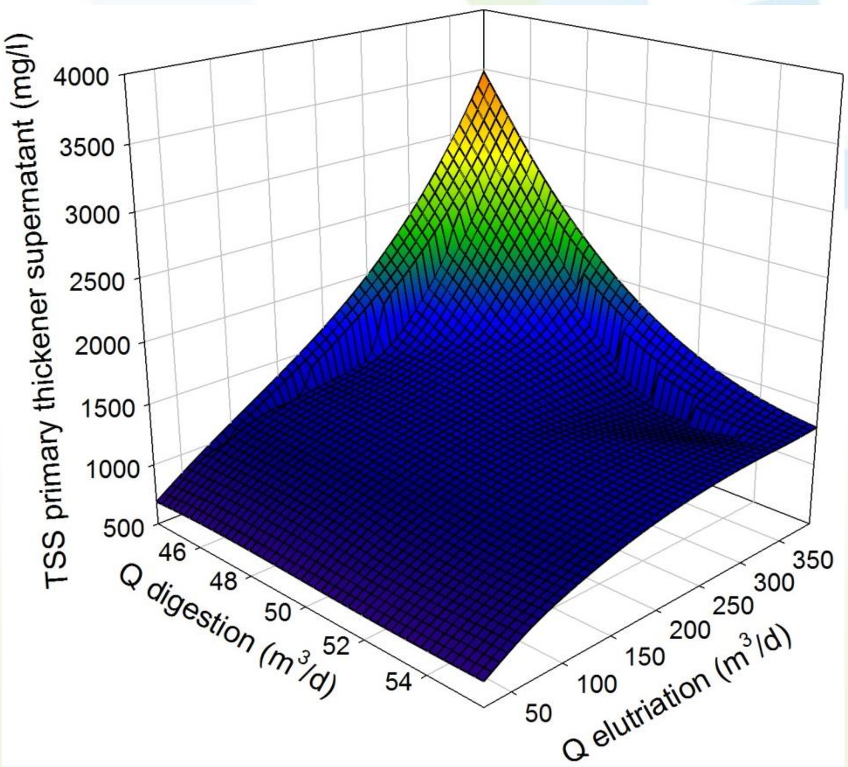
Identification of the optimal WWTP configuration

- The proposed sludge line configuration was exhaustively simulated with a software tool (DESASS©) in order to:
  - determine the optimal operation conditions that reduces the P precipitation during the anaerobic digestion
  - increases the P concentration in the effluent of the primary thickener for further P recovery.

RESULTS B1: Integral management of WWTP

Identification of the optimal WWTP configuration

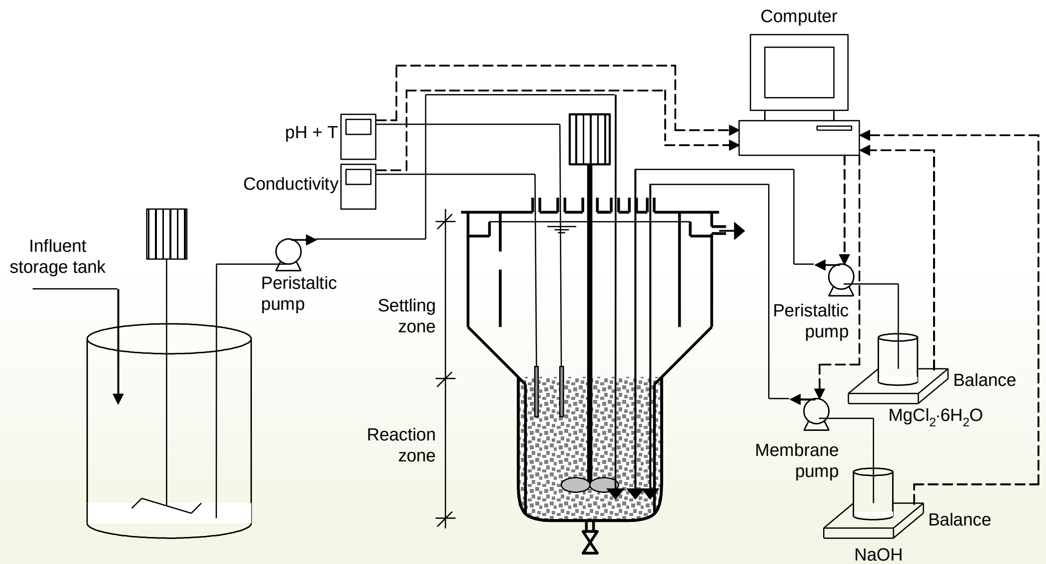




RESULTS B1: Integral management of WWTP

Lab-scale crystallization assays

- Three lab-scale experiments with this real gravity thickener supernatant were carried out in a 20.6 L crystallization reactor.



RESULTS B1: Integral management of WWTP

Lab-scale crystallization assays

- Three lab-scale experiments with this real gravity thickener supernatant were carried out in a 20.6 L crystallization reactor.

Main characteristics of the experiments

	Exp. 1	Exp. 2	Exp. 3
pH	*8.7*	*8.7*	*8.7*
HRT (h)	*4.35*	*2.05*	*1.05*
Agitation speed (rpm)	*200/300*	*200*	*200*
Molar ratio Mg/P	*1.5*	*1.6*	*1.6*
Molar ratio N/P	*2.3*	*2.6*	*2.4*

RESULTS B1: Integral management of WWTP

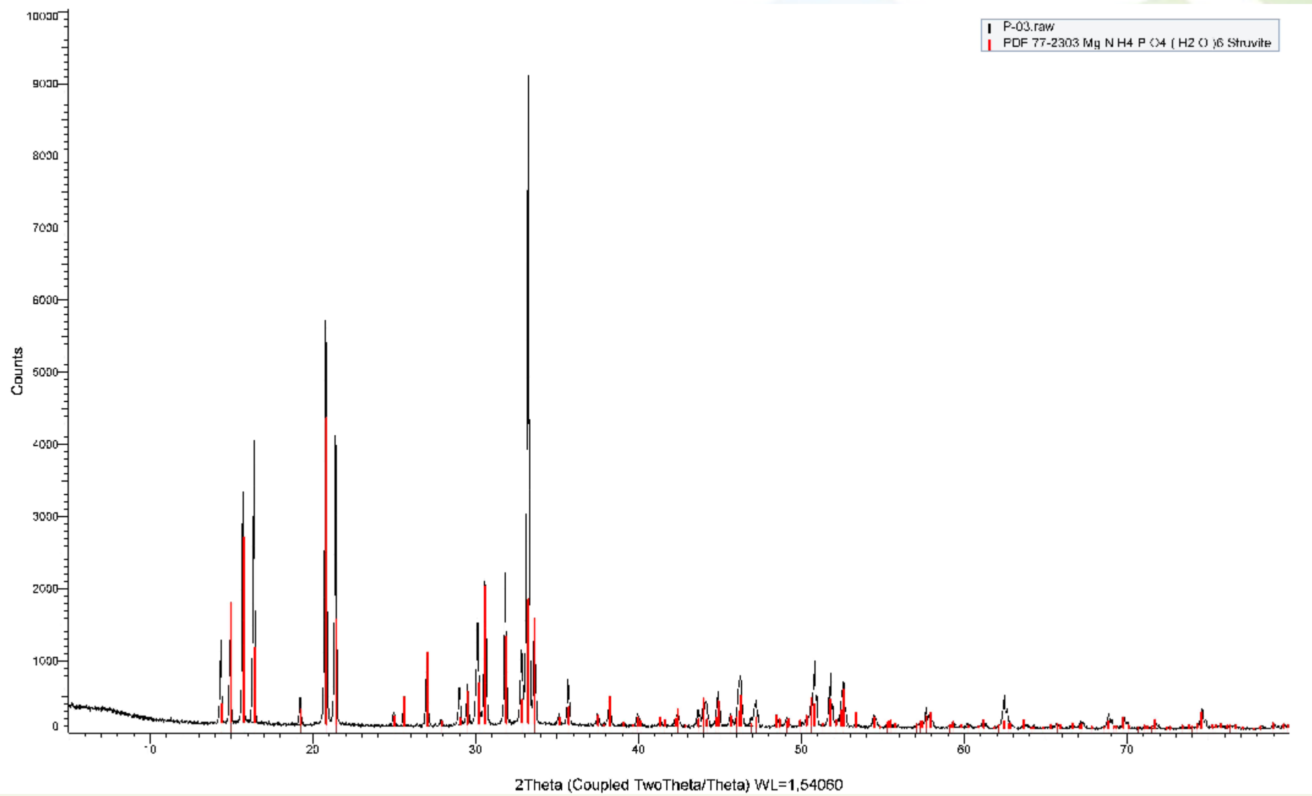
Lab-scale crystallization assays

Crystallizing process results for the three experiments

	Exp. 1	Exp. 2	Exp. 3
HRT (h)	*4.35*	*2.05*	*1.05*
PO_4-$P_{influent}$ *(mg/l)*	*150*	*134*	*132*
Total $P_{effluent}$ *(mg/l)*	*13.8*	*24.1*	*35.9*
PO_4-$P_{effluent}$ *(mg/l)*	*5.9*	*4.7*	*5.5*
Precipitation Efficiency (%)	95.8	96.4±0.3	95.8±0.9
Recovery Efficiency (%)	89.7	82.1±1.7	72±10
Struvite production (g struvite/L supernatant treated)	1.1	1.0	0.96
Average particle size (μm)	183±59	207±8	213±19

RESULTS B1: Integral management of WWTP

Lab-scale crystallization assays



RESULTS B1: Integral management of WWTP

Lab-scale crystallization assays

RESULTS B2: Design, construction and start-up of the crystallizer process

- Flowrate: 20 m^3/d.
- In the lab-scale, the reactor works correctly with: 2h<HRT<4h.
- The HRT chosen for the design has been 2 h.
- The reactor is a stirred tank reactor and has been divided in two parts:
  - the reaction zone
  - the settling zone to keep the crystals inside the reactor
- Total volume of 4.4 m^3 and a total height of 3 m
- It is equipped with a profiled propeller and four baffles

RESULTS B2: Design, construction and start-up of the crystallizer process

More project information at:

http://www.phorwater.eu

Thank you for you attention

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