Counters Creek

Strategic Sewer Flooding Alleviation

Study findings and proposals for our
2009 Final Business Plan

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Summary

This document summarises our study findings and proposals for AMP5 (2010 - 2015) to alleviate the risk of sewer flooding in the Counters Creek; a catchment which straddles the border of the London Boroughs of Hammersmith & Fulham and Kensington & Chelsea. The findings, proposals and investment requirements contained herein will be repeated in Chapter C6 of our Final Business Plan submission in April 2009.

We recognise that sewer flooding is the worst service failure that our customers can experience. Numerous studies into localised sewer flooding incidents in the Counters Creek catchment have been completed over the last 10 years. In some cases, studies have led to capital schemes. The most recent, at Norland Square, will reduce the number of properties currently on our DG5 register (at risk of flooding internally more frequently than 1 in 10 years) in the catchment to around 30. However, our study into the cause of flooding at Askew Road within the Counters Creek catchment demonstrated that we need to consider a solution at the catchment level, rather than a continued piecemeal programme of local sewer flooding alleviation. A hydraulic model of our trunk sewers in the catchment has existed since the mid nineties; over time we have enhanced our model to include local sewers, as studies have been completed. Our strategy is that Counters Creek will be the first of several proactive catchment solutions.

Capacity across our sewerage network was severely tested during the July 2007 storm event. Since then, we have undertaken a significant amount of work to understand the cause of flooding; particularly in the Counters Creek catchment. The following sections summarise our findings and the options that we have appraised to alleviate this risk. The most cost effective solution to alleviate flooding across the catchment is a new strategic storm relief tunnel network. We have included planning and development costs totalling £32m in our expenditure forecast for 2010-2015, but not the full cost of construction as this is uncertain at this stage. We anticipate that planning and design activity will be complete by the end of Year 4 of AMP5 and intend to use the appropriate change protocol to facilitate construction in Year 5 of AMP5.

The need for catchment solutions

In AMP5, sewer flooding alleviation will predominantly be delivered by local solutions (such as pumped offline storage) reducing the risk of flooding to small clusters of properties. Our AMP5 programme represents the maximum possible reduction to the DG5 register using local solutions within a Cost Benefit Assessment framework.

In some cases, where the source of flooding is due to the incapacity of a trunk sewer or interceptor sewer or storm overflow sewer and not the local sewerage network, the cost of a local solution becomes prohibitively expensive and not cost beneficial to deliver. This is because the size of the tanks required to attenuate the storm flow become very large and impractical to construct in urban areas. In such circumstances, catchment solutions are required to alleviate the current risk of sewer flooding and to prevent new properties from flooding in the future.

It is intended that our preferred option to alleviate the risk of flooding in the Counters Creek will be the first of several proactive solutions at the catchment level. We intend to prevent widespread sewer flooding from occurring in the future.

The Counters Creek catchment

There are over 37,000 basement properties in the Counters Creek area, all of which lie within the flood plain of the River Thames. Many of these basements have only become habitable since the reduction in risk of fluvial flooding due to the construction of the Thames Barrier in the early 1980s.

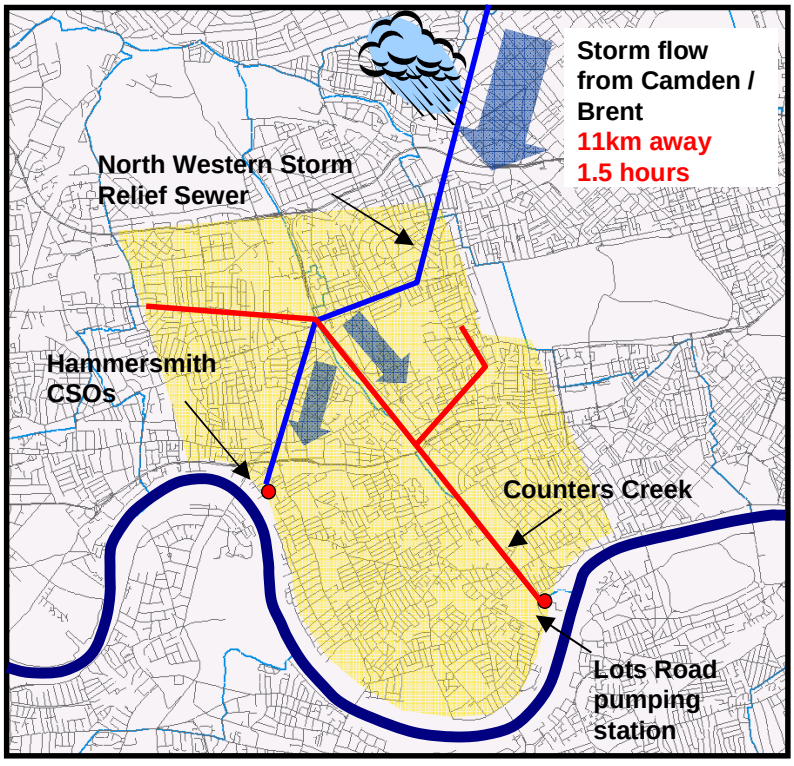

Figure 1: Catchment characteristics that give rise to sewer flooding

The figure above presents certain characteristics of the catchment that place many basement properties at risk of sewer flooding. Firstly, the Counters Creek itself is a watercourse that was culverted over in the late 19th Century; there is consequently no local watercourse for excess surface water to drain to. Secondly, the north of the catchment receives stormwater from as far away as Brent and Camden; flooding in the Counters Creek area can therefore be caused by a rainfall event in the wider catchment many miles away. Thirdly, storm flow travels under gravity and in most cases is pumped out into the River Thames; this limits the capacity of the current storm relief network. Finally, Fulham has never benefitted from a storm relief system; drainage is entirely dependant upon foul interceptor sewers.

The cause of sewer flooding

The mechanism of flooding in the Counters Creek catchment is different to most instances of sewer flooding. Flooding is not caused solely by local surface water inundating the local sewerage network. Instead, we have confirmed that levels in the deeper storm relief sewers rise following rainfall in the wider catchment, removing the capacity to relieve the trunk sewer network (the Counters Creek) and placing the high density of basement properties at risk. Flooding in the area is not caused by overland flow through surcharged manholes; sewage levels have not risen this high to date.

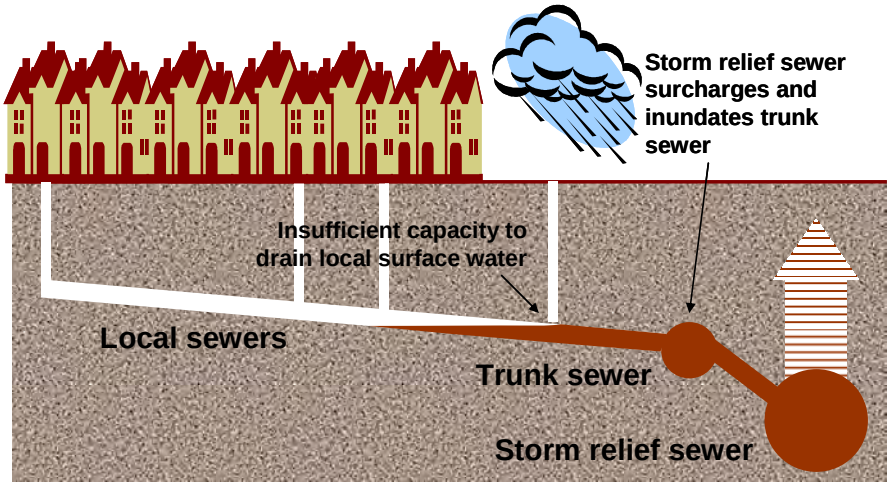

Figure 2: Mechanism of flooding at Counters Creek

Reported incidents of flooding in the area

There are currently 1,400 properties in the area which have reported sewer flooding to us and which are recorded on our Sewer Flooding History Database. Of these, only around 160 properties are currently on the DG5 register. Over 500 properties reported flooding for the first time after the July 2007 event; the majority of which have been classed as at risk of flooding due to severe weather. However, preliminary hydraulic modelling that we have conducted over the last 4 years shows very high sewage levels during storm events and gave us cause for concern. Furthermore, public scrutiny meetings in the two boroughs revealed a significant number of

understandably distraught customers who had experienced flooding on more than one occasion. Many of these had chosen not to report the incident to us, perhaps for fear of the impact on property valuations and insurance premiums.

Key objectives

We set ourselves two key objectives in developing our Final Business Plan:

- We needed to understand the apparent disparity between the number of properties that have actually reported flooding and those deemed to be at risk from our preliminary hydraulic modelling. We have achieved this by refining our hydraulic model and understanding the impact of historic development, population growth and increase in the impermeable area within the catchment; and
- We needed to appraise a broad range of options to alleviate the risk of flooding and select a preferred option for development in AMP5.

Hydraulic modelling

A hydraulic model of the trunk sewer network in Counters Creek has existed for many years. We have refined this model to a street scale level to include many local sewers. The depth of a sample of 212 basements has been obtained together with sewage flow and depth measurements which will be used to verify the model. However, the most important aspect of refining the hydraulic model was an independent project that we commissioned to identify and quantify the increased surface run-off over the last 4 decades. The results indicate that the impermeable land in the wider catchment supplying Counters Creek has increased by about 17% since 1971 - far higher than had hitherto been expected. No assumptions for climate change have been incorporated in the model; this will need to be assessed as soon as the UKCP09 data becomes available.

The hydraulic model has been used to determine: the historic erosion of headroom due to urban creep; the current number of properties at risk of flooding in the Counters Creek area; and the predicted number of properties at risk of flooding by 2020 if no action is taken. The model calculates sewage levels below ground during a storm event. We created three bands: green indicates that sewage levels rise up to 1.85m below ground level; yellow between 1.85 and 1.25m below ground level; and red between 1.25m to ground level. From the 212 basement depths, we are able to determine the probability of a basement flooding in each band (93% for red, 50% for yellow and 18% for green).

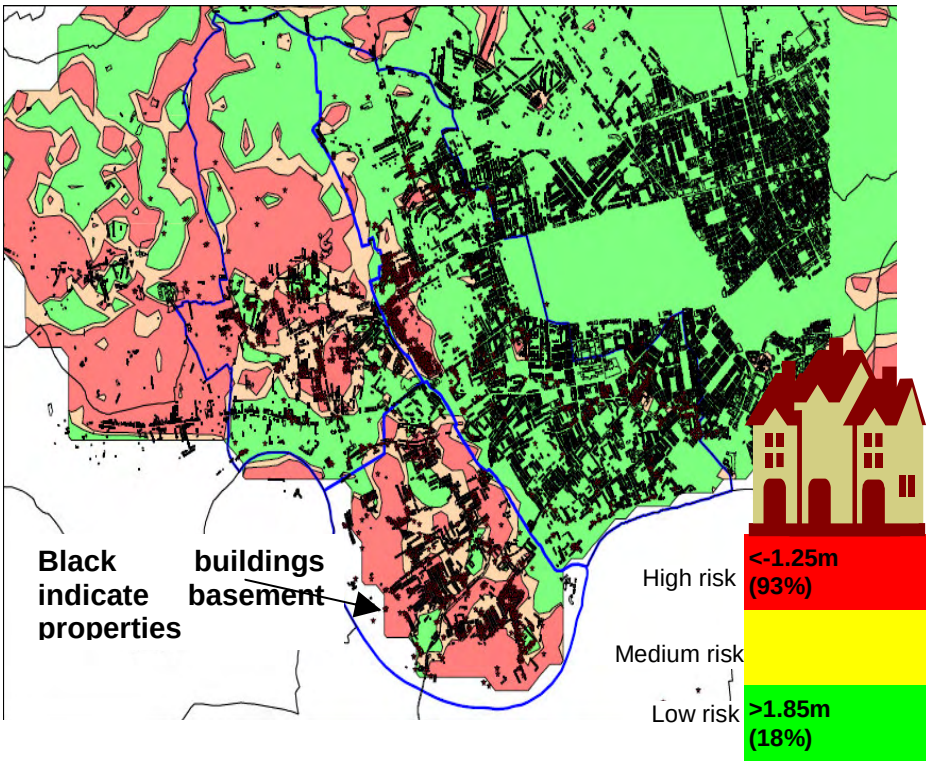

Figure 3: Results from hydraulic modelling

A key assumption in the model is that 70% of basements are actually connected to the sewerage network. This figure was arrived at by calibrating the modelled results with actual flooding incidents. The results from the model are presented below and indicate that over 7,000 properties will be at risk of internal flooding from a 1 in 10 or more frequent event by 2020. The model also shows that average sewage levels in the Counters Creek area have risen from around 2.13m below ground level in 1971, to 1.92m below ground level in 2008. This is a rise of more than 10% and a sufficient increase to cause sewage to overtop a doorstep of a basement previously at a low risk of flooding.

	1971*	2007	2020**
2 in 10 risk	5423	5438	5628
1 in 10 risk	1144	1829	2162
1 in 20 risk or greater	1823	2189	2222

**** 1971 model excludes the Local Storage Tank Solution in Greyhound Road W6 and Strategic extension of North Western SRS to Camden***
***** 2020 model assumes a 5% increase in impermeability for the period 2007 – 2020 (based on a straight-line extension of the increase over the period 1971 - 2007 of 6.5% minus an allowance of 1.5% for implementation of SUDS)***

Table 1: Results from hydraulic modelling of Counters Creek

Whilst there is a disparity between reported flooding incidents and the number of properties modelled to be at risk, the results demonstrate that there has been a substantial erosion of headroom in the storm relief network since 1971. If nothing is done to alleviate this risk, we will have to respond to a catastrophic sewer flooding

event in the Counters Creek area at some point in the near future. It would be completely unacceptable for us to do nothing and let this happen.

Options appraisal

We have appraised a broad range of options to reduce sewage levels in the Counters Creek area. A number of Sustainable Urban Drainage systems have been appraised and ruled out because:

- they would need to be very large to achieve the requisite reduction in surface water run-off;
- they are very expensive to retrofit in highly urbanised areas;
- The underlying London clay would cause groundwater to rise in the catchment causing damage to building foundations; and
- they need to be well maintained to continue to work effectively and have a poor cost benefit ratio.

Sustainable Urban Drainage Systems	Whole Life Cost (40yr)	Benefit (40yr)	Reward
Grass Roofs	£3,594,661,067	£406,164,719	-£3,188,496,348
Permeable Roads	£2,351,032,071	£406,164,719	-£1,944,867,352
Foul Separation	£934,053,359	£406,164,719	-£527,888,640

We have also explored protecting properties with local package pumping stations (FLIPS), but we found that a large programme of these devices simply serves to transfer the problem elsewhere in the catchment.

Our conclusion is that a solution to the problem lies with improving the supply capability of the network. However, we need to work closely with the boroughs to minimise any further increases to the impermeable area, by ensuring that Sustainable Urban Drainage Systems are incorporated into all new developments and that any further drop-kerb applications and basement planning applications in the catchment are rigorously appraised. This conclusion has been endorsed by Mott MacDonald who have undertaken an independent strategic review of our study.

We began our appraisal of supply-side options by modelling increased capacity of existing pumping stations to reduce water levels in the relief sewers. The effectiveness of this solution reduces significantly with distance from the pumping stations. Pumped offline storage was also appraised and ruled out because of the very large volumes involved and scarcity of available land. Diverting flows in the wider catchment (from Brent and Camden) is also not possible because interceptor sewers are also running at full capacity.

We conducted a Cost Benefit Assessment (CBA) for technically feasible options, consistent with the approach used for the rest of our AMP5 sewer flooding programme. Benefits were calculated using the number of properties modelled to benefit from each option using scores over a 40 year period. The CBA results are presented in the table below.

Strategic Conveyance Solutions		Whole Life Cost (40yr)	Benefit (40yr)	Reward
Solution 2 Phase 1	New Storm Relief Sewer from Kensington to Acton	£233,680,542	£423,163,087	£189,482,545
Solution 2 Phase 2	New Strategic Relief Sewer in Fulham to new CSO	£164,762,779	£385,270,188	£220,507,409
Solution 2 Phase 3	New Storm Relief Sewer in South Fulham to Lots Road	£15,559,791	£61,304,366	£45,744,575
Solution 2 Phases 1-3	Full Solution	£411,200,952	£720,295,059	£309,094,107
Solution 3	Combined Alternative Option	£384,902,896	£556,206,679	£171,303,783

Table 2: CBA Results for Counters Creek options

- Solution 1 was developed following a desktop exercise in February 2008; it is not included in the study report as it is been superseded by Solution 2
- Solution 2 (Phases 1 to 3 – see Figure 5 below) generates the greatest reward as it benefits the greatest number of basements.
- Solution 3 maximises the existing network and utilises a redundant storm water pumping station at Hammersmith. Whilst cheaper to construct, the number of properties benefitting is much less than Solution 2, resulting in a poor cost benefit ratio.

A key uncertainty in this analysis is the percentage of basements assumed to be connected to the sewerage network in the hydraulic model. The results above assume a figure of 70%. A sensitivity analysis on the preferred option (Solution 2 Phases 1 to 3) was undertaken on this connection rate and show that our preferred option will still pass CBA using modelled risk, even if the proportion of basements assumed to be connected to the sewerage network falls to 40%.

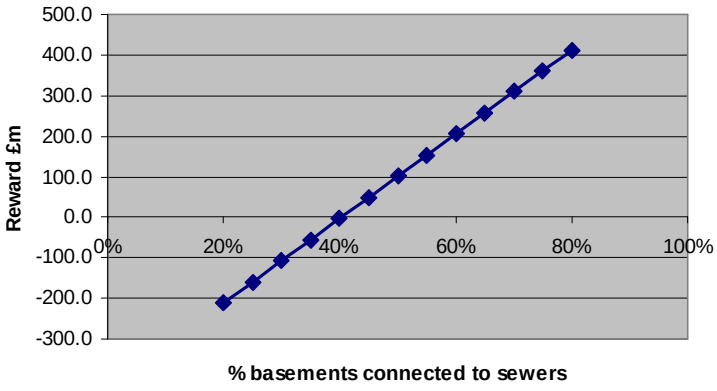

Figure 4: CBA sensitivity to basement connection rate

Developing our preferred option in AMP5

Our preferred option is to develop Phases 1 to 3 of Solution 2 in AMP5. This solution is illustrated below.

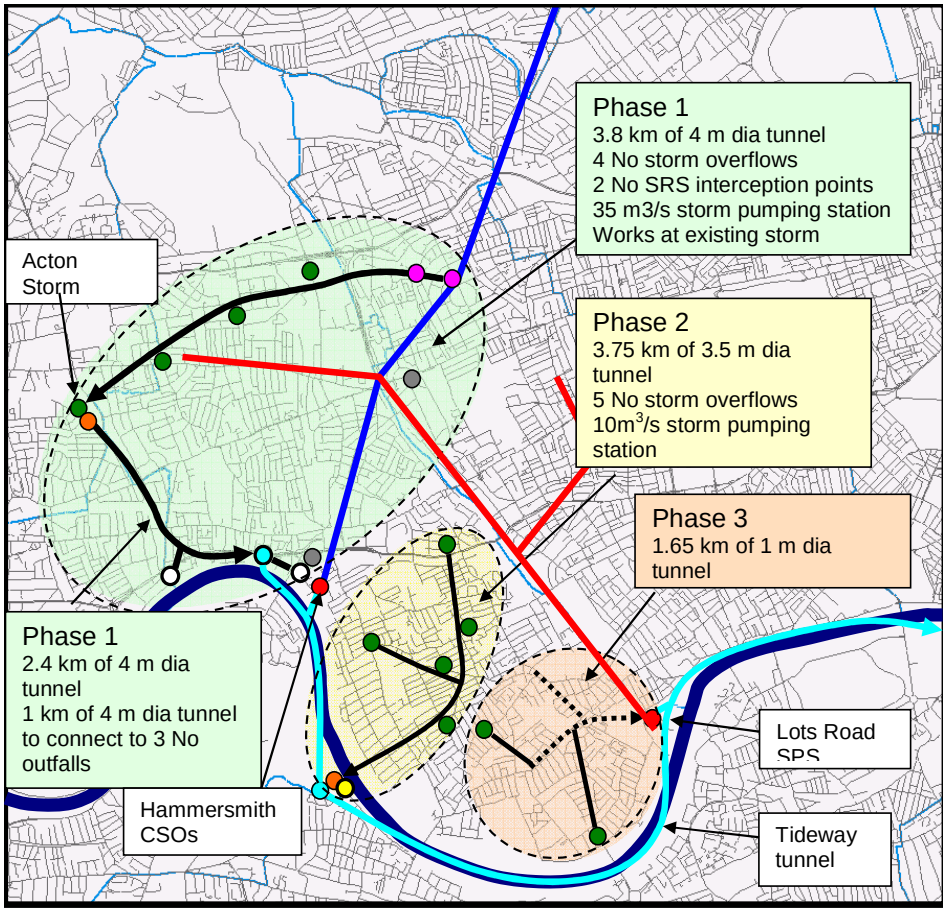

Figure 5: Preferred option for Counters Creek

Phase 1 diverts storm flows to the north of Counters Creek from Brent/Camden west to Acton. Phase 2 provides storm relief to central Fulham and Phase 3 improves drainage in the south of Fulham by increasing flow to Lots Road pumping station. We note that each phase can discharge to the Thames Tunnel when there is spare capacity to do so.

We anticipate that planning and design activity will be complete by the end of Year 4 of AMP5. We intend to use the appropriate change protocol to facilitate construction in Year 5 of AMP5. Mott MacDonald have confirmed that this programme is achievable but note that there are a number of external factors that may adversely affect the start and duration; notably the availability of land for shafts, ground conditions, services diversions and third party approvals. Table 3 below sets out the key regulatory milestones and their contribution towards the overall planning and development expenditure requirement of £32m in AMP5.

Milestone	% of planning & development cost	To be completed by
Completion of further basement surveys & revised model	7.9%	Nov-11
Completion of ground investigations and surveys	22.0%	Sep-12
Report summarising planning and land negotiations	17.0%	Oct-12
Completion of outline design culminating in submission of planning application	35.8%	Nov-13
Production and issue of tender documents	3.5%	Dec-13
Completion of Environmental Impact Assessment	13.8%	Mar-14

Table 3: Counters Creek Milestones

In Table 4 below we provide a detailed summary of our estimate of planning and development estimate of £32m for Counters Creek in AMP5.

Activity	Unit	Cost
Thames Water Staff Costs		
Team of 34 Thames Water Engineers	221,900 hours	
Contractor Resources		
Estimators, solution advice, site engineers	3,390 hours	
Contractor Activities		
Basement Surveys	5 months	
Manhole survey	3 months	
Sewer Survey	6 months	
Topographic survey (include search for piled / underground structures	6 months	
Services tracing survey	6 months	
UXB Survey	6 months	
Ground Investigations		
Road Closure Notices	1 months	
Geotechnical investigation	11 months	
Trial holes	11 months	
Parking Bay Suspensions	11 months	
Environmental		
EIA	38 months	
Noise, Odour and Ecological Surveys	35 months	
Env & Archeology	35 months	
Traffic Management Impact Assessment	35 months	
Design Consultants		
Tunnelling Consultant	30 months	
Tunnelling Settlement Analysis	30 months	
Structural Design Consultant	30 months	
Architectural Design Consultant	30 months	
P Stn wet well modelling	30 months	
Consents & Agreements		
Network Rail Agreement	30 months	
TFL Underground Agreement	30 months	

Activity	Unit	Cost
Port of London Agreement	30 months	
EA Consent	30 months	
Utilities		
Cost of C4 Estimates	12 months	
EDF Estimate for Power Supply to P Stns	12 months	
Planning		
LA Consultations and Infrastructure Planning Commission	26 months	
Property		
Property Surveys	12 months	
Project Oncosts		
TOTAL		**£31,977,382**

Table 4: Counters Creek Planning & Development Costs

We recognise that our programme leaves customers in the two boroughs without a permanent long-term solution for at least another 5 years. Where feasible, we will alleviate all properties remaining on the 2:10 and 1:10 sewer flooding risk register in the Counters Creek area in AMP5 by the installation of a FLIPS type solution. Capital expenditure has been included in our sewer flooding programme to accommodate this. We have not able to identify any alternative more immediate tactical solutions to alleviate the risk of flooding, further to the mitigation devices that we already offer to our customers.