Annex – Main Report

1. Introduction

1.1. In 2017, the Thames RFCC approved the development of the London Strategic SuDS Pilot Study (LSSPS). The pilot aimed to evaluate the benefits of installing small retrofit sustainable drainage systems (SuDS) features dispersed across a catchment, referred to in this report as 'Distributed SuDS'. To cover the range of topography found across London, the proposal included a number of catchments in six London Boroughs. The pilot also aimed to maximise the wider health and social benefits associated with SuDS by prioritising green infrastructure measures such as rain gardens, green roofs and SuDS tree pits.

1.2. The long-term intention was to develop a strategy for retrofitting SuDS delivery that could be rolled out in surface water catchments, aligning them with existing public work programmes where possible to improve efficiency. This has the potential to provide cumulative flood risk protection that meet the standards required to release Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) and Levy funding. This has previously been a challenge for small surface water projects. The inclusion of the multiple benefits can further strengthen the business case and attract partnership funding.

1.3. The Thames RFCC allocated £750,000 Levy to the pilot, which was due to be matched by Thames Water Utilities Limited (TWUL). The pilot was established in 2017 and concluded in April 2021, at the end of the Flood and Coastal Erosion Risk Management (FCERM) capital programme (2015-2021). A spending breakdown is shown in section 5 below.

2. Objectives

2.1. The LSSPS set out to achieve the following five objectives:

- Use hydraulic modelling to determine the flood risk benefits of strategic dispersed SuDS solutions within an urban river or sewerage catchment.
- Identify and evaluate the wider social and health benefits of Green Infrastructure (GI) SuDS delivery across London. To fulfil this objective it is proposed to develop an alternative to the existing Partnership Funding (PF) Calculator, which is used to evaluate flood alleviation schemes. This will be known as the Urban Partnership Funding Calculator (UPFC). It is also proposed to develop a simple calculator that can be used to estimate the proportion of the overall benefit that is contributed by each individual SuDS feature that contributes to the overall strategy. Known as the SuDS Calculator, it will consider attributes that can be easily measured, for example, drainage area attenuated, volume stored, GI provided and urban density of the site. This will look to feed into the Environment Agency's national review of the PF Calculator.
- Deliver SuDS measures in up to six boroughs to demonstrate the feasibility and benefits of this approach. The pilot will support the delivery of strategic SuDS measures by providing assessment tools, guidance and funding. It is the responsibility of the boroughs to manage their own individual projects.
- Monitor the delivery of strategic SuDS measures in selected catchments within the boroughs involved. The purpose of monitoring is to gather evidence to evaluate the impact of a wide range of benefits and support the overall business case. The monitoring findings will be written up into a separate report that sets out recommendations and identifies the benefits of developing a long-

term strategy to enable alignment of non-flood related public works with FCERM GiA, Local Levy and other funding to deliver SuDS.

- Develop a long-term programme for SuDS implementation to facilitate alignment with other public works programmes. The pilot will identify methods of identifying opportunities for SuDS and helps to align the benefits in order to attract potential funding sources to help to deliver them.

3. Who the LSSPS involved

3.1. A Pilot Steering Group (PSG) was formed to oversee the running of the LSSPS. The PSG, which met quarterly throughout the LSSPS, was led by the London Borough of (LB) Enfield and comprised representatives from the following partners:

- Environment Agency
- Greater London Authority
- LB Enfield (lead borough)
- LB Hammersmith and Fulham
- London Councils
- Thames Flood Advisors
- Thames RFCC champion
- TWUL
- Transport for London

3.2. A Thames RFCC champion was nominated to sit on the PSG. Their role was to provide guidance and support from the perspective of the Thames RFCC. In addition, they were able to promote the pilot to a wider audience. This included decision makers at key organisations such as the Environment Agency, Defra and TWUL.

3.3. To meet the objective of the delivering SuDS in up to 6 boroughs in London, the following boroughs volunteered and were selected to take part in the study were:

- City of Westminster (a Transport for London project)
- LB Camden
- LB Enfield (lead borough)
- LB Hillingdon
- LB Southwark
- RB Kingston

3.4. This was the first experience of SuDS for three of these boroughs (LB Camden, LB Hillingdon and RB Kingston). The Transport for London (TfL) project also represents an opportunity that could potentially be repeated many times across London.

3.5. The modelling and UPFC work was tendered to Arcadis NV and Metis Consultants respectively. The consultants have been integral in the delivery of the LSSPS and their input has been invaluable in setting direction and realising the objectives.

3.6. The monitoring work was not tendered. Instead, a consortium of partners was formed in order to draw on the expertise of their respective organisations. The partners forming the consortium were the University of East London and Thames21. The members of this consortium brought a wealth of knowledge that shaped the monitoring from the working group's initial concepts into a deliverable project. The work started by the LSSPS can be continued by the consortium with external funding.

4. Governance

4.1. The previously mentioned PSG oversaw the running of the LSSPS. Each of the working groups reported to the PSG quarterly.

4.2. The delivery of the SuDS projects was devolved to the five boroughs and TfL. This was done to support the LLFAs in delivering SuDS in their boroughs, ensure optimal delivery through local knowledge and to see how delivery varies across different organisations. In addition, LLFA officers were able to assume key roles and use their internal delivery mechanisms for the projects. This allowed the PSG to remain focussed on the other work streams that made up the LSSPS.

4.3. To achieve the objectives beyond the delivery of SuDS in up to six London Boroughs, a working group of a subset of different members of the PSG was set up for the following elements:

- Modelling
- Monitoring
- UPFC

5. Borough projects

5.1. It should be recognised that the boroughs involved committed significant time and effort into the delivery of these projects. Especially noteworthy is the fact that the LSSPS supported one of the boroughs in their first successful delivery of SuDS.

5.2. This section will provide an overview of the types of projects delivered and the interventions they installed. A report on the projects delivered by each borough can be found in the appendix 1.

5.3. All projects aimed to deliver improvements to the public realm. This was done through a range of SuDS features that included rain gardens, bio retention planters and SuDS trees. A number of the projects were already internal non-flood risk works into which SuDS were incorporated. This led to a significant reduction in delivery costs. The others were standalone SuDS projects developed for inclusion in the LSSPS.

5.4. The Outline Business Case for the LB Enfield project is appended to this report. Much of the strategic and economic content remained the same for both the LB Hillingdon and RB Kingston business cases. Only the borough-specific details were amended, for example, catchment details and delivery mechanisms.

5.5. The projects in the three outer London Boroughs were funded through the Thames RFCC Levy allocation. As a result, the deadline for this to be claimed was April 2021. The Levy allocated for the construction of each borough was:

- LB Enfield - £350,000
- LB Hillingdon - £100,000
- RB Kingston - £150,000

5.6. The projects in the three inner London Boroughs were funded by TWUL through their surface water partnership funding programme.

6. Modelling

6.1. *Background / Introduction*

6.1.1. The first objective of the LSSPS was to hydraulically model the selected catchments. Modelling is often seen as a necessary part of delivering an FCERM capital project. This is because the modelling will indicate what will happen during a given rainfall event in a catchment both before and after a project has been constructed. One of the challenges with delivering small-scale SuDS is that the cost of the modelling is disproportionately high when compared to the overall cost of delivery.

6.1.2. Modelling for small-scale SuDS at a catchment level will identify all the opportunities for interventions and help to calculate the benefits of the dispersed approach. These interventions can then be ranked on the benefit they return giving a prioritised list of intervention types and locations.

6.2. *Process*

6.2.1. The modelling, which was funded through the Thames RFCC Levy, was split into two stages. Stage 1 would establish a methodology and model the outer London catchments (LBs Enfield and Hillingdon and RB Kingston). This methodology was then refined for Stage 2, which looked at the inner London catchments (City of Westminster and LBs Camden and Southwark). This was done through an automated process by which to identify all possible locations that would be suitable for SuDS. For example, a parameter of footpath width was set. This meant that all space beyond 2 metres on a footpath was highlighted as a possible location for a rain garden.

6.2.2. The outer London boroughs were funded through Thames RFCC Levy. This meant an Outline Business Case needed to be approved by the Environment Agency's Area Flood and Coastal Risk Manager in order for funding to be released. The development of the business cases formed part of Stage 1 of the modelling. In addition to releasing the funding, this process would indicate the level of benefits, and therefore funding, that a dispersed SuDS project could achieve under the current funding rules.

6.2.3. Stage 2 looked at the reduction in flows in the combined sewer network that serves the catchments modelled. The results show that dispersed, small scale SuDS can have a cumulatively large impact on downstream sewer capacity. This could allow water companies to understand the scale of investment in these types of interventions required for future development. Such SuDS projects could be preferable to sewer upgrades as they deliver multiple benefits such as improving amenity space, potentially attracting partnership funding.

6.3. *Findings and outputs*

6.3.1. The primary finding of the modelling is that SuDS features can have a positive impact on flood risk in all locations.

6.3.2. Each borough received information on possible locations for SuDS features. This will be used to support the delivery of Dispersed SuDS in an opportunistic way, aligning delivery to other works in the public realm in order to reduce costs, or using a targeted and optimised approach, delivering the most beneficial interventions first.

6.3.3. The key benefit of an opportunistic approach is that SuDS can be included in the design of any works in the public realm. They can often be delivered for little or no cost when compared to an 'ordinary' construction.

6.3.4. Optimising the location of SuDS features can significantly increase their effectiveness and benefit-cost ratio (BCR). It can make the delivery eligible for full funding through FCERM GiA. Return on investment can be maximised in terms of financial benefit and flood risk reduction. However, this requires more planning and construction specifically for the installation of SuDS, often at a higher cost than opportunistic delivery.

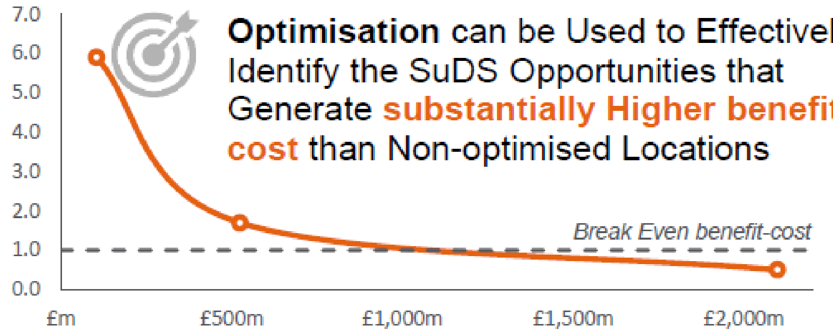
6.3.5. The methodology established and refined through the LSSPS is usable in other urban areas. The process of modelling a catchment for the purposes of delivering Dispersed SuDS is repeatable. This should enable other risk management authorities to identify and prioritise the opportunities in their catchments. Furthermore, the economic evaluation undertaken in the modelling should encourage other LLFAs to deliver Dispersed SuDS.

6.3.6. Some key results from the Stage 2 economic calculations include:

- The average cost ranges of delivering all of the possible SuDS features available within the realisation levels modelled are:
  - 5% of all possible interventions = £25m-£43m
  - 25% of all possible interventions = £125m-£217m
  - 100% of all possible interventions = £530m-£870m
- Based on the realisation levels of 5% and 25%, the average benefit-cost ratios for direct procurement range from 2:1 to 11:1.
- For opportunistic delivery for the same realisation levels, the average benefit-cost ratios range from 4:1 to 15:1.
- The average cost of modelling a London borough ranges from £20k-£50k.
- An average increase in benefits realised of £18m per year can be achieved by optimising the delivery over an opportunistic approach.

6.3.7. The key technical outcomes of the modelling are summarised below:

Optimisation can be Used to Effectively Identify the SuDS Opportunities that Generate **substantially Higher benefit-cost** than Non-optimised Locations



(All Streetscape SuDS Scenario Data)

SuDS Opportunities *(ordered by most effective SuDS Features)*

Flood Damage Reduction *(proportion of total possible)*

5% of Most Optimal SuDS Features Represent…

£35 Million Capital Investment in SuDS *(On Average per London Borough)*

Could generate…

£190 Million in **Flood Damage Reduction**

£40 Million in **Natural Capital Value**

Natural Capital Value Increases the Benefit-Cost Ratio from **0.4 to 1.6**

(Average of un-optimised Streetscape SuDS Scenarios)

All SuDS Opportunities (un-optimised)…

£700 Million Capital Investment in SuDS *(On Average per London Borough)*

Could generate…

£300 Million in **Flood Damage Reduction**

£800 Million in **Natural Capital Value**

Creation of **Wastewater Network Capacity** for between **116,000 and 180,000 additional dwellings**

Requiring **Comparable or Less CAPEX** than Typical Strategies to Create the Same Capacity

(Beckton & Crossness STW Catchments)

£3 Million in Street Tree SuDS Improvement Could Secure **Full FCERM GiA Funding**

(On Average per London Borough)

Project Already Secured **£600,000** in Short-term **Local Levy Funding**

Figures taken from the LSSPS modelling report p.38

Flood Mitigation Value – Dispersed SuDS can provide extensive flood risk mitigation value and deliver significant reductions in flood damages. This can be achieved through both the number and scale of opportunities available (realised through long-term delivery) and a focus on the most optimal SuDS sites.

Natural Capital Value – The socio-economic benefits calculated by the modelling outweigh all other benefits by up-to an 10 times for some scenarios evaluated. This demonstrates the underlying holistic value of SuDS as a key component of investing in Green Infrastructure.

Optimisation Issues – It is possible to optimise the selection and placement of SuDS features based on predicted catchment flows at individual locations. However, the benefit of optimisation is somewhat reduced through the inclusion of cost and socio-environmental benefits during the selection process.

Catchment Commonality – Some correlation was demonstrated among the various Evaluation Scenarios across different catchments but it cannot be considered statistically reliable. The inherent variation in catchment complexity prevents a reliable estimation of benefit for a catchment that has not been modelled.

Optimisation Uncertainty – Technical limitations in determining causality between SuDS opportunities and flood benefit can reduce confidence. This implies a need for further refinement of the optimisation process.

Value of Optimisation – The importance of location and feature type is demonstrated by the significant variation in the benefit-cost ratio of dispersed SuDS across the realisation levels evaluated. This further emphasises the need for effective modelling in identifying the most cost-effective opportunities.

Sewerage Network Capacity – Dispersed SuDS could be implemented as an affordable alternative 'green' strategy (or a component of a strategy) to generate sewerage capacity to accommodate future growth. Facilitating long-term reductions in sewer flow through cost-effective funding partnerships could achieve this.

FCERM GiA Funding – Economic evaluation shows that the optimisation of dispersed SuDS can significantly improve eligibility for FCERM GiA funding, which could lead to full or part funding being achieved. Using evidence to demonstrate value could incentivise potential beneficiaries to provide additional contributions.

Cost Uncertainty – The difficulty of estimating Capital Expenditure and Natural Capital can affect confidence. However, the optimal SuDS sites show positive benefit-cost ratios (sufficient to secure FCERM GiA), irrespective of the uncertainty bands.

FCERM GiA Funding – A small-scale Dispersed SuDS approach has successfully secured FCERM GiA.

6.4. *Recommendations for delivery models:*

6.4.1. **Optimised delivery** To maximise flood risk management (FRM) benefits, the delivery of Dispersed SuDS should be optimised through catchment-wide hydraulic modelling. In these cases, the BCR, based solely on flood benefits, will be significantly greater than 1 (the average was found to be 5.4) and the scheme can potentially be funded entirely by money allocated to FRM.

6.4.2. **Opportunistic delivery** In addition, an alternative delivery model can be used where there are opportunities to integrate SuDS measures into non-FRM works. As the modelling demonstrates, non-optimised SuDS do not meet the criteria for FCERM GiA without a significant amount of partnership funding. The average BCR for a non-optimised SuDS feature was found to be 0.42. Therefore, funding from FRM sources should be used to support this approach provided that the FRM funding contribution is less than 40% of the SuDS cost (rounded down from 42%).

6.5. A technical modelling report can be found in the appendix 2.

7. Urban Partnership Funding Calculator (UPFC)

7.1. *Background*

7.1.1. At the outset of the LSSPS, the 2011 Partnership Funding (PF) Calculator, used for calculating the FCERM GiA eligibility of a project, did not adequately recognise the benefits of small-scale SuDS projects. An important part of the LSSPS was to develop an alternative that would appropriately recognise the SuDS-specific benefits of these schemes. This would feed this into Defra's review of the PF arrangements, which involved the publication of a new version of the PF Calculator in April 2020. This work was funded by Thames RFCC Levy.

7.2. *UPFC development*

7.2.1. To deliver this work, Metis Consultants carried out a comprehensive review of the current literature around the benefits of SuDS. The scope of the study extended to everything that could be positively influenced by the use of SuDS measures such as rain gardens, street trees, permeable paving and green roofs within the urban environment. Priority was given to outcomes that can be quantified and monetised (i.e. deliver the objectives of a specific beneficiary's business plan). These were then categorised into SuDS Outcome Measures, to align with how the FCERM GiA eligibility is currently calculated. The following SuDS Outcome Measures were developed:

- SuDS OM 1a – base flow
- SuDS OM 1b – water quality
- SuDS OM 2a – air quality
- SuDS OM 2b – amenity
- SuDS OM 2c – education
- SuDS OM 2d – health
- SuDS OM 3 – biodiversity and ecology

7.2.2. To account for benefits related to reduced flood risk to infrastructure, the following Infrastructure Outcome Measures were also established:

- Infra OM1a: Critical & High Risk Infrastructure
- Infra OM1b: Electricity sub-stations

- Infra OM1c: Water & Wastewater facilities
- Infra OM1d: Transportation

7.2.3. One of the aims of developing the UPFC was to influence the Defra review of PF arrangements, ahead of the next FCERM programme (2021-2027). Therefore, the PSG maintained a dialogue with colleagues at Defra who were reviewing the PF rules. This involved a number of conversations to ensure that Defra understood the rationale behind what was being done and why. It was important to make clear that conclusions and decisions were evidence-based and what benefit they would bring. The PSG is confident that this dialogue had an influence on the outcome of the PF arrangements.

7.3. *PF Calculator 2020*

7.3.1. In April 2020, the Environment Agency released an updated version of the PF Calculator. In addition to revised payment rates, this included changes to the Outcome Measures. While these changes have improved the FCERM GiA eligibility of some SuDS projects, the increase is likely insufficient to greatly increase the number of this type of project successfully applying for FCERM GiA.

7.4. *Findings and output*

7.4.1. The most significant overall impact on a PF score is achieved by altering the way it is calculated; by either including or excluding future costs. When submitting a bid for FCERM GiA, non-Environment Agency risk management authorities (such as LLFAs) must include the future costs in the amount for approval but cannot claim FCERM GiA towards them. In addition, contributions to future costs are not recognised in the PF Calculator as contributions towards the total cost of the scheme. Excluding these future costs made the greatest improvement to PF Scores during the testing of the UPFC.

7.4.2. One of the findings of this work is that including wider benefits into the calculation of PF Scores is not sufficient on its own to significantly alter the FCERM GiA eligibility of SuDS schemes. The UPFC alone does not make enough of a difference to overcome the barrier of funding for SuDS delivery. This is because the increase in funding eligibility achieved by including wider benefits is eclipsed by the need for non-Environment Agency risk management authorities, such as LLFAs, to include future maintenance costs in their project cost calculations.

7.4.3. Similarly, just increasing the payment rates for SuDS-specific benefits results in a relatively small increase in a project's FCERM GiA eligibility and is therefore not sufficient. This is because the SuDS-specific benefits are not weighted highly in comparison to the benefits of avoiding flood damages. The overall value of SuDS benefits is low compared to overall project benefit.

7.4.4. Four real-life SuDS projects in London were used as case studies to test the UPFC and the 2011 and 2020 PF Calculators. Using the UPFC led to an increase of between 1-2% in PF Scores, while the new 2020 PF Calculator led to an increase in PF Scores of between 2-6% against the 2011 PF Calculator. Three sensitivity analyses were carried out with scenarios such as the inclusion of local infrastructure specific benefits, which are not generally quantified for PF Calculator input. The ranges of increase in PF Score against a baseline of the 2011 PF Calculator can be seen in the table below.

	PF Score Change			
	2011 PF Calculator	2020 PF Calculator	UPFC	UPFC (excl. future costs)
Current rules	-	2-6%	1-2%	10-48%
Additional SuDS benefits	0-1%	2-6%	1-3%	10-49%
Infrastructure benefits	2-5%	4-11%	3-27%	13-112%
Reduced future costs (by 50%)	2-13%	5-20%	4-15%	10-48%

7.5. Recommendations

7.5.1. Due to the funding rules for FCERM GiA not adequately valuing the benefits of Dispersed SuDS, an alternative primary funding source for this type of project. Levy could be used by the Thames RFCC to support LLFAs in delivering Dispersed SuDS. A value per square metre of surface area drained by SuDS features could be used to calculate Levy eligibility.

7.5.2. A Thames RFCC working group could be established to appraise applications for Levy to deliver Dispersed SuDS. This working group could then make recommendations to the committee based on the proposed project meeting the design standards and using an appropriate approach.

7.6. A full report on the UPFC can be found in appendix 3**.**

8. Simple SuDS Calculator

8.1. Along with the UPFC, the Simple SuDS Calculator was developed. The aim was to create a 'simple' spreadsheet-based tool that can be used to estimate the proportion of the overall benefit that is contributed by each individual SuDS feature (by considering attributes such as drainage area attenuated, volume stored, green infrastructure provided and footfall).

8.2. The output is a calculator that can be used to compare the benefits of individual SuDS features within a scheme based on basic, readily available, parameters. This can give the user a high-level indication of the partnership funding they may be able to attract.

9. Monitoring

9.1. *Introduction*

9.1.1. The monitoring programme is to be funded by TWUL and is due to commence in spring 2021. It will be delivered by a consortium comprising representatives from the University of East London and Thames21. This approach was adopted to draw on the expertise of each organisation in delivering the various elements of the monitoring.

9.1.2. The benefits that were selected for monitoring are:

- *Water quantity* to help determine the cumulative flood risk reduction of dispersed SuDS.

- *Water quality* to identify what environmental benefit there is to these features. In addition, a potential reduced treatment cost to water companies.
- *Attitude/perception* to better understand what residents and passers-by think of SuDS as opposed to traditional measures.
- *Maintenance costs* to understand any difference against traditional measures.

9.2. A full report will be shared with the Thames RFCC upon completion of the monitoring programme in 2022.

10. Challenges

10.1. One of the main challenges faced by the LSSPS was that six different organisations (five London boroughs and TfL) were responsible for delivery for their own projects. Each had its different delivery mechanism and this meant there were six individual ways of working.

10.2. What was evident from the varied success of delivery by the boroughs was that a lack of funding is not the only barrier to SuDS delivery. It became apparent that in addition to sufficient and secure funding, it is vital that the staff resource is committed early and the relationships among the relevant internal departments exists. Input from a number of different departments is required to successfully deliver SuDS including LLFA, Highways, Grounds Maintenance, Trees, Traffic, Street Cleaning and Regeneration among others. Support from Senior Management is also key to overcoming obstacles. Without these, successful delivery is unlikely.

10.3. Coronavirus posed significant challenges to all partners involved in the LSSPS. This ranged from a shift to remote working with virtual meetings to staff furloughed and unable to progress delivery. These changes were unforeseen and unprecedented, making it impossible to plan for or mitigate.

11. Lessons learnt

11.1. Dispersed SuDS implemented at a large scale can be highly effective at reducing both property level flood risk and general surface water flooding.

11.2. SuDS are beneficial wherever they are constructed within an urban area.

11.3. Integrating SuDS into other public realm projects can reduce costs and increase partnership funding contributions. This should be the standard process for all LLFAs.

11.4. Including wider environmental and socio-economic benefits can significantly improve the business case for Green Infrastructure SuDS delivery.

11.5. The optimisation of Dispersed SuDS delivery maximises flood benefits and can identify projects that are eligible to be fully funded through FCERM GiA.

11.6. Achieving full funding will not guarantee delivery. There remain significant barriers to delivery to overcome to ensure successful SuDS delivery.

11.7. One of the key factors affecting delivery is the existence of relationships among those involved in delivery and the allocation of appropriate resource to manage the project.