CIWEM Chartered Institution of Water and Environmental Management
Urban Drainage Group

# Review of the UWWTD implementation, and the treatment of CSOs in the EU

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Wood and HR Wallingford[1] have recently supported the European Commission (EC) (DG Environment) with a study reviewing the implementation and achievements of the Urban Wastewater Treatment Directive (UWWTD[2]) since its adoption[3]. This paper aims to build on this review and our supporting technical knowledge in presenting the latest developments related to European Union (EU) waste water policy. Our presentation will start with an overview of the state of implementation of the Directive and its achievements with regard to the improvement of inland and bathing water quality, and the increase in research and development across the EU for waste water treatment techniques. We will then cover some of the remaining key challenges in particular the issue of Combined Sewer Overflows (CSOs).

## 1. Overview of the UWWTD

Untreated sewage contains organic matter (carbohydrates, fats and proteins), bacteria and chemicals. Bacteria naturally present in environmental waters break these substances down, but in doing so they use the oxygen dissolved in the water. If there were large or continuous untreated discharges of urban waste water the result could be too little oxygen for fish and other aquatic life to survive. The purpose of waste water treatment is to remove organic substances to protect the environment from these effects.

Waste water treatment plants reproduce what would occur in the environment, settling out much of the solid matter (primary treatment), and using bacteria that 'digest' and break down the organic substances (secondary treatment). Sometimes, further treatment (tertiary treatment) is required to protect sensitive water environments. Tertiary treatment can involve disinfecting the treated effluent to protect bathing or shellfish waters. It can also involve the removal of phosphorus or nitrates (nutrients present in sewage) to protect waters that are threatened by eutrophication.

The EC Council Directive concerning urban wastewater treatment 91/271/EE was adopted on 21 May 1991. It sets out requirements for the collection, treatment and discharge of waste water. The Directive sets out the principles of planning, regulation, monitoring and information and reporting. The Directive acknowledged that different levels of treatment would be required depending on the sensitivity of receiving waters and recognised the need to monitor treatment plants, receiving waters and disposal of sludge to ensure that the environment is protected from the adverse effects of waste water discharge. There is a requirement to adequately inform the public of these operations. The performance of the treatment is assessed using five different parameters (biochemical oxygen demand, chemical oxygen demand, total suspended solids, total nitrogen and total phosphorus).

The requirements of the Directive are summarised in Table 1.

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[1] Further supported by COWI, IEEP and National Technical University Athens
[2] Ninth implementation report, European Commission, DG Environment
[3] Wood, not published yet, Study to support the evaluation of the UWWTD

**Table 1 Summary of the Directive's requirements according to the agglomeration size and status of receiving water body (by the final deadline)**

| *Cases* | *Size of agglomeration* | *Receiving water body* | *Requirements for the treatment[26] of urban waste water and Directive deadlines (and deadlines Accession Treaty)[27]* | *Requirements for discharge point* |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| **Case A** | < 2,000 p.e. (freshwaters and estuaries) | NA and SA +CAofSA | Art.7 - appropriate treatment * (deadline 31/12/2005) | Art.2(9). Urban waste water after discharge allows the receiving waters to meet the relevant quality objectives and relevant provisions of this and other Community Directives |
| | < 10,000 p.e. (coastal waters) | | Art.7 - appropriate treatment * (deadline 31/12/2005) | Art.2(9). Urban waste water after discharge allows the receiving waters to meet the relevant quality objectives and relevant provisions of this and other Community Directives |
| **Case B** | >= 2,000 p.e. (freshwaters and estuaries) | NA and SA + CAofSA | Art.4 - secondary treatment (deadline 31/12/2005) | Art. 4(3) and relevant requirements for Annex IB |
| | >= 10,000 p.e. (coastal waters) | | Art.4 - secondary treatment (deadline 31/12/2005) | Art. 4(3) and relevant requirements for Annex IB |
| **Case C** | >10,000 p.e. | SA +CAofSA | Art.5(2,3) - more stringent treatment (deadline 31/12/1998 or within 7 years after new sensitive areas have been identified | Art.5(2,3) and relevant requirements of Annex IB |

*Note: NA – normal areas, SA – sensitive areas, CAofSA – catchment areas of sensitive areas*
** in case if agglomeration is equipped with a collecting system*

Source: UWWTD-REP working group (2007) "Terms and Definitions of the Urban Waste Water Treatment Directive 91/271/EEC"

# 2. State of Implementation of the Directive

Member States (MS) regularly report on the implementation of the UWWTD. The latest review has been published in 2017 by the European Commission and constitutes the Ninth implementation report.[4] It is based on data reported for 2014. According to the data reported, there were 23,500 agglomerations falling under the scope of the Directive (i.e. of 2,000 p.e. and above). The total load generated was equivalent to 604 million population equivalent (p.e.).

Overall the report concludes that there is a high level of compliance with the requirements of the Directive.

However, there is some variation between MS, as certain countries have not made as much progress on the implementation of some requirements, especially regarding tertiary treatment in sensitive areas. An overview of the level of compliance based on groups of MS is given in Table 2.

[4] European Commission (2017) 9th Report on the implementation status and the programmes for implementation (as required by Article 17) of Council Directive 91/271/EEC concerning urban waste water treatment

**Table 2 Evolution of overall legal compliance status across EU MS groupings and comparison with UK**

| Legal Compliance | Collection | Secondary treatment | More stringent treatment |
|---|---|---|---|
| EU 15 | 98.6% | 90.8% | 90.4% |
| EU 13 | 87.2% | 80.9% | 57.3% |
| EU 28 (EU 15+EU13) | 96.9% | 89.4% | 85.0% |
| UK | 100% | 99% | 93% |

Notes:

EU 15 countries = Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom; EU 13 countries = Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia

The European Commission calculates the 'distance to compliance' to show the remaining p.e. that must be collected and receive appropriate treatment for the Directive to be implemented fully. An overview of the distance to compliance results are presented in Table 3.

**Table 3 Overview of the 'distance to compliance' across EU MS groupings and comparison with UK**

| Distance to Compliance | Collection | Secondary treatment | More stringent treatment |
|---|---|---|---|
| EU 15 | 0.2% | 5.7% | 6.2% |
| EU 13 | 3.8% | 9.8% | 30.6% |
| EU 28 | 0.7% | 6.3% | 10.2% |
| UK | 0% | 1.4% | 6.5% |

# 3. Evaluation of the UWWTD

Evaluations are performed against the methodology described in the Better Regulation package, last updated in the summer of 2017. It emphasises the importance of assessing and evaluating after a policy or measure has been implemented to ensure that it stays fit for purpose and delivers, at minimum cost, the desired changes and objectives.

The purpose of an evaluation is to go beyond the analysis of the implementation (i.e. what has happened) to understand 'why' the intervention had a specific impact (or no impact) and understand how much the situation has changed since the initial adoption of the legislation. The evaluation is performed by analysis of the effectiveness, efficiency, coherence, relevance and EU added value of the intervention.

The evidence was gathered from a wide range of qualitative and quantitative sources, including stakeholder consultations, which must comply with the Commission's standards for consultation. The findings from the European Commission are not yet published but some information on stakeholders' engagement is available online[5].

[5] https://circabc.europa.eu/ui/group/65764c73-4a57-45dc-8199-473014cf65bf/library/ef774058-2f00-48f5-84a6-6fcf0491bdbd?p=1&n=10&sort=modified_DESC

# 4. A European Body of Evidence relating to pollution from Stormwater Overflows (Combined Sewer Overflows) and Direct Surface Water Runoff

## 4.1 The requirements of the UWWTD and supporting European Directives

Article 3 of the UWWTD requires Member States to collect and treat all waste waters. Stormwater overflows (SWOs or CSOs) occur where the excessive contribution of stormwater to combined sewer networks causes an untreated discharge to the receiving environment as a result of the capacity of wastewater treatment plants (WWTPs) being exceeded. Such spills are the only defined exception to meeting the obligations of the Directive, however there are clear conditions for these exceptions that are defined in Annex 1, Section A, i.e "*The design, construction and maintenance of collecting systems shall be undertaken in accordance with the best technical knowledge not entailing excessive costs, notably regarding limitation of pollution of receiving waters due to storm water overflows*" and the supporting footnote (1) "*Given that it is not possible in practice to construct collecting systems and treatment plants in a way such that all waste water can be treated during situations such as unusually heavy rainfall, Member States shall decide on measures to limit pollution from storm water overflows. Such measures could be based on dilution rates or capacity in relation to dry weather flow or could specify a certain acceptable number of overflows per year*." This footnote is also supported by Article 10 which requires WWTPs to be '*designed, constructed, operated and maintained to ensure sufficient performance under all normal local climatic conditions*', and for '*seasonal variations of the load*' to be taken into account.

It is clear from the evidence reviewed that the variation in interpretation of the above clauses by MS relates to a number of key definitions and principles:

- the definition of 'unusually heavy rainfall' (i.e. that which defines the acceptable frequency and volumes of spills);
- the definition of 'a spill' (in terms of volume and/or duration);
- the use of measures taken to limit pollution potentially resulting from such spills once they have occurred; and
- the application of BTKNEEC (Best Technical Knowledge Not Entailing Excessive Cost) on a 'per agglomeration' basis.

It is also clear that, whilst the UWWTD requires Member States to decide the measures and methods to apply to limit overflows, a raft of other Directives will often underpin the drivers and designs of improvement strategies for overflows at WWTPs. For inland waters, requirements to achieve good ecological status by 2015 are set out by the Water Framework Directive 2000/60/EC (WFD) and discharges from CSOs are, therefore, routinely considered and reported in river basin management plans (RBMPs). Similarly, for coastal waters, the Bathing Water Directive 2006/7/EC (BWD) address CSO impacts by classifying affected bathing waters as "*subject to short-term pollution*", thus indirectly requiring limits to spills to coastal waters as a result. The Groundwater Directive (GWD, 2006/118/EC), the Marine Strategy Framework Directive (2008/56/EC) and the Environmental Quality Standards Directive (EQS, 2008/105/EC), amongst others also contain provisions that set *quality objectives* for water bodies. Such 'rule-based' requirements will not only drive monitoring of that status and the influences on it, but when those influences are found to endanger or prevent compliance, they will also drive strategies for management and control[6].

## 4.2 National standards and guidance

A significant study was undertaken for the EC by Milieu et al[7] looking at the impact of SWOs on water bodies. This study found that 16 Member States have national standards specifically regulating spills, and another 8 have standards that either partially cover the Directive provisions or are only applied across some of the MS area. 11 of 28 Member States had CSO spill management guidance. The review found that all Member States address CSOs at some level i.e. where not all of the provisions were transposed, standards or guidance addressing the issue did exist.

The outcomes of the Milieu study were combined with evidence drawn from interactions with MS stakeholders to gain an understanding of the methods most commonly used by Member States to manage CSO events. Limits on the number of authorised overflows were most common measure used, followed by minimum requirements set for dilution rates and design capacity requirements based on a proportion of dry weather flow prevailing in others. Other requirements include limits on the total volume of overflows or the maximum number of days of overflow events. Some countries had requirements to specifically consider management of a specific initial depth of rainfall (or 'first flush of pollutants').

However, the lack of harmonised European-wide definitions for key terms (or concepts), including 'storm water overflows', acceptable spill frequency and unusually heavy rainfall is understood to be hindering the development and implementation of a consistent set of actions to address overflows. This was debated in the CJEU's ruling regarding storm water overflows in Case C-301/10 against the UK [8]and the rulings from this (i.e. that spills were excessive and occurring during unexceptional rainfall) will need careful consideration by other Member States in developing such definitions.

## 4.3 The extent of the SWO/CSO problem & comparison with direct surface water runoff

Milieu et al reported more than 100,000 CSOs from just 19 of the Member States, However, although more than half of the countries had quantitative data on their sewer systems, a significantly lower proportion had similar data on their overflow structures, and there was a very significant lack of data on the occurrence and impact of CSOs.

Interrogating the European Environment Agency (EEA) 'Pressures and Impacts' Database to identify proportions of water bodies impacted by different pressures (as reported in the 2nd round of River Basin Management Plans) yielded the results presented in Figure 1 in terms of the proportion of rivers impacted by CSOs. An equivalent plot (Figure 2) for rivers impacted by urban diffuse pollution from direct surface water runoff demonstrates similar or increased impacts.

In 2012[9] Defra accepted that, in the heavily urbanised Thames river basin, road runoff accounted for the majority of water body pollution failures, at least 1000 water bodies had a significant urban diffuse pollution problem, and diffuse urban pollution also accounted for the major reason behind 23 bathing water failures.

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[6] Milieu (2016a) Final Report. Assessment of impact of storm water overflows from combined waste water collecting systems on water bodies (including the marine environment) in the 28 EU Member States. Specific Contract No. 070201/2014/SFRA/693725/ENV/C.2.
[7] Milieu, 2016, Final Report for Task 1.3: Assessment of impact of storm water overflows from combined waste water collecting systems on water bodies (including the marine environment) in the 28 EU Member States
[8] Commission v UK Case C-301/10, judgment 18 October 2012
[9] Tackling water pollution from the urban environment Consultation on a strategy to address diffuse water pollution from the built environment November 2012 (Defra)

It was recognised that improving this aspect of the urban environment would provide benefits in terms of well-being and economic development.

**Figure 1 Percentage of rivers impacted by storm water**

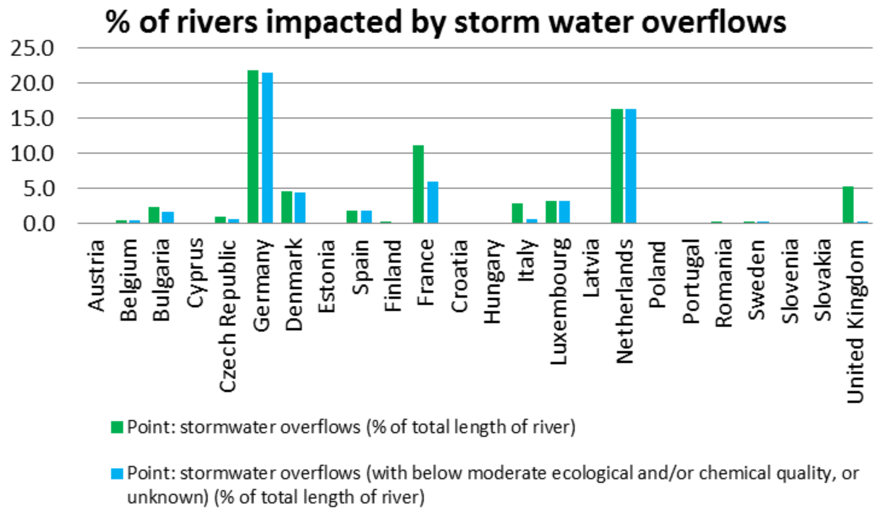
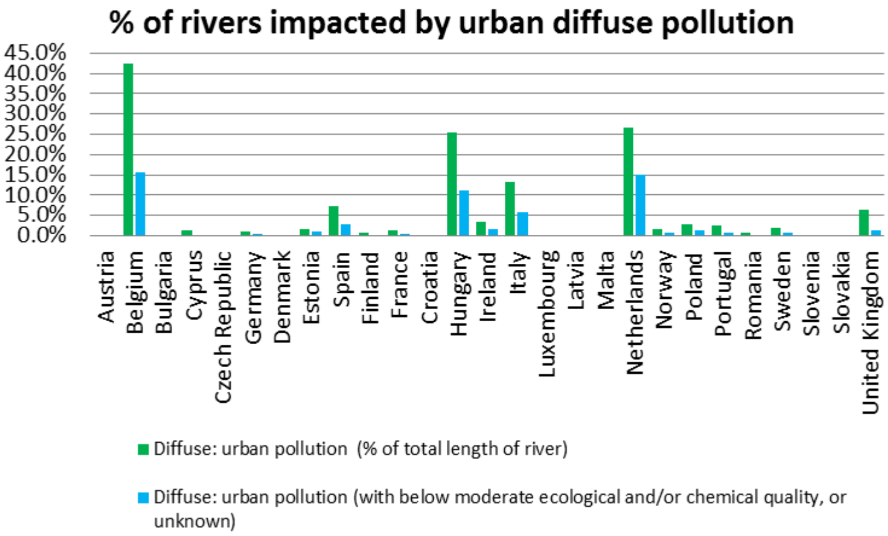



**Figure 2 Percentage of rivers impacted by urban surface water runoff**



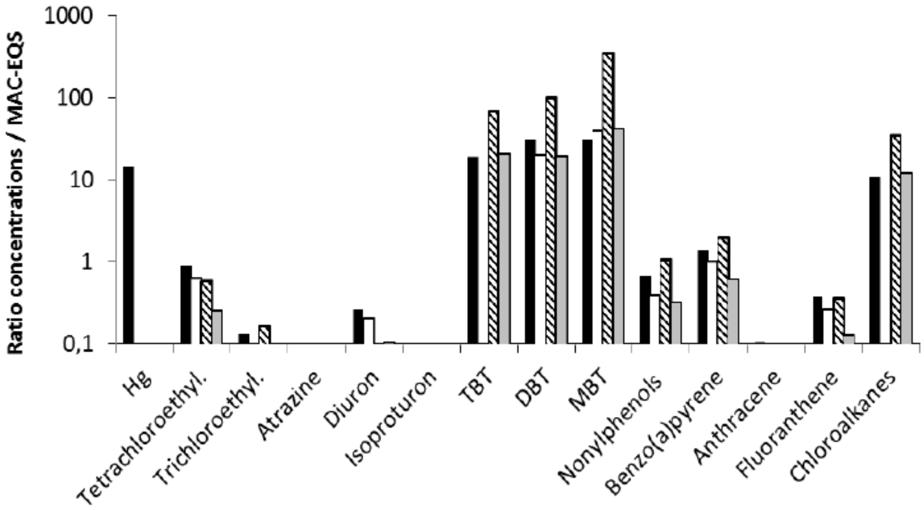

## 4.4 Pollutants

The UWWTD itself explicitly concerns the impacts of domestic and certain industrial waste waters and wastewater treatment technology is evolving to deal with an evolving and growing range of new contaminants. However, the same is true of surface water runoff pollutants, and thus both the direct discharge of runoff from separate surface water systems and the contribution of these contaminants to CSO discharges are likely to pose increasing threats to WFD compliance for inland waters. Misconnections (unintentional connections) and illegal connections to separate systems (often of residential waste water) also increase pollution risks associated with direct discharges from surface water systems.

Standard surface water contaminants include sediments, heavy metals, petroleum products, nutrients, oils, grease, bacteria, salt and a variety of chemicals (including pesticides). Whilst some pollutant concentrations in surface water decline as a result of changing automotive wear and exhaust constituents (e.g. some heavy metals), surface water pollutants now include wide-ranging and novel pesticides, polycyclic aromatic hydrocarbons (PAHs) and microplastics[10].

Figure 3 compares the concentrations of a number of priority pollutants observed in four separate discharges of a CSO in Paris and the Maximum Allowable Concentration - Environmental Quality Standards (MAC EQS).[11] Many of these compounds are found in surface water runoff.

**Figure 3 Ratio between concentrations in SWOs (CSOs) (discharges 1-4) and Maximum Allowable Concentration Environmental Quality Standard (note the different bars represent each of the 4 discharges)**




Source: Gasperi et al. (2010) Combined sewer overflow quality and EU Water Framework Directive

The Environmental Project Report 1906 (Ministry of Environment and Food, Denmark (2017))[12] concluded that discharge of treated waste water from the WWTPs has a minor role in terms of microplastic emission to the aquatic environment as a result of the treatment systems applied and that other sources such as storm water runoff, CSOs, and atmospheric deposition are more important sources.

## 4.5 Threats to compliance

The review highlighted that the impacts from CSOs are likely to be more important in the future due to changes in storm water loadings to combined networks. Changes in rainfall patterns with increasing storm intensities, together with intensification of urban development as well as urban expansion, will all tend to increase rates and volumes of surface water runoff and, where this has to be accommodated by an existing combined sewer network – will potentially increase the frequencies and volumes of CSO spills.[13] This is backed up by an Ofwat study[14] (Future Impacts on Sewer Systems in England and Wales, Ofwat 2011) which assessed that climate change, urban creep and growth, when considered together, could lead to a median 51% increase in the 1:10 year sewer flood volumes by 2040 and a mean increase of about 92%.

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[10] Corine J. Houtman (2010) Emerging contaminants in surface waters and their relevance for the production of drinking water in Europe, Journal of Integrative Environmental Sciences, 7:4, 271-295, DOI: 10.1080/1943815X.2010.511648
[11] https://rod.eionet.europa.eu/instruments/634, Environmental Quality Standards Directive, 2013
[12] Microplastic in Danish wastewater Sources, occurrences and fate Environmental Project No. 1906 Marts 2017
[13] EurEau (2016) Overflows from collecting systems
[14] Future Impacts on Sewer Systems in England and Wales, Ofwat 2011

### 4.6 Mitigation strategies

Government bodies and water utilities across the EU are implementing a range of structural measures to reduce spills from CSOs/SWOs - including sewerage improvements to increase pass-forward capacities at CSOs, the installation of screens and the construction of storage tanks for in-sewer stormwater retention. Constructed wetlands are also being implemented downstream of CSO locations in a number of countries (e.g. Germany, Italy, France and the UK) to provide treatment of spills prior to discharge. An example is Cowdenbeath wetlands – forced flow aerated wetlands that provide both treatment to protect an environmentally sensitive stream with low dilution capacity and a high value biodiversity asset for Scottish Water.

Event Duration Monitoring (EDM) of CSOs is seen by the EC as an important step in both quantifying the problem and then in determining the most effective remedial actions. At MS level, the development and use of models to simulate existing conditions and to forecast both short-term and long-term system performance is beginning to occur with the UK and France both having good examples of such applications. Predictions will allow operators to take more active control of systems (changing valve / gate settings and pump operations to maximise the use of internal system capacity), aiming to reduce the impacts of flood and CSO spill events. Modelled systems will allow more comprehensive quantification of spill risks, even where monitoring and active management is constrained by cost (EPA report[15]).

Strategies to increase the capacities of existing combined waste water collection systems or to convert of combined to separate systems may be either economically or environmentally infeasible. In practice, it is likely that a range of solutions (that, in combination, deliver an acceptable and affordable solution for each Member State) will need to be considered. These strategies are required not only to meet acceptable standards of spills for the present day but also to consider building in the necessary system resilience for the effects of future climate change and urban growth [16]

A component of the majority of these programmes is the diversion of storm water away from waste water collecting systems (i.e. surface water disconnection) through the control of runoff at 'source' – collecting runoff for 'use' and conveying and storing runoff in attenuation and treatment systems - with tight hydraulic controls on any residual discharges to sewer networks. Through integration with city Green Infrastructure strategies, such schemes can deliver multiple benefits (including amenity, biodiversity, air quality, health and climate resilience) to a wide range of stakeholders thus facilitating multi-partnership approaches to their development and funding.

## 5. Conclusions

This evidence review has highlighted a number of key issues in relation to CSO/SWO spills and their impacts on the implementation of the UWWTD. Our work indicated that this is an area where more clarifications would be useful, in particular, it appears that the term "*unusually heavy*" with respect to rainfall intensity leaves the provisions of the Directive open for interpretation, potentially hampering achieving the overarching objective of environmental protection. This definition is further complicated by rapid and often unpredicted levels of urban growth within sewer catchments, together with increasing rainfall intensities resulting from climate change. The lack of explicit guidance on required monitoring and evaluation strategies (together with the significant numbers of CSOs and their often inaccessible locations) means there is often poor MS understanding of the their occurrence and their impacts on the quality of receiving water bodies.

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[15] http://www.epa.ie/pubs/reports/research/water/Research_Report_240.pdf
[16] EurEau (2016) Overflows from collecting systems

The evidence also points to the likely significance of direct surface water discharges (urban diffuse pollution) as potentially posing similar scales of impact on receiving environmental quality and to the important challenges associated with both understanding and managing emerging micropollutants within our urban landscape.

Retrofit urban green infrastructure and natural water retention measures for reducing surface water inflows to combined systems are likely to be key tools for MS in managing spills from both point and diffuse urban discharges, increasing system resilience whilst delivering crucial environmental, social and climate resilience for future urban environments.