

## Creating Sewer Capacity - Sustainable Solutions in Severn Trent Water

Michael Wood – Urban Drainage Engineer, Severn Trent Water & Hyder/Aecom JV

Email: [Mike.Wood@Severntrent.co.uk](mailto:Mike.Wood@Severntrent.co.uk); [Mike.Wood@Hyderconsulting.com](mailto:Mike.Wood@Hyderconsulting.com)

### Abstract

This paper describes factors that are leading solution engineers within Severn Trent and its supply chain to consistently investigate the viability of long term sustainable and collaborative drainage solutions and two case studies are described:

- i) A separation and SuDS solution is proposed in Stoke-On-Trent which will alleviate cellar flooding and support sustainable redevelopment. Operational carbon will reduce following removal of up to 40,000m<sup>3</sup> / annum of storm water runoff from the combined sewer system. Reprogramming across AMP periods is necessary to realise long term benefits.
- ii) Severn Trent and Telford & Wrekin Council are working together to reduce a long standing and complex flooding problem in Ketley Town. A combination of SuDS and more conventional piped solutions are proposed to manage surface water runoff.

### Introduction

Within Severn Trent Water, three area 'Asset Creation' teams are responsible for developing solutions and creating infrastructure to solve sewer system problems. Teams comprise in-house solution and programme engineers, consultants and D&B partners which integrate into the 'One Supply Chain'. There is an increasing emphasis and expectation for these teams to deliver 'smarter' solutions by exploring the possibilities for SuDS, drainage separation and benefits of collaborative working.

### Context and Impetus for SuDS, Separation and Collaborative Working

Sustainable drainage solutions are not new. Engineers in Severn Trent have provided their past examples of balancing ponds constructed to alleviate surface water sewer flooding, drainage separation to abandon CSOs and numerous examples of working together with stakeholders.

However, the demand for solution teams to explore potential benefits associated with SuDS, separation and collaborative working are arguably greater than at any other time and this is driven by a number of pressures.



Figure 1 - Detention pond, Cannock municipal golf course, alleviates downstream sewer flooding

### Company Business Plan and Strategic Direction.

Engineers are required to present their solutions in the form of a business case report. Projects have a greater likelihood to gain approval if requested investments are focused towards the Company business objectives. Sustainable drainage solutions are encouraged in this respect. The Severn Trent's Strategic Direction Statement to 2035 commits to dealing effectively with wastewater; *'Our customers should have confidence that we will take away their waste and treat it to the highest environmental standards...to achieve this we will....'*

- *Progressively separate foul and surface water drainage;*
- *Promote the installation of Sustainable Urban Drainage Systems (SuDS).'*

The AMP5 Business Plan Summary also promises: *'Sustainable solutions including promotion of catchment management, sustainable drainage solutions, increased renewable electricity generation, and taking into account carbon impacts in all the decisions on our programme'*.

### Demand for Smarter Solutions

There is an ever increasing demand for 'smarter' solutions which achieve positive financial and social cost benefit and contribute to beating AMP5 efficiency targets.

Electricity Consumption and Carbon Footprint

During July 2012, the Company’s electricity costs were 11% higher than forecast due to a period of sustained wet weather and the Company’s electricity costs targets are further compromised by escalating energy costs. Separation and SuDS solutions can reduce power consumption at pumping stations and sewage treatment works and provide alternatives to pumped storage.

Legislation

The Flood and Water Management Act has provided a new impetus for the promotion of sustainable drainage solutions and puts new duties on Water and Sewerage Companies. Under the Act, Severn Trent has a duty to act consistently with EA national strategy, have regard for LLFA flood risk management strategies, to cooperate, provide information and investigate flooding. Severn Trent’s Sewer Strategy team liaise with OFWAT, Defra and represent Severn Trent on the panels of local authority flood groups. They provide a link between LLFAs and asset creation teams, identifying and promoting potential benefits for collaborative working amongst stakeholders.

Engineer Professional Obligation / Competency

It is sometimes easy to forget the professional obligations of engineers during every day working life. The role of professional engineers in sustainability is described within The Engineering Council UK’s sustainability guide. Engineers are ‘the providers of options and solutions to maximise social value and minimise environmental impact’. It lists six guiding principles including contributing to building a sustainable society and applying professional and responsible judgement.

**Case Study 1 - Wilfred Place Flood Alleviation, Stoke-on-Trent.**

Background and Problem.

Wilfred Place is located in the Hartshill suburb of Stoke. The catchment is fully combined and comprises old residential properties and the North Staffordshire Royal Infirmary (NSRI). Flows ultimately discharge to Strongford STW via the combined network and Trent Vale Sewage Pumping Station.

Five properties are at risk of cellar flooding due to backing up of flows from an overloaded 450mm diameter combined sewer in Queens Road during 10 year+ return period rainfall events.

The network gravitates to Strongford Sewage Treatment works via CSOs and Trent Vale Pumping Station.



Figure 2 – Wilfred Place, location and network

Rejected Options

The following ‘conventional’ options were considered following re-promotion of the scheme in AMP5.

Option	Why Rejected/ Not Progressed
Upsize	No downstream capacity. Upsize through Stoke Cemetery.
Gravity / Pump Storage	High cost. Poor cost benefit.
Individual property ‘cut and pump’	No emergency access, electrical non-compliance issues.
Joint ‘cut and pump’ – package pumping station	Preferred conventional solution. Viable but flows would need to be routed to a package SPS remote from the properties.

Redevelopment of North Staffordshire Royal Infirmary

A robust sustainable solution was triggered following identification that the North Staffordshire Royal Infirmary was to be gradually closed down to 2014 and redeveloped with up to 300 new houses in the period 2015-2020. The redevelopment of the 9 hectare site is expected to include a sustainable surface water drainage strategy vetted by a SuDS approval board. Surface water connections to the sewer system are still anticipated but with runoff at a reduced rate and volume.

A ‘do-nothing’ option became a realistic proposition given the anticipated reduction in runoff into the combined sewer system. However, the opportunity for full system separation became an exciting and preferred opportunity following identification of an outfall 0.75km downstream, a distance which would normally be considered too far for a surface water connection from a redeveloped site to be made.

Consultation with Stoke City Council

Stoke City Council are a lead flood authority and welcomed the opportunity to work collaboratively on the project. Potential benefits quickly escalated following identification of non-sewer flooding in Newcastle Road, Hilton Road and Thornburrow Drive from within their own flooding database.

Preferred Solution - separation and SUDS strategy with multi-agency collaborative working

A SuDS and separation solution with partnership working with Stoke CC was approved by Severn Trent’s programme board. The solution requires a new surface water sewer to be constructed between Queens Road and a culverted watercourse off Thornburrow Drive which conveys controlled surface water runoff from the redeveloped hospital sites, highway drainage, and interception of the existing surface water sewer in Yoxall Avenue. It is proposed to optimise attenuation and infiltration potential by construction of on/off line swales and SuDS detention storage. The scheme was re-programmed to AMP6 to coincide with the redevelopment of the North Staffordshire Royal Infirmary.

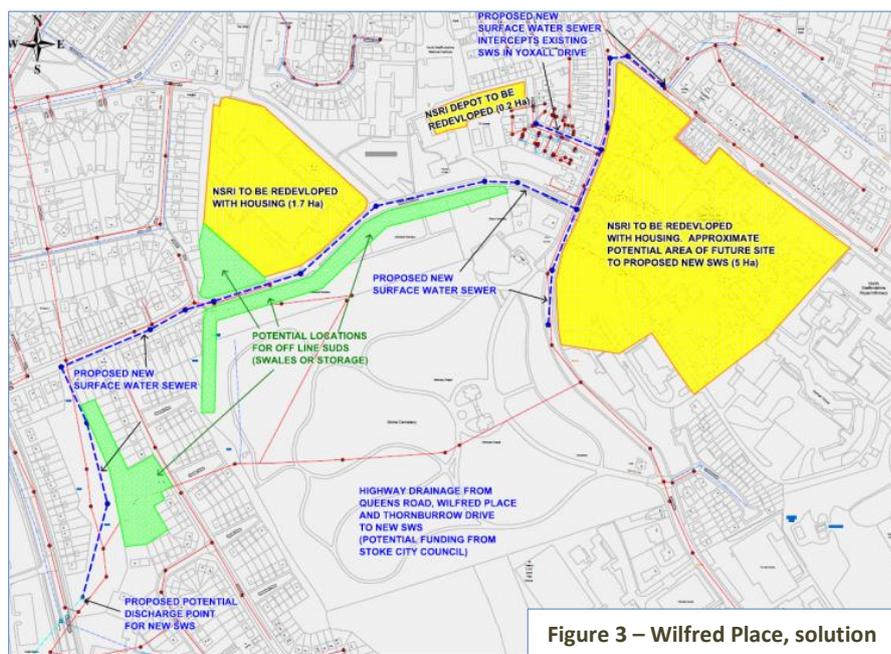


Figure 3 – Wilfred Place, solution

Customer Impact

A key consideration in deferring the scheme was the care for customers who remain at risk of sewer flooding until the scheme is realised. Customers were contacted directly and provided details of the proposal and their responses were largely ‘pragmatic’. Three of the five properties already have temporary flood mitigation in place whilst the remaining two customers were offered the same mitigation.

Solution Benefit Comparison

	Do Nothing	Intercept to new Pumping Station	Separation / SuDS
Sewer flooding benefits (nr)	5	5	5
Other flooding benefits (nr)	0	0	3
Change, surface water runoff into combined sewer system (m <sup>3</sup> /annum)	0 (assumes no SuDS infiltration)	0	-40,000m <sup>3</sup>
Estimated Scheme Cost (£)	0	£168,000	£419,000 *
Social Cost Benefit (£)	£16,000	£5,000	£51,000
Est. change in electricity cost (£/yr)	negligible	+£75	-£525
Programme Impact	+4 years	0	+4 years
CSO spill volume, 1Yr-120min storm	+298m <sup>3</sup> **	0	-397m <sup>3</sup>

\* Estimated cost for Severn Trent (subject to runoff from redeveloped areas), \*\*Increase due to greater retained system volume

## Case Study 2 - Ketley Town Flood Alleviation, Telford

### Background and Problem.

Properties in Ketley Town have been subject to a long standing and complex flooding problem. This has resulted in numerous customer complaints, MP letters, press articles and claims for negligence. Temporary mitigation measures are in place including non-return valves and flood gates but these have proven to have limited effectiveness in larger events.

Previous solutions to improve sewer system capacity using 'conventional' solutions were rejected by Severn Trent's programme board due to poor cost benefit. The project was re-promoted during the current AMP to review a sustainable approach working in partnership with other stakeholders.

### Flood Mechanism

The flood mechanism is complex and multi-causal. Flooding has occurred from foul and surface water sewer incapacity, pluvial runoff from land and embankments off Waterloo Road, service defects, a partially blocked outfall, low channel capacity and blocked / insufficient highway drainage provision. Flood water routes overland down Waterloo Road and ponds in the Ketley Town 'basin'.

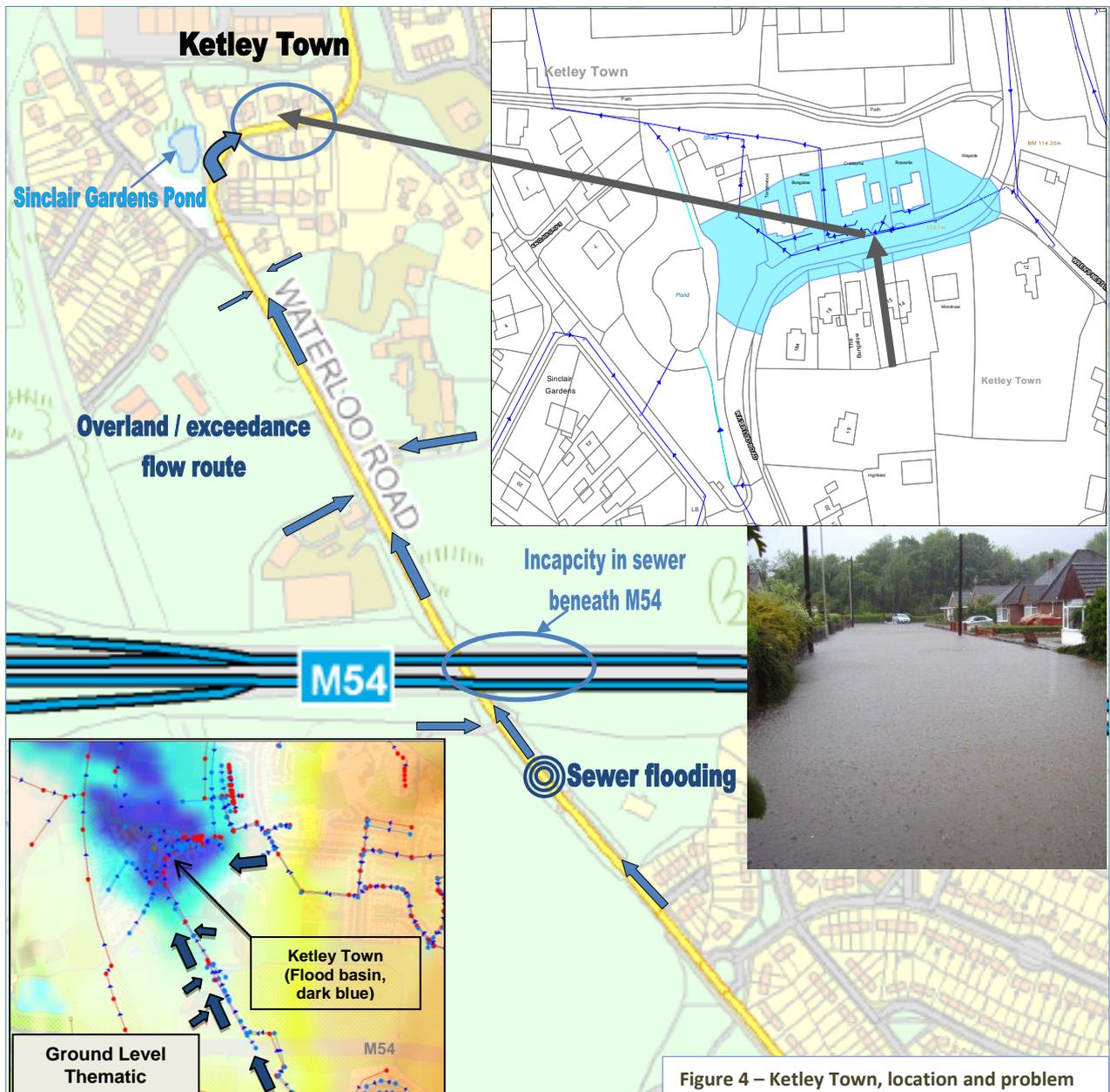


Figure 4 – Ketley Town, location and problem

A severe hydraulic restriction exists in the public surface water sewer network where it crosses beneath the M54 motorway bridge due to a reduction in pipe diameter from 600mm to 450mm, and headloss from a series of 90 degree pipe bends. 180m<sup>3</sup> of flooding is predicted for a 10 Yr return period. The sewer downstream of the M54 runs surcharged with little capacity available to accept runoff from the highway, embankments and land either side of the valley highway. The sewer outfalls into Sinclair Gardens Pond whilst overland flow routes towards Ketley Town.

Inadequate highway drainage provision towards the bottom of Waterloo Road is exacerbated by mud and debris running off embankments. The capacity of the outfall into Sinclair Gardens pond is compromised by partial submergence and a service pipe which crosses the outfall channel.



Fig 5 – Mud on highway



Fig 6 – Sewer outfall

Collaborative Working

The problem and history of flooding requires a collaborative approach to be taken by Telford & Wrekin Council and Severn Trent Water. The relationship is summarised in the following table:

	Severn Trent Water	Telford & Wrekin Council
Solution Development	✓ (lead)	✓ (support)
Hydraulic Modelling	✓ (lead)	(agreements)
Construction: Sewer capacity improvements	✓ (design and build)	x
Pond, highway, highway drainage improvements	? (to be confirmed, possible Severn Trent Water D&B contractor)	
SuDS Provision	✓ (design and build)	✓ (adoption & maintenance)
Land sacrifice	x	✓
Funding	✓ (capital programme)	✓ (grants / planning fund)

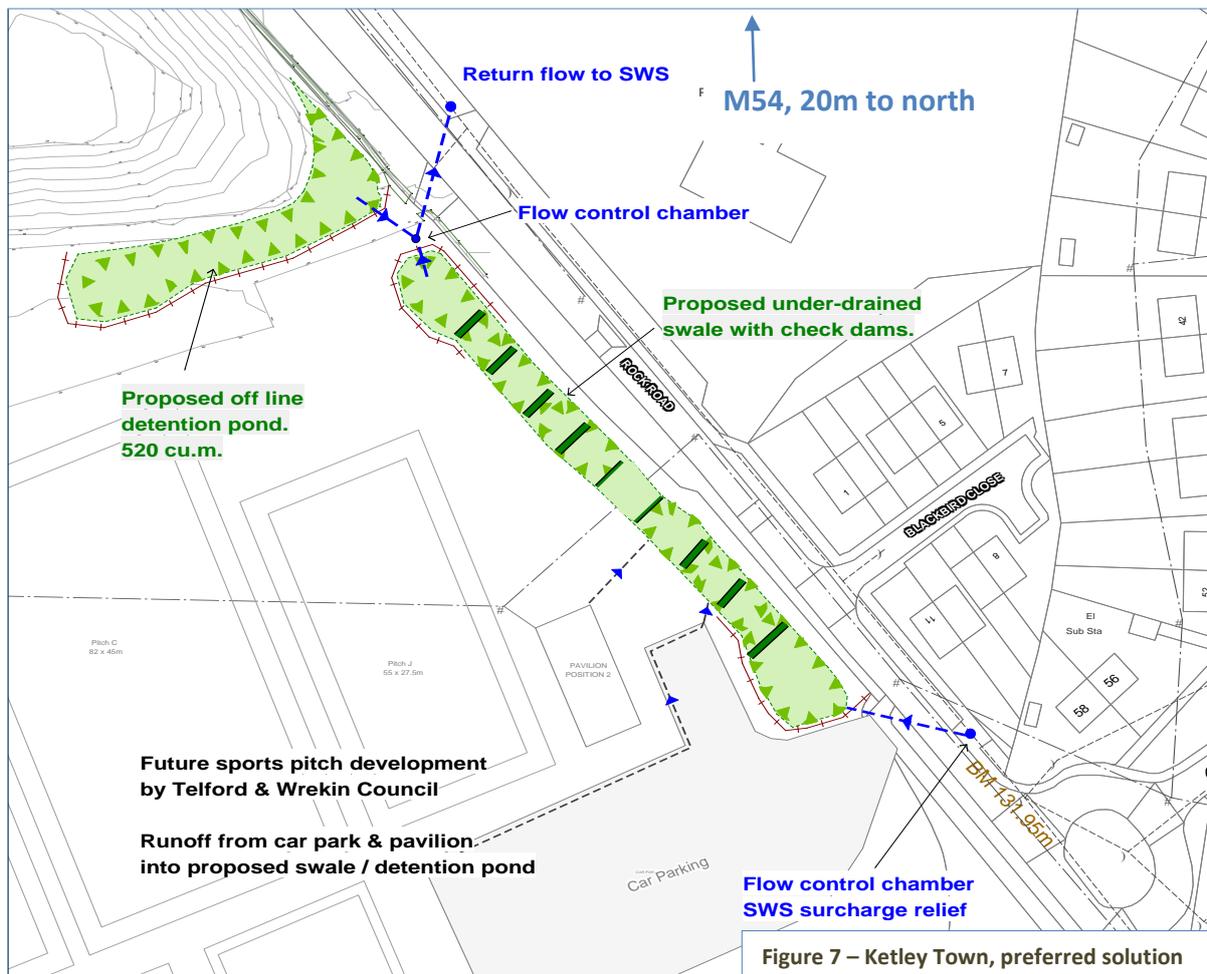
Surface Water Management Solution

Conventional solutions were considered to improve the capacity of the surface water sewer system in Waterloo Road. Upsizing the surface water sewer from the pinch point upstream of the M54 was rejected because it would require tunnelling beneath the M54 motorway bridge and the closure of Waterloo Road leading to major disruption to the local road network. Pipe storage solutions were rejected due to high unit cost and low social cost benefit. ‘Sustainable’ alternatives were considered.

Two pieces of land either side of Waterloo Road and upstream of the M54 motorway bridge were identified with SuDS potential. An idea was developed to divert, attenuate and store surface water flows within a swale and balancing pond within a playground to the east of Waterloo Road. However it was unfavoured for safety concerns as the area is used by young children.

Telford & Wrekin Parks officer informed how there were long term plans for the land to the west of Waterloo Road to be developed for sports pitch use which would require a new access road, car park and changing facility. A SuDS solution on this site therefore has potential multiple benefits supporting flood alleviation and sustainable growth. Additional feasibility was undertaken to assess the viability of a surface water balancing pond at the northern end of the sports pitch development. However, topographical surveys and geotechnical investigations conspired against this solution following identification that land had been formerly been built up with colliery spoil from old mine workings. The volume of earth shift to form the pond and landscape the area was deemed unfavourable and there was concern at exposing contractors to potential contaminated waste risks. The final solution

requires construction of a swale along the eastern boundary of the proposed sports pitch supported by two detention ponds towards the bottom of the site. The SuDS element will provide a stored volume of up to 700m<sup>3</sup>, low groundwater infiltration rate and pollutant reduction from future car park runoff. It reduces surcharge within the downstream sewer system to acceptable levels so that additional highway drainage provision is hydraulically effective. A speed hump is being considered towards the bottom of Waterloo Road as a traffic calming measure and to help divert exceedance flows into Sinclair Gardens pond.



**Solution Benefit Comparisons**

	<b>Upsize on line</b>	<b>Pipe Storage</b>	<b>SuDS</b>
Sewer flooding benefits (nr)	5	5	5
Est Construction Cost (£) *	£339,000	£345,000	£204,000
Social Cost Benefit (£)	£87,000	£86,000	£90,000
Support for 'growth'	Y	Y	Y
Environmental benefits (Y/N)	N	N	Y
Programme Impact	0	0	+18 months

\* Note on cost. The above costs comparison is not undertaken on a 'like for like' basis. Pipe infrastructure costs have been determined from 'cost curves' which have been built up from a database of previous projects and have been subject to competitive tendering. SuDS features such as swales and detention ponds are not included within these curves and are priced as 'non-standard items' built up from base labour and material rates and are subject to an approximate 40% on cost. There is significant potential for differential cost between conventional and SuDS solutions to increase over time with changes to financial procurement models.

## Findings and Lessons Learnt

The findings of the above two case studies are summarised as follows: -

- SuDS solutions have had a negative impact on original planned delivery dates due to additional feasibility and to coincide with timescales of dependent projects. This has been accepted to realise long term benefits and has been made possible by active and flexible programme management and by keeping customers informed;
- As SuDS are not classified as 'sewers', there is no power of entry to land and there has been a need to work closely with landowners to agree solutions. In the Ketley Town example, Telford & Wrekin Council volunteered, as landowner, to fund and undertake site investigation to help speed up the process and mitigate the need for statutory notices to be served.
- Stakeholders for these schemes have all welcomed opportunities to work collaboratively;
- Both lead local flood authorities identified funding as a potential barrier. However, Telford & Wrekin Council is optimistic that future funding applications to the EA will be successful and strengthened given Severn Trent funding contributions towards the overall project. Severn Trent funding is from the capital programme;
- In the Wilfred Place example, the most sustainable option has the highest construction cost but was ratified by Programme Board since it provides greatest cost benefit;
- It was not possible to compare the cost of SuDS versus 'conventional' solutions on a like for like basis because SuDS are not currently incorporated into Severn Trent's standard cost curves and have to be estimated using 'bottom up' pricing. Despite this, the cost of constructing the SuDS solution in Ketley Town is estimated to be 40% lower than conventional pipe solutions demonstrating potential financial benefits of these methods;
- The Wilfred Place example identifies how there are significant opportunities for separation where redevelopment takes place with combined sewer catchments;
- Not all potential benefits were known at the start of the project. Non-sewer flooding and support for recreational growth in Telford only came to light after consultation with Stoke and Telford & Wrekin Councils respectively.
- Not all development proposals are included within local plans or known by Council drainage staff. In the Telford example the long term recreational development was only identified following consultation with the parks and open spaces officer.

## Acknowledgements

The author acknowledges input, support material and proof by reading Paul Hurcombe, Tim Smith and David Gordon. Thanks also to Ian Hodgkiss and Ben King for provision of electricity data.

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