Research Summary

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Practical measures for reducing phosphorus and faecal microbial loads from onsite wastewater treatment system discharges to the environment: A review

Key Findings

Onsite wastewater treatment systems (OWTS), the majority of which are septic tanks, are a contributing factor to phosphorus and faecal microbial loads. OWTS contribute to waterbodies failing to meet Water Framework Directive (WFD) objectives and as such, measures to improve the quality of OWTS discharges are required. Literature has been reviewed for a range of measures designed to reduce phosphorus and pathogen concentrations in effluent from OWTS. A feasibility assessment focussed on their application, effectiveness, efficiency, cost and ease of adaptation. A wide range of measures have been identified that could potentially improve water quality.

Results show no one solution could be applied to reduce phosphorus and pathogen loadings to the water environment. The literature suggests that OWTS need to be designed to the local flow and load characteristics of the effluents streams, as well as site specific conditions. With that in mind, measures such as awareness raising, site planning, and maintenance are likely to contribute to reduction of impact of OWTS on the environment. The level of load reduction possible from measures such as awareness raising is difficult to quantify, but it is low-cost and relatively easy to implement. Those most effective for phosphorus and pathogen removal are post-tank measures that maximise physical removal, through adsorption and filtering, and maintain good conditions for biological breakdown of solids and predation of pathogens.

A full summary of the measures reviewed is presented in Section 7 of the report. The following table presents a selection of the most practical measures to reduce P or pathogen releases from OWTS.

Measure	Removal of P possible	Removal of pathogens possible	Practicality	Site requirements	Cost	Likely uptake
Using P-free detergents	Yes - up to 50%	No	Legislation will ensure this is implemented	None	Low	Guaranteed
Reducing food waste flushed to drains	Yes - quantity unknown	Unknown	Awareness raising could assist. May be more practical for hotels, restaurants	None	Low - awareness raising	Possible with awareness raising
Appropriate site and setback distances	Likely	Likely	May require change in building regulations (linked to risk based approach)	Increased distance to water body	Related to increased land take and pipe distances	Possible
Risk based measures	Unknown	Unknown	Targeting measures to most at risk sites	None	Cost of consultation, deregulation	Currently being applied in England
Awareness raising	Unknown	Unknown	Practical if providing advice on operations, inspection and maintenance	None	Low if electronic; costs associated with leaflets or public events	Likely
Replacing old tanks with new tanks: Tank design (baffles and shape)	Yes	Yes	Practical where current system is poorly functioning. Baffles may be more practical for pathogen reduction than P reduction	Access for machinery and adequate space for new system	High	Possible
Increased Hydraulic Retention Time (HRT) – correcting misconnections	Yes	Yes	Practical as an inspection measure for site owners/ occupiers to improve function	Access to pipe connections and knowledge of OWTS	Low	Likely
Increased HRT - desludging	Unknown	Yes	Practical as a maintenance measure; may have unintended impact on P releases	Access to desludging equipment; consideration of end use of sludge	Relatively low	Likely

Measure	Removal of P possible	Removal of pathogens possible	Practicality	Site requirements	Cost	Likely uptake
Introducing chemical additives	Yes	Yes	Depends on site, scale of improvement required and dosing mechanism. In tank chemical use may destabilise microbes	Access for dosing, may be more suited to multi-chamber system. May require electricity	Medium (depending on additive and dosing frequency)	Possibly as a polishing step
Soak away, drainfield, or mound system	Yes	Yes	Could provide additional treatment at sites with direct discharges to water body	Land requirement, suitable soil conditions and slope. Electricity need if pumps used	High, depending on level of site work required	Likely
Lagoons/WSP	Yes	Yes	Depends on site and polishing requirement. Can allow for UV treatment or chlorination	Land requirement, and protections against exposure to pathogens	Installation and maintenance costs may be high	Possible
Removing P from discharged effluent using ochre	Yes	Unknown	Depends on site and polishing requirement, could dose in WSP or use as filter medium	Land requirement for treatment area, or dosing mechanism	High	Possible for additional polishing
Constructed wetland	Yes	Yes	Practical where space available, allows for increased retention time, facilitates increased absorption of both P and pathogens	Land requirement, protection against exposure to pathogens, substrates and vegetation harvesting over time. Electricity need if pumps used	Installation and maintenance costs may be high depending on system	Likely
Sand filter	Yes	Yes	Practical where adequate space allows	None	Installation and maintenance costs may be high	Likely
Peat filter	Yes	Yes				
Alternative filter media	Yes	Yes	Practical where space available, and proven to be safe (no additional pollutant releases)	Land requirement, electricity need if pumps used; consideration of filter material disposal	Installation and maintenance costs may be high	Possible with further evidence
Combination systems	Yes	Yes	Practical where adequate space on site allows	Land requirement higher for site with mixed treatments; electricity need if pumps used	May be high depending on system	Possible for sites in sensitive areas
Package treatment plants	Yes	Possible	May allow for treatment where limited space available onsite	Similar to septic tanks, requires electricity	Range of costs, can be cheaper than septic tanks to install, but maintenance costs may be higher than septic tanks	Possible

Introduction

The 2013 WFD classification identified 220 WFD baseline rivers and 71 baseline lochs in Scotland as being impacted by phosphorus in their chemistry and/or ecology. Faecal microbial loads are also recognised as a contributing factor to downgraded protected areas. In particular, pathogen pollution can result in contamination of bathing waters and shellfish waters, increasing the risk of human exposure to pathogens and associated impacts on industries such as shellfish growing.

Large numbers of properties in rural Scotland (estimated to be circa 160,000) are not connected to mains sewerage systems and instead rely on OWTS to process their domestic wastewater. These systems, mainly septic tanks, private sewage treatment works, and package treatment plants, are thought to contribute to the phosphorus and faecal microbial loads that impact on the status of WFD waterbodies and protected areas.

Research Undertaken

The project, in seeking to identify measures to improve OWTS discharges, considered:

1. The available measures for reducing phosphorus and faecal microbial loads from septic tanks and other OWTS.
2. An assessment of the feasibility of applying such measures to domestic households or larger private/ communal septic tanks, and the practicality of retrofitting any additional treatment.
3. Measures to deliver sustainable waste management solutions including energy generation and/or nutrient recovery that may reduce pressures on waterbodies and, at the same time, deliver value.
4. The load reductions which could potentially and realistically be achieved through each measure, individually and collectively.

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