SECTION 6: DYNAMICS OF FLOW AND HYDROMORPHOLOGY

"Our Vision is a river full of water that is plentiful and clean, and varied in its flow speeds, widths and depths"

Wandle Catchment Plan Objective 3: The river has a re-naturalised varied profile that creates a diversity of flow speeds and water quantity to provide all the key habitat types required by the native flora and fauna associated with lowland chalk streams"

6.1: Flood risk management

"Even in the 1980s the river bed was literally being flattened with bulldozers every winter for flood defence. Now we want to see the natural shape of the river restored, with riffles, bends, shallow bits and deep bits – which will actually help stop so much water rushing downstream to flood Earlsfield and Wandsworth!"

- from Ketso community and stakeholder workshops

Reducing the likelihood and incidence of floods, and their effects on local people, is an important aspect of catchment management. Climate change research suggests that the UK's winters may become wetter, and all weather events may become more intense. This suggests that the highly urbanised Wandle valley will need to find new solutions, including Sustainable Urban Drainage Schemes (SUDS), to mitigate the future effects of urbanisation and climate change.

Like most rivers across the Thames basin, the natural chalkstream hydrograph of the Wandle has been heavily modified over many years – not just for industrial purposes, but also for flood risk management (FRM) in an urban environment where infiltration is extensively compromised by roads, roofs and impermeably paved gardens.

Today, the river's remaining channels have all been radically simplified, often for the purposes of conveying the maximum volume of flood water to the Thames Tideway as rapidly as possible. Over the course of the catchment's evolution from rural to urban, most of the modifications made to the Wandle had industrial functions. As the mills declined, these structures were adapted or replaced by others, ostensibly for FRM purposes: a reduction in industry along the river has not been matched by a decline in hydromorphological modifications. Scientific understanding of the causes of flood risk has also improved. Consequently, many of the features once installed for FRM may now only be serving a redundant historical function which conflicts with robust modern science and the priorities of WFD catchment management, and may even be increasing the risk of flooding.

FRM has historically been seen by local people and authorities alike as an important ecosystem service provided by the river. In the context of climate change and the likelihood of more extreme weather events, the importance of FRM is only likely to increase: however it may also provide valuable opportunities to restore natural catchment processes including flood storage and infiltration.

Flood risk has two components:

- The chance (probability) of a particular flood
- The impact (consequence) of a flood if it happened: ie a product of the geographical extent and duration of the flood

Flood risk is often expressed in terms of the return period: for instance, a one-in-ten year flood would on average be expected to occur once in every ten years.

Flood risk is calculated on the likelihood of a flood of a given size occurring within a one year period: a 1% flood has a 1% chance or 0.01 probability of occurring in any one year.

In the Wandle catchment, flood risk may arise from the following separate but partially interconnected factors:

- Ground water: rising water in the river's aquifer and hyporheic zone (which also forms the river's natural baseflow)
- Surface water: including fluvial flooding and runoff from rainfall, exacerbated by hard surfaces across the catchment, causing flash flooding in vulnerable areas
- Combined urban drainage systems: if capacity is overwhelmed by heavy rainfall

In the Thames region, c135,000 properties currently have a more than 1% chance of flooding in any one year from rivers. London and the Lower Thames have the greatest number of people and property at risk.

According to the EA's Thames Catchment Flood Management Plan (CFMP), Merton has the highest flood risk of the four local authorities within the River Wandle's influence, with a 1% annual probability fluvial flood putting more than 5,000 properties at risk. Wandsworth, Sutton and Croydon have slightly lower risk levels, with between 2,000 and 5,000 properties each at risk (EA, 2009).

To tackle flood risk, the EA have divided the Thames CFMP region into 43 sub-areas, and applied one of six policy options for flood risk management in each sub-area, depending on the perceived level of flood risk. The River Wandle falls into sub-area 8 ("heavily populated floodplain") under policy number 5: "an area of moderate to high flood risk where (the EA) can generally take further action to reduce flood risk".

Under Section 21 of the Flood and Water Management Act 2010, lead local flood authorities are required to maintain a register of structures and features which are likely to have a significant effect on flood risk in their area.

The EA's current FRM regime for the Wandle focuses on risks from fluvial flooding since only limited data is available for flooding from other sources in the region. As such, the EA now requires that any surface water runoff from new development and re-development, especially within the floodplain, does not impact on flooding by increasing fluvial flood risk. Modern urban planning champions source control as the most sustainable route to mitigating urban runoff, ideally by identifying pollution sources and addressing runoff as close as possible to the point of precipitation – for instance, by installing SUDS (see Section 6.2). As such, this is also a means of minimising flood risk, which is often elevated in urban areas.

In addition to clearing rubbish screens (installed to prevent blockage of box culverts), part of the routine work of the EA also involves creation of flood storage schemes, sometimes incorporating existing permanent water bodies. One such opportunity exists in the Beddington Mitcham Area of Opportunity (BMAO) adjacent to Beddington STW, where additional flood storage is already provided via the flume installed on the Wandle at Beddington Park.

Alluvial gravels are currently being extracted in the BMAO, with permission for extraction originally granted by the GLC in 1985 on condition that rehabilitation plans eventually included re-landscaping for conservation, recreation and large-scale flood storage purposes. The Beddington flume already considerably reduces flood risk, resulting from precipitation and runoff from Croydon, in the Hackbridge area. The EA is working with Thames Water, LB Sutton and other interested parties to realise the potential of this site in the long term.

In addition to the Beddington Park flume, river levels on the Wandle are extensively controlled by tilting weirs at Beddington Park lake, Goat Bridge, Watermeads, Ravensbury Park and Merton Abbey Mills. These were installed in order to maintain historic water levels and manage the time-response of the river to heavy rainfall in different parts of the catchment, but may now be questioned on WFD grounds.

Future flood risk will be influenced by a range of factors, most notably changes in land use from urban growth, as well as climate change which is likely to increase both chance and impact of flooding. Using broad scale modelling, the EA have estimated that the number of properties at a 1% risk of flooding from rivers in the Thames CFMP area will increase by approximately 20% as a result of climate change. Milder, wetter winters resulting in increases in peak river flows will mean flooding will occur more often and large-scale flooding is more likely. More frequent, short duration, intense storms in summer will be likely to cause more widespread and regular surface water “flash flooding” from overwhelmed drainage systems, and in some cases rivers.

Fluvial flood risk in catchments like the Wandle is typically of short duration, with rapid rise and fall of river levels. The depth of the floodwater, speed and duration are not likely to be great but the lag period between the rainfall and a flood will be relatively short. This can mean that a flood can still be disruptive, depending on the time of occurrence.

Where removal of weirs on the Wandle is contemplated, detailed modelling will be the first step towards establishing impacts. Increasing evidence from practitioners engaged in catchment-scale restoration on other rivers now shows that increasing upstream flood storage, as well as restoring channel roughness and morphology throughout a river system, may also provide significant FRM benefits by delaying the arrival of peak fluvial flood flows at vulnerable pinch points like urban bridges. In turn, this approach implies major opportunities for restoring natural river processes whilst also obviating hard engineering solutions like tilting weirs and reducing catchment flood risk.

<u>Further information required</u>

Further investigation into feasibility of removing redundant structures

<u>Further reading:</u>

Environment Agency (2009) *Thames Catchment Flood Management Plan*

Local Councils’ Strategic Flood Risk Assessments

6.2: Sustainable Urban Drainage Schemes (SUDS)

“We want to see more imaginative solutions to droughts and floods in the Wandle Valley, including green roofs, grey water recycling, swales and rain gardens.”

- from Ketso community and stakeholder workshops

Sustainable urban drainage systems (SUDS) are drainage solutions that are designed to provide an alternative to channelling surface water directly into the nearest watercourse via pipes and sewers. By attempting to recreate natural ‘rainscapes’, SUDS aim to increase infiltration and flood storage capacity, reduce surface water flooding and urban runoff into nearby rivers, and enhance the environment for people and wildlife.

Provision for SUDS and the national standards required for their design, construction, maintenance and operation is included in the Flood and Water Management Act 2010.

The EA is generally supportive of installing SUDS to mitigate flood risk, subject to certain caveats. For instance, experience has indicated that many SUDS proposed by developers are effectively soakaways sited in very vulnerable and sensitive locations, such as where ground water is particularly shallow or close to water supply boreholes. As a result, the EA advises developers to refer to best practice SUDS guidance provided by CIRIA, and enter into discussions with the EA at the earliest possible opportunity.

Under the Flood and Water Management Act 2010, local drainage approving bodies (SABs) will be designated to take responsibility for approving SUDS within new developments. In most cases these SABs will be local councils, which will assess applications for SUDS under national standards set by Defra. The assessment process will involve consulting statutory consultees, including sewerage companies, highways authorities and the EA.

As a highly urbanised catchment subject to significant flood risk, the Wandle offers clear opportunities for management of surface water via SUDS: either by incorporating them into new developments *ab initio* or by retrofitting them into existing urban landscapes.

In 2012 a study summarising the potential for SUDS in Hackbridge found that local geology, depth to ground water and possibly contaminated land could affect the feasibility of direct infiltration systems. The likely predominance of clay soil could result in an infiltration system being largely ineffective, and the probability of contamination from previous industrial uses would make infiltration unsuitable (Wandle Trust, 2012).

As a result, this study recommended installing source control measures, with storage areas outside zones of main flood risk to attenuate runoff, to reduce the risk of flooding on site and slow the rate of runoff into the river:

- A number of 3m wide grass swales, and a generously-sized rain garden, would allow large volumes of water to be held on site (c5000m^3). These areas would also be used for amenity and provide opportunities for environmental gain

- Investigate potential measures, including large communal rainwater harvesting tanks, to provide capacity for reducing water consumption and providing additional surface water storage

- As a last resort, the SUDS would be linked into the main flood drainage paths to discharge water into the river after exceptionally heavy downpours

To maximise the impact of SUDS installation, opportunities were also identified for local communities' involvement in wise water use campaigns and helping to monitor the long-term effectiveness of the SUDS.

Further reading:

CIRIA SUDS Guidelines: available via http://www.susdrain.org/resources/ciria-guidance.html

The London Plan: available via http://www.london.gov.uk/priorities/planning/londonplan

Wandle Trust (2012) *Sensitive Water Management in Hackbridge, London*

6.3: Dynamics of flow action tables

The information in these tables has been assembled from suggestions made in community consultations, TAG meetings and specific stakeholder input to develop a series of Objectives, Targets and Actions. Information on existing projects has been collated and used to identify gaps, and where additional projects may need to be developed to fulfil Actions, Targets and Objectives.

Actions to achieve the Catchment Plan's overall aim for water: Water is plentiful and clean, and varied in its flow speeds, widths and depths

Objective 3: *Dynamics of flow*: the river has a re-naturalised varied profile that creates a diversity of flow speeds and water quantity to provide all the key habitat types required by the native flora and fauna associated with lowland chalk streams				
Specific Actions to attain GEP				
Target	**Actions**	**Project**	**MM**	**Indicative cost to deliver these Actions**
3.1 Volume and timing of surface water input rates, including transitional water, reflect natural regimes	3.1.1 – Undertake research to identify a suitable proxy for natural patterns of volume and timing for the Wandle (eg historic, pre-industrial data; surface water runoff reduced from current approx. 55% for an urban area to 10% to reflect natural drainage).	None	9	This Target has been fulfilled to a large extent by the EA's existing analytical reports and by previous independently funded work.
Carshalton WB by 2015 Croydon-Wandsworth WB by 2027	3.1.2 – Identify causes of any changes in discharge rates from historical natural flows; via investigation for patterns that might be due to natural seasonal variation, pumping systems, industry etc.	None	9	
	3.1.4 – Identify and obtain funding sources for measures, such as Sustainable Urban Drainage Systems (SUDS), to reflect / restore natural input patterns within the catchment.	None	9	The cost for installing SUDS and other measures to help replicate natural flow patterns varies considerably, depending on location, ease of access, flood risk implications, ease of installation and maintenance. For example, **porous and**

	3.1.5 – Implement measures such as SUDS to replicate natural patterns without increasing flood risk.	None	9	**permeable paving for a $20m^2$ driveway can cost between £100 and £2000** (to purchase and install gravel or Concrete Block Permeable Paving respectively). The cost of installing micro-wetlands is highly dependent on a number of factors, notably land prices. An **indicative cost, based on a location in Hackbridge, LB Sutton, is estimated at £20,000 per acre to install, plus monthly management costs and health and safety considerations such as fencing.** Estimations of cost for the whole river would be dependent on walkover surveys and detailed feasibility studies drawing on the local authorities' Surface Water Management Plans.
	3.1.6 – Develop an infrastructure to enable monitoring (ie recruiting volunteers and obtaining monitoring equipment / funds, plus monitoring and analysing results).	None	9	Independent monitoring to measure the success of measures aiming to restore natural processes of surface water input (eg by measuring discharge rates for stability of flow patterns and emulation of chalk stream characteristics) could be run with volunteers at minimal cost once monitoring equipment and analysis capabilities were obtained (such as data-analytical computer software). **Estimated cost for start up and maintenance for 10 years £65,000**.
	3.1.7 – Instigate an ongoing programme of monitoring to measure success. Agree terms with partners – perhaps defining success as ensuring surface water discharge rates are stable, sustainable or replicating natural patterns. Measures to be amended as needed if they are not demonstrating success.	None	9	
3.2: Channel profile is enhanced to restore natural functioning and impact on flow speeds and	3.2.1 – Identify stretches of the river that require restoration work to achieve a varied and naturally functioning channel profile, including removing weirs and other barriers to water flow or wildlife movement.	A4, B1, B3, B10/C9, B13, B14, B17, B18	1, 2, 3, 4, 5,	<u>Actions 3.2.2 and 3.2.3</u> Independent work to undertake feasibility studies to restore natural functioning at a key reach on the Wandle has been **estimated as costing £15,000 to £25,000**.

directions with minimised impact of barriers on water flow or wildlife movement Carshalton WB by 2015 Croydon-Wandsworth WB by 2027	3.2.2 – Identify and obtain sources of funding to undertake feasibility studies to identify the best remedial measures to remove barriers to water flow or wildlife movement. Draw upon latest scientific recommendations and best practice techniques for sound ecological grounding and robustness of approach: consider using modelling	B19, B20, B21, B28, B30, B31, B33, C1, C4, C5, C6	6, 7, 8, 9, 10	3.2.4 As with other Actions relating to underpinning habitat enhancement works and restoring chalk stream fluvial processes, it is difficult to estimate cost without reach-specific or structure-specific evaluation. However, comparable projects involving hydraulic modelling, weir removal, creation of fish bypass channels, introduction of woody debris and other habitat enhancements important to all fish life stages suggest **such work would cost some millions, with indicative costs accruing as follows:** Modelling the feasibility of removing or modifying weirs which are causing a barrier to fish migration and identifying flood risk implications is **estimated to cost £100,000 to £200,000**. Physical removal of impoundments such as weirs is very heavily dependent on the complexities of the structure. Comparatively simple structures are **estimated to cost £30,000 per weir to remove** though this may be reduced to £20,000 if removing multiple weirs facilitates economies of
	3.2.3 – Identify and obtain funding for carrying out restoration work within the catchment identified through the feasibility studies (and monitor success afterwards).			
	3.2.4 – In partnership with relevant landowners, managers and statutory agencies, implement measures to re-naturalise the channel profile and restore natural functioning (ie incorporating pools, riffles, meanders, backwaters, in-stream deflectors and islands).			
	3.2.5 – Review existing remedial work to check whether expected improvements have been realised. Address any shortcomings with revised plans and implement works as necessary.	None	1, 2, 3, 4, 5,	

	3.2.6 – Collate evidence and techniques used to create a 'best practice' manual for urban river restoration that can be applied as a template to other urban projects.	None	6, 7, 8, 9, 10	scale. A proportion of this cost may be required for modelling. Conversely, to remove a large, heavily engineered weir and make good afterwards could cost as much as **£250,000. Costs may be higher where weirs are keyed into river walls.** In-stream and bank enhancement works are estimated to cost **between £150 and £350 per linear metre**, depending on the particular characteristics of a reach, such as accessibility for machinery and the level of channel reinforcement.
Wider Actions to improve the ecological functioning of the river				
Target	**Actions**	**Project**	**MM**	**Indicative cost to achieve these Actions**
3.3: Urban development optimises the visibility of the river at all times (eg no culverting)	3.3.1 – Using examples from elsewhere in the UK and overseas, create an awareness-raising campaign aimed at local authorities, developers, landowners and managers (and also the general public) to promote positive results from incorporating Water Sensitive Urban Design (WSUD) into new development plans. Show how WSUD can create aesthetic regeneration as well as provide vital flood management and water quality control services.	None		This could be delivered via an MSc student desk-based research project to inform an awareness-raising campaign funding bid incorporating best practice techniques and experiences.

	3.3.2 – Research deculverting the river at all remaining feasible points, including those that are currently considered Technically Infeasible or Disproportionately Expensive (eg Southside shopping centre in Wandsworth) so that opportunities can be seized whenever they arise in the future.	None		This Action will need to be led by the EA in partnership with the water companies and local authorities. Formalising existing liaison channels, to establish a local authority led system to flag up opportunities as and when they arise, could be a valuable asset supporting this work.
3.4 Water Sensitive Urban Design (WSUD) is implemented throughout catchment	3.4.1 – Identify all sites within the catchment likely to be redeveloped or prime for such work, to develop good relations and encourage partnership working to instigate WSUD from the outset, and seek opportunities for fundraising.	None		Ongoing dialogue with councils and integration of the WSUD approach through their SUDS approving body function.