**Speciation of emerging contaminants in wetland systems**

**Lead Supervisor Name**

Professor Barbara Kasprzyk-Hordern

**Lead Supervisor Contact Details**

b.kasprzyk-hordern@bath.ac.uk

**Lead Supervisor Location/Student Home Institution**

Institution: Bath

School: Chemistry

**Full Project Description**

Pharmaceuticals and personal care products (PPCPs: pharmaceuticals and antimicrobial agents, endocrine disrupting chemicals) are unregulated environmental pollutants. They enter the environment principally through communal wastewater. They are bioactive, ubiquitous and persistent and furthermore, they have interactive properties. A major concern regarding their release into the environment is their impact on biota. Examples of the adverse effects of pharmaceuticals on wildlife include a high incidence of intersexuality in fish due to exposure to contraceptive estrogens in water and localised population extinctions in Asian gyp vultures due to the use of the anti-inflammatory drug diclofenac in livestock. Usage of PPCPs continues to increase due to an ageing population in western countries and a general increase in consumption in the developing world. Urban waters and its users are likely to be at the highest risk of exposure. Some pharmaceuticals including ethinyloestradiol, diclofenac, and a selection of antibiotics are now on the European Chemicals Watch list due to environmental health concerns and tighter regulation of these and other PPCPs in water is envisaged in the near future. A growing population and changing climate will influence the accessibility of clean water and force new solutions for water reuse. An introduction of a natural attenuation driven treatment processes, such as wetland systems, offers a highly sustainable and safe water resource management solution for water treatment. This project will focus on understanding fundamental bio-physicochemical processes driving degradation of a series of selected PPCPs in wetland systems, with emphasis on PPCPs uptake and metabolism by plants.

Objective 1. To understand life-cycle of PPCPs in a full scale wetland system. This will involve mass spectrometry based chemical analysis (using methods available at the University of Bath and Bristol) screening the aqueous samples and biota for specific PPCP groups: pharmaceuticals as well as endocrine disrupting chemicals in personal care products.

 Objective 2. To verify key transformation pathways of PPCPs in lab-controlled wetland simulating microcosms. 5-10 chemical targets (Objective 1 output) representing key PPCP groups will be subject to comprehensive verification of their transformation pathways in lab-controlled wetland simulating microcosm systems.

 Objective 3. To verify effectiveness of the wetland system in PPCPs removal via biological activity assessment of selected chemicals using biossays. A series of bioassays (including cell based assays and transgenic fish engineered to detected specific chemical classes – e.g. oestrogens, oxidative stress) will be employed to asses PPCP removal efficacy in both the full-scale wetland systems and microcosms. 16S sequencing will be also applied to verify the microbial assemblages present in the wetland for considrations into what organism might be key in the biodegradation pathways for selected PPCPs.

This studentship will take advantage of the first full size constructed wetland in the UK being developed by Wessex Water. The project findings will inform water industry design and Environment Agency permitting policy on the use of wetlands. The research student will receive training in modern bioanalytical techniques. In addition, he/she will work with the leading water utility company in the UK. Furthermore, he/she will join interdisciplinary teams at the University of Bath, Bristol and Exeter with key research expertise and excellent research infrastructure.

**Real Life challenges this project will address**

Water security, deteriorating ecosystem health and population growth/urbanisation affecting the natural environment. The water sector faces the challenge of providing sustainable solutions for the reduction in nutrients and emerging substances from small sewage treatment works and the provision of a wider ecosystem service benefit. This studentship will also provide information on the ability of constructed wetlands to remove emerging chemical pollutants. The data produced will inform future wetland design, permitting and highlight issues surrounding wetland management and disposal of green wastes produced.

**What you should know about this project**

Water pollution is a problem of multi-dimensional nature and here we establish an interdisciplinary studentship project proposal interfacing with environmental/water science, analytical chemistry and water engineering to assess how a newly constructed wetland remediates for discharged chemicals of environmental concern. All academic and industrial supervisors are experienced researchers with skills required to effectively guide the project. The supervisory team includes: Barbara Kasprzyk-Hordern, University of Bath (environmental chemistry), lead supervisor Richard Evershed, University of Bristol (biogeochemist), co-supervisor Charles Tyler, University of Exeter (environmental biology), co-supervisor Ruth Barden, Wessex Water (environmental management), industrial supervisor. The wider collaborators (local co-supervisors) within each institution include: University of Bath: Jannis Wenk (chemical engineering) and Jan Hofman (water engineering) University of Bristol: Penny Johnes (aquatic biogeochemistry) Wessex Water: Liam Reynolds and Alex Martin (wetland systems)

**What expertise you will develop**

1. Understanding of processes and functions of constructed wetlands, issues related to water quality in the context of environmental and public health.
2. Expertise in advanced bioanalytical techniques applied to environmental samples
3. Skills in ecotoxicology
4. Operational understanding of the UK water industry and regulatory systems.

**Why this project is novel**

This studentship will take advantage of the first full size constructed wetland in the UK to provide tertiary treatment for phosphorus removal from a sewage treatment works effluent. This wetland will be operational from November 2019 and recognised as the solution to phosphorus removal by the Environment Agency within the National Environment Programme. The project findings will inform water industry design and Environment Agency permitting policy on the use of wetlands within the sewage treatment system. Wetland systems are designed to remove nutrients from wastewater. However, little work has been undertaken on micropollutant speciation and fate in constructed wetlands. This is despite their high potential for micropollutant removal. We will, for the first time, undertake an analysis of micropollutant speciation in a full-scale wetland system and advance understanding on micropollutant uptake and metabolism in plants and animals via laboratory-controlled microcosm experiments. We will pay special attention to stereoselective transformation.

**Rest of Supervisory Team:**

**Stakeholder Organisation** Wessex Water

**Stakeholder Supervisor** Ruth Barden

**Co-Supervisor 1** Professor Richard Evershed

Affiliation: Bristol

Email: R.P.Evershed@bristol.ac.uk

**Co-Supervisor 2** Professor Charles Tyler

Affiliation: Exeter

Email: C.R.Tyler@exeter.ac.uk