Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
BW4 Wastewater treatment works in areas at flood risk				**10/03/16**
Indicator type:	**Risk/opportunity**	**Impact**	**Action**	
	X			

SCCAP Theme	SCCAP Objective	CCRA risk/opportunity
Buildings and infrastructure networks	B2: Provide the knowledge, skills and tools to manage climate change impacts on buildings and infrastructure	FL7/24/27 Flooding of non-residential property

At a glance
• Wastewater treatment works (WWTW) tend to be located at the bottom of catchments near watercourses, and thus may be at flood risk • Some Scottish wastewater assets have already experienced flooding, and others may be at risk now and in the future due to climate change. • Until 2002, water assets were managed at regional and local levels, with case-by-case management. From 2006 Scottish Water has undertaken flood risk assessments at a national level, followed by interventions where required • Flooding of WWTWs is unlikely to impact directly on service (as receiving watercourses are likely to be in spate during floods so the relative environmental impact from flooded WWTWs is reduced). Therefore this indicator does not measure impact on customers • The Scottish Water Asset Register includes wastewater treatment works, water treatment works and pumping stations. The approaches to, and methodology for, any assessment of asset flood risk undertaken, or commissioned by, Scottish Water are broadly similar

Latest Figure	Trend
<u>2010-2012</u>: 39 (of around 1800) wastewater assets have experienced historical flooding issues (2.17%). An additional 390 wastewater assets lay within SEPA's 0.5% (1in 200 year) Annual Probability indicative coastal and fluvial flood boundaries (21.7%).	No additional data for trend analysis.

Why is this indicator important?

As the sole provider of wastewater treatment to around five million customers dispersed over a wide geographic area, Scottish Water has responsibility for more than 1800 wastewater treatment works, as well as for standalone wastewater pumping stations (approximately 600) and sludge treatment centres (27). The treatment of wastewater may be vulnerable to climate change because of the potential for flooding of localised assets (Scottish Government, 2011).

Flooding of wastewater assets may arise as a function of inundation via fluvial, coastal or pluvial sources. Typically, short term loss of treatment due to flooding would occur during high environmental flows in watercourses. This is recognised in the licences by which Scottish Water operate. Failure of provision of the treatment function arises principally due to the impact upon critical equipment (particularly electrical) rather than due to impact on the process. The core function of wastewater treatment works can however also be affected. For example, when filter beds become submerged and subsequently, when the water depth recedes, biomass can be washed out. This takes time to re-establish, which leaves the wastewater treatment works at risk of reduced performance and can also cause a reduction in final effluent quality. Enabling quicker recovery through appropriate siting of control panels and so on would be the first measure, and only if a site is repeatedly experiencing such difficulties may it be appropriate to 'defend' the site.

Understanding this risk is important for Scottish Water, in order to inform both central strategic objectives and local asset management plans. However, it should be noted that the impact of loss of treatment on the community or the environment is likely to be limited, as wastewater treatment works are designed to operate on a 90-95% percentile within their licence agreement. Transient failures do occur without flood risk, and would tend to have a higher impact during low flow conditions in the watercourse – during a flood, the relative impact on the environment of temporary loss of treatment would be much less.

It is therefore worth noting that asset resilience and service resilience are two different concepts. Temporary loss of treatment at a wastewater treatment works will not usually impact customer service levels. By their nature, wastewater treatment works are generally located at the bottom end of catchments adjacent to watercourses, and upstream impacts on customer service following a flood event would be unusual. Additionally, the receiving watercourse would be in spate, impacted by land runoff and so on, such that the relative impact from the wastewater treatment asset would be low. Service resilience through the management and reduction of customer flood risk is a key factor in Scottish Water's 2015-21 regulatory business plan (Scottish Water, 2014).

Related indicators
BW5 Water treatment works in areas at flood risk

What is happening now?

Wastewater assets may be vulnerable to fluvial, pluvial and coastal flooding. At present, 429 wastewater assets are noted either as having experienced historical flooding issues or as falling within SEPA's 0.5% annual probability indicative coastal and fluvial flood boundaries. This represents around 24% of wastewater assets.

To help understand the risk, Scottish Water maintains a register of critical assets vulnerable to flood risk. This database identifies the asset by name, as well as presenting data on fluvial, pluvial and coastal flood hazard probabilities and peak water levels determined through the flood risk assessment process. Information on both proactive options to mitigate flood risk and reactive options for repair or replacement of specific critical/vulnerable equipment is also included.

Scottish Water identifies wastewater treatment works lying within SEPA's stated 0.5% Annual Probability indicative coastal and fluvial flood boundaries, but not previously affected by flooding as 'Amber Risk'. Those assets previously affected by flooding are categorised as 'Red Risk'.

A Flood Risk Assessment was undertaken in 2012 for 42 wastewater assets, identified from a total of more than 1800 as either being critical assets (in terms of operational provision) or PFI assets. Of these 42, 1 had previously experienced flooding and was included in the 39 noted above. The remaining 38 assets were also assessed. Local asset planners and managers were informed of the outcomes of this flood risk assessment, and have responsibility for risk mitigation through a coordinated programme of capital investment and maintenance. Scottish Water is now developing a more risk-based approach that focuses on critical assets in order to prioritise the management of flood risk. This determines related activities set out in their business plan with the aim of ensuring customer service and infrastructure resilience.

What has happened in the past?

Between 2006 and 2010, Scottish Water undertook assessments of flood risk. Raw water storage, raw water pumping stations, water treatment works, treated water pumping stations, wastewater pumping stations and wastewater treatment works were examined in a desk based study using SEPA's 1:200 flood risk maps (coastal & fluvial), and Scottish Water's anecdotal records of surface water flooding of assets. This information was consolidated into an asset flood risk register.

Following the introduction of the Flood Risk Management (Scotland) Act 2009 and the subsequent release of SEPA's National Food Risk Assessment 2011, Scottish Water was able to update the way in which it assessed the flood resilience of its asset base. In 2012, and with the authorisation of the Water Industry Commission, Scottish Water commissioned the development of an asset selection methodology (Scottish Water, 2012a), with the aim of better understanding the risk exposure and intervention options for a number of wastewater (and other) assets. This methodology considered wastewater treatment works that had either been flooded, or were located within SEPA's 0.5% annual probability indicative coastal and fluvial flood boundaries (but had not already been flooded).

Additionally, and at a service resilience level, 42 wastewater treatment works were identified as 'critical' from which it was possible to determine that only one of these also fell into the category of having previously been flooded. At the time of this study, 39 wastewater assets were known to have experienced flooding issues. A flood risk assessment (Scottish Water, 2012b) was therefore carried out for the 42 'critical and PFI' assets and for an additional 38 assets known to have experienced flooding. A further 205 'amber risk' wastewater treatment assets were also identified via the screening process, and are kept under review.

What is projected to happen in the future?

It is widely accepted that climate change will bring an increase in sudden and intense rainfall, that coastal flooding will become more frequent and more severe, and that we will experience sea-level rise (Scottish Government, 2009). More specifically, climate change will influence catchment response through an increase in peak rainfall intensity, thereby also increasing peak fluvial flows. With respect to coastal flooding, climate change will bring an increase in both sea levels and in storminess, making those assets located nearer Scottish shores more susceptible to waves and breaches of defence crest levels. This overtopping of coastal defences may result in increased flood risk due to ponding (as

influenced by topography) or may result in structural problems due to the ingress of seawater from coastal spray.
As noted above, Scottish Water is now developing a more risk-based approach that focuses on critical assets in order to prioritise the management of flood risk.

Patterns of change

The data for 2010-2012 offer a baseline for assessing the number of wastewater treatment works located in areas at risk of flooding. However, they do not indicate the direct impact to communities.

Interpretation of indicator trends

There are no additional data to allow for analysis of trends.

Limitations

For the 39 wastewater treatment works known to have previously experienced flooding and the additional 41 wastewater assets deemed 'critical and PFI assets', the outcome of the flood risk assessments is not known to the project team. However, it should be noted that the 41 additional 'critical and PFI assets' may not necessarily have been (or be) at risk of flooding.

References

Dixon and Tawn (1997). Estimates of extreme sea conditions: spatial analyses for the UK coast. POL report 112.

Environment Agency (2011). Coastal flood boundary conditions for UK mainland and islands.

SEPA (2010) Technical Flood Risk Guidance for Stakeholders, Version 6.0. Ref SS-NFR-P-022.

SEPA (2011) National Flood Risk Assessment. Available at: http://www.sepa.org.uk/flooding/flood_risk_management/national_flood_risk_assessment.aspx

Scottish Government (2009). Scotland's Climate Change Adaptation Framework (SCCAF). *Water Resource Management Action Plan.* Available at http://www.gov.scot/Resource/Doc/295166/0091322.pdf

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Scottish Water (2012a). Asset Flood Resilience, Asset Selection Methodology, SW Ref: 401191-0000-20-GEN-0001

Scottish Water (2012b). Asset Flood resilience, Flood risk assessments. Hydrological and hydraulic modelling strategy to assess flood hazard at asset sites. SW ref: 401191-0000-20-GEN-0003

Scottish Water (2014). Strategic Projections and Business Plan 2015-2021
http://www.scottishwater.co.uk/about-us/publications/strategic-projections

Further information

Acknowledgements

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Katherine Beckmann, Heriot-Watt University / CXC contributed to this indicator.

Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	BW4 Wastewater treatment works in areas at flood risk
Indicator contact: Organisation or individual/s responsible for the indicator	ClimateXChange
Indicator data source	Numbers supplied direct by Scottish Water, and determined from flood risk assessment methodology reports
Data link: URL for retrieving the indicator primary indicator data.	The data is not publicly available, but was supplied via the contacts listed above.

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	The data is for the 2012-2013 period.
Frequency of updates: Planned or potential updates	These data will be periodically reviewed; however the timeline for this is not yet specified.
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	For the 39 WWTW known to have experienced flooding and the additional 41 assets deemed 'critical and PFI, the outcome of flood risk assessments is not known.
Spatial resolution: Scale/unit for which data is collected	The data is at the scale of the individual asset.
Categorical resolution: Potential for disaggregation of data into categories	
Data accessibility: Restrictions on usage, relevant terms & conditions	None (as no assets are named)

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
n/a

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
Numbers supplied direct by Scottish Water, and determined from flood risk assessment methodology reports. The method of determining flood hazard (defined as the extent and depth of flooding) for Scottish Water assets was based on the SEPA Technical Guidance document (Technical Flood Risk Guidance for Stakeholders, 2010) and used design flood events for annual probabilities 3.33%, 1%, 0.5% and 0.1% (i.e. 30-year, 100-year, 200-year and 1000-year return period events respectively). Furthermore, a climate change scenario was considered for the 0.5% annual probability for a time horizon of 2080. This flood hazard information was then combined with information on the 'vulnerability' of the asset; i.e. a reflection of the level of importance of a particular asset and of the possible damage from a flooding event. Fluvial, tidal and pluvial flooding mechanisms were all addressed. Where assets were deemed to be at risk of more than one flooding mechanism, consideration of 'joint probability' was addressed also. Fluvial flood risk was established using hydrological models to derive rates and volumes of runoff from the upstream catchment areas which were then translated into flood water levels for asset sites using hydraulic models. For tidal hazards, the risk assessment methodology included the flood hazard from extreme still water sea levels (encompassing coincident high tide and storm surge) and from wave overtopping. Extreme sea levels were assessed using either the POL112 method (Dixon and Tawn, 1997) or the later (and more accurate) SEPA extreme sea level data, and information from the Environment Agency's coastal flood boundary conditions report (2011). Similarly, climate change was considered for the 0.5% annual probability, in this case by establishing an uplift to the still water level using UKCP09 estimates (medium emissions scenario for 2080). Risk from pluvial flooding due to direct runoff was assessed using the 2D model TUFLOW or latterly and where appropriate, SEPA flood information. Climate change was considered again for the 0.5% annual probability, in this case by increasing peak rainfall intensity by 20% for a time horizon of 2080.