LONDON SUSTAINABLE DRAINAGE ACTION PLAN

Draft for public consultation

MAYOR OF LONDON

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Greater London Authority
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EXECUTIVE SUMMARY

London is outgrowing its drains and sewers. The combined sewer system originally built over 150 years ago by Joseph Bazalgette has served us well, but it was designed for a smaller, more permeable city. The combined challenges of London's growing population, changing land uses and changing climate mean that if we continue to rely on our current drains and sewers, we face an increasing and potentially unacceptable risk of flooding.

This Action Plan is a long-term plan intended to inspire, facilitate and co-ordinate a step-change in how we manage rainwater in the Capital. It seeks to roll back the tide of grey, impermeable surfaces and replace them with a mosaic of green 'sustainable drainage' systems. These add to the services provided by our existing drains and sewers, as well as bringing wider benefits to London and Londoners. This new approach recognises the value of rainwater, seeking to capture, use, delay or absorb it, rather than reject it as a waste by-product.

Vision
By 2040, London will manage its rainwater sustainably to reduce flood risk and improve water security, maximising the benefits for people, the environment and the economy

We have all seen the impacts of heavy rainfall elsewhere in the UK and around the world. London has been fortunate to escape the worst of these storms, but it is only a matter of time before heavy rainfall seriously affects parts of London. In parallel, if London continues to seal off its permeable surfaces, effectively 'waterproofing' the city, even relatively light rainfall may overcome the drains and sewers. We therefore face a choice: to build further enhanced and expensive storm drains and sewers across large parts of London; or steadily increase London's resilience by ensuring that more sustainable drainage techniques, such as greenroofs and rainwater harvesting systems, are commonly and widely used.

As well as reducing and slowing down the flow of rainfall to the drainage system, many sustainable drainage techniques have a range of wider benefits for London, such as improving the water quality in our rivers and streams, providing attractive areas for people and wildlife, storing water for vegetation, irrigation, and helping keep the city cool in hot weather. Sustainable drainage measures can also have direct financial benefits by capturing and storing rainwater for non-potable uses, such as irrigation or vehicle/building cleansing, thereby reducing water bill costs, reducing the risk and cost of flooding and providing insulation/cooling.

Target
To achieve a 1% reduction in surface water flows in the sewer network each year for 25 years, resulting in a 25% reduction in flows by 2040.

Sustainable drainage is an important element of Water Sensitive Urban Design (WSUD). The aim of WSUD is to reduce the demand for water, improve water quality and manage flood risk through taking an integrated approach. These wider principles are supported through the London Plan, but this Action Plan is focused specifically on the sustainable drainage element of WSUD, although some measures such as rainwater harvesting do have direct benefits in terms of saving water. The WSUD approach is also important in ensuring that sustainable drainage measures are functional through periods of drought as well as flood.

London faces some particular challenges in implementing sustainable drainage measures, including soil type and the overall density of development in inner and central London. However, these are not reasons to give up, but a chance to assess which options best suit and add value to particular locations, land uses and buildings.

Most sustainable drainage techniques are not new: they are tried and tested, and have been increasingly used over recent years. Indeed, some other cities around the world are ahead of us in implementing these approaches. The Government is committed to increasing the use of sustainable drainage via the Flood and Water Management Act 2010 and recent changes to the National Planning Policy Framework (NPPF), which have strengthened the emphasis on sustainable drainage for new development.

This document supports the use of sustainable drainage in new development. More importantly, it sets out a plan of activity to engage with property owners, public organisations, private companies, local groups and individual residents to advise on and encourage the use of sustainable drainage within their land, buildings or local areas. The Action Plan recognises that there are costs associated with any such interventions and suggests that sustainable drainage should be considered at the same time as other maintenance, repair, rebuilding or refurbishment works are planned. This way, the additional costs will generally be marginal, and for anyone who uses large quantities of non-potable water there may ultimately be cost savings as well as improved appearance and resilience of land and buildings.

Many large commercial premises are charged for their drainage based upon how much potable water they use. This means that their water bills may not fully reflect the demands they place on the sewer system. The Mayor believes that landlords of large commercial buildings should pay for the rainwater that runs off their properties and will work with Thames Water to engage with customers on this issue and to explore more cost reflective charging options that incentive rainwater being managed more sustainably.

No single intervention will radically alter London's drainage regime. Instead, this Action Plan recognises that smaller-scale actions, carried out incrementally over a period of at least 25 years are required to bring about a significant cumulative change. The aim is for sustainable drainage techniques to become normal working practice for all future building, repair and renovation works.

This Action Plan has been developed by the Drain London Programme, a partnership of the Mayor of London, Environment Agency, London Councils and Thames Water. It is split into two parts. The first sets out the background and case for sustainable drainage in London. The second sets out a range of actions for the major land-use sectors in London: education, housing, transport, health, retail, recreational and other open space, other public sector buildings, commercial office, industrial and major utilities and agriculture. These actions are tailored to suit each of these sectors and are programmed over the first few years to initiate activity across all sectors in what is intended to be a long-term plan of action. The implementation of the Action Plan will be monitored and reported on annually and, if necessary, actions will be amended or new actions introduced.

How to respond to the consultation

This draft Action Plan is open for consultation on how it can be improved until midday on 15 January 2016. Responses can be made online: http://www.surveygizmo.com/s3/2220306/London-Sustainable-Drainage-Action-Plan.

Alternatively, you can send your written consultation response to LSDAP_consultation@london.gov.uk or Katherine Drayson, Greater London Authority, City Hall, The Queen's Walk, London SE1 2AA).

PART 1. WHY WE NEED & WANT MORE SUSTAINABLE DRAINAGE

Surface Water Management in London

Surface water is the rainwater that falls on the city's surfaces; on the ground, streets, pavements, roofs, parks, and gardens.

Flooding
When this water does not soak into the ground or drain through normal drainage systems, but lies on or flows over the ground instead, it can cause surface water flooding (Environment Agency 2015). Whilst London is currently very well protected against flooding from the tidal Thames, it has a relatively lower standard of protection against surface water flooding.

The first draft London Regional Flood Risk Appraisal (RFRA) identified the high potential risk of surface water flooding in London (GLA 2007). It noted London's density of development, high proportion of impermeable surfaces, general lack of records, and poor mapping of the potential risk areas as particular problems. The Mayor's Climate Change Adaptation Strategy (GLA 2011) identified surface water flood risk as the greatest short-term climate risk to London.

Shortly after the publication of the draft RFRA, other areas of the country, including parts of western England, Sheffield, York or Hull, suffered severe flooding. This was initially from surface water as a result of heavy rainfall, and later from rivers as the rainwater naturally moved through the system. London was spared the worst of those storms, but it was clear that had these storms been concentrated over parts of London, there would have been huge disruption, high economic impacts and long recovery times, especially if major infrastructure was severely affected. Within London, there are several localised examples of surface water flooding, most recently during heavy rainstorms in summer 2015.

Water Quality
The quality of water in London's tributary rivers is generally poor to moderate. Of 40 Greater London river waterbodies monitored for the Thames River Basin Management Plan in 2009, 14 were classified as poor and 26 as moderate, with no waterbodies being classified as good. The classifications can change from year to year and the overall aim of the EU Water Framework Directive is to lead to an improvement in water quality in rivers and lakes. However, it is clear that there is considerable scope for improvement within London.

Drought
London is often mistakenly perceived as having abundant rainfall. However, London (and indeed the whole of the South East of England) is classified as 'seriously' water stressed, meaning that more water is taken from the environment than the environment can sustain in the long term. Fifty-five per cent of all the rain that falls in the Thames Valley is abstracted and used – this is more than anywhere else in the UK. London is usually relatively resilient to drought and it takes two consecutive drier-than-normal winters to create water supply issues. In 2006 and 2012, London experienced significant droughts, and in 2012 only avoided serious water restrictions by the wettest summer in a century. It is therefore important that future measures to manage flood risk are also drought resilient.

Surface Water Management Challenges

The frequency and severity of future surface water flooding, drought and poor water quality in London depend on several different factors. Some of these factors are physical, others are social, and some are a result of London's historical development, whilst others are the result of projected future trends. These are explored further in the following sections.

Physical

The climate of the future is likely to be increasingly different from that of the past. The South East of England is expected to experience warmer, wetter winters and hotter, drier summers. It is also expected that there will be more frequent and intense extreme weather events, such as heatwaves and heavy rainfall events. By the middle of the century, the probability of a rainstorm of an intensity likely to overcome the drainage system will have increased from a 1 in 30 (3.3 per cent) chance to a 1 in 13 (7.7 per cent) chance in any one year.

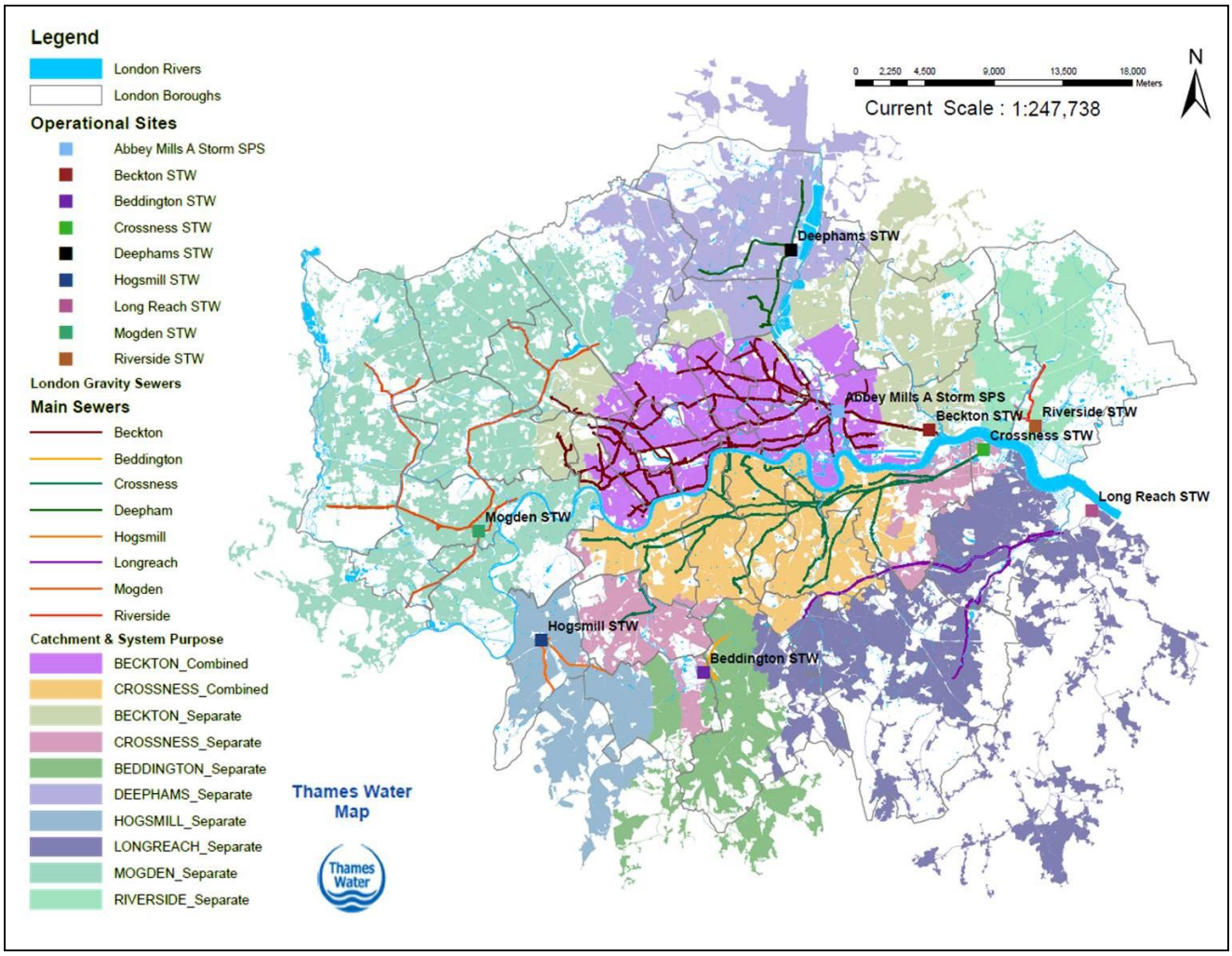
Like all cities, London has a high proportion of impermeable surfaces, which prevent water from soaking into the ground. In addition to this, London's clay soils reduce the rate of infiltration, which results in more water at the surface. Although it should be noted that whist this is often used as a reason not to install sustainable drainage solutions, there are techniques that do not depend on infiltration.

London also has a relatively old drainage system, often designed to lower standards than currently used and to cater for a smaller population. In general the drainage system can be split into two distinct systems. In central and inner London there is a combined sewer system that conveys both rainwater and foul water in the same pipework and sewers to the major sewage treatment works of Beckton and Crossness. In outer London, there are mainly separate systems that convey rainwater into local tributary rivers and foul water to sewage treatment works (see Figure 1).

In 2014, the Government gave permission for the Thames Tideway Tunnel (TTT). This project is considered necessary to address the current problems of combined sewer overflows into the Thames. These problems are fundamentally caused by the rainwater flowing into the combined sewer network. The TTT will not increase capacity in the combined sewer system, but will prevent all but the most severe sewer overflows into the Thames.

However, the options to significantly increase the capacity of London's drainage system using traditional underground piped networks, such as the TTT, are becoming increasingly complex and prohibitively expensive. This is due to the requirement for large-scale and widespread excavations in large numbers of streets, and the need to work in and around the plethora of other buried infrastructure that now lies under most streets.

Figure 1: Combined and separated sewer systems. Source: Thames Water



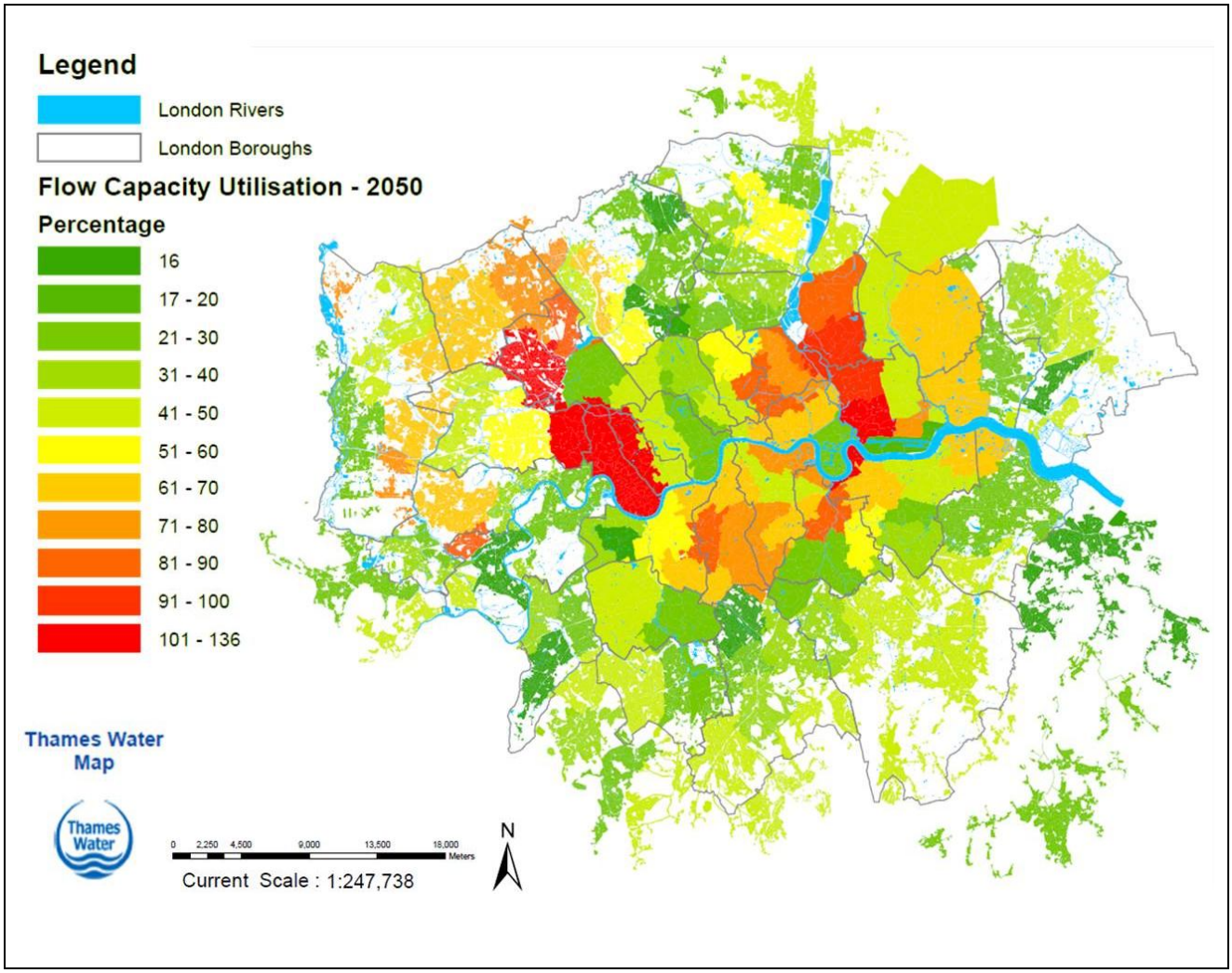
Social

Over the past few decades, there has been an increasing trend of paving over front gardens (and to some extent, rear gardens) with impermeable surfaces. Estimates of the scale of the change vary, but range from two-thirds of front gardens being at least partially covered by surfacing other than vegetation (London Assembly 2005) to an annual average loss of an area of vegetated garden land the size of 2.5 Hyde Parks (London Wildlife Trust, GiGL and GLA 2010). A recent poll for the Royal Horticultural Society also suggested that half of London's front gardens have been paved over (Ipsos MORI 2015). This is placing an ever increasing strain on our drainage systems and needs to be not only stopped, but reversed, if flood risk is to be managed.

London's population has grown significantly over the past 25 years, by nearly two million people. The London Plan estimates that the population will be over 9 million by 2020, and nearly 10 million by 2031. The London Infrastructure Plan suggests that by 2050 the population could be around 11 million. This will lead to further intensification of development and could exacerbate pressures on the city's drainage and water supply systems, potentially increasing the risk of flooding and drought.

Thames Water has modelled the impact of London's projected population growth and climate change on its drains and sewers to understand their ability to cope with these future challenges. The modelling shows that for a relatively common rainfall event in 2050 (one that would be expected on average once every other year), some areas of London would not have sufficient drainage or sewerage capacity to manage the expected flows, leading to an increasing risk of surface water and sewer flooding. Figure 2 shows the mapped output of this modelling for the 2050s. Areas highlighted in red on the map are where the projected flows in the system exceed its capacity and some flooding should be expected.

Figure 2: Modelled drainage and sewerage capacity to manage future population growth and climate change for the 2050s. Source: Thames Water



What is Sustainable Drainage?

Sustainable drainage includes both good management practices, and the installation and use of sustainable drainage techniques. These help drain or capture surface water, and can also reduce the volume and/or concentration of pollutants reaching watercourses. This action plan focuses mainly on sustainable drainage techniques, rather than management practices.

Sustainable Drainage Techniques

Details on particular techniques can be found in a range of other documents and websites. It is also possible that new techniques or variations on techniques may well arise. A particularly useful reference will be the CIRIA Sustainable Drainage Guidance (due to be published shortly), which has a specific chapter dedicated to the use of sustainable drainage in urban areas.

Maintenance varies for different types of sustainable drainage facility. Overall maintenance requirements are unlikely to be excessive but will be different to traditional engineered drainage systems.

Table 1: Summary of Sustainable Drainage Techniques

Sustainable Drainage Technique	Typical Uses
Rainwater harvesting	Capture of rainwater into a tank(s) for use (usually non potable) such as irrigation, toilet flushing, vehicle or plant cleansing. For some premises the rainwater harvesting can generate significant cost savings on water bills. Care is needed to prevent the development of bacteria, algae and insect infestation.
Green/brown /blue roofs	Used on flat or shallow pitched roofs to provide a durable roof covering which also provides thermal insulation, amenity space, biodiversity habitat as well as attenuation of rainwater. The use of roof areas for Solar PV energy generation is sometimes quoted as a reason for not installing a greenroof, however the two uses of a roof can be combined and there is even some evidence to suggest that by keep a roof cooler, the greenroof actually increases the efficiency of the PV panels. Depending on the design, such roofs can attenuate differing volumes of rainwater, with the term blue roof being reserved for those roofs designed to maximize water retention.
Raingardens	Creation of planted areas usually close to buildings to allow the diversion of a portion of rainwater from either downpipes or surrounding paved surfaces. These techniques can be incorporated into the landscaping plans for a site and are especially effective if the landscaping regime is designed with the aim of capturing as much rainfall as possible. Raingardens can either allow infiltration into the ground or have tanked systems for water retention, depending on the site and soil conditions.
Bio-retention	A chain of landscaped features designed to hold and treat surface water, often used where there is a likelihood of low level pollutions, such as from road run-off, but does require areas of open space. Design can vary widely depending on site conditions and available space.

Sustainable Drainage Technique	Typical Uses
Permeable pavements / surfaces	Permeable hard surfaces which operate in much the same way as traditional impermeable surfaces apart from the ability to allow rainwater to pass through. Recent innovations have enabled the development of bound granular surfaces with both high load bearing and high permeability properties. Permeable surfaces can either allow infiltration into the ground or have tanked systems for water retention, depending on the site and soil conditions and are suitable in even the most densely built-up developments.
Swales	Dry ditches used as landscape features to allow the storage and infiltration of rainwater. Often used as linear features alongside roads, footpaths or rail lines but capable of being integrated into the design of many open spaces.
Detention basin/ponds	Landscape features designed to store and in some cases infiltrate rainwater. Detentions basins are usually dry, whereas a pond should retain water. These features need areas of open space but can often be combined with other sustainable drainage techniques.
Discharge to tidal river/dock	Although not normally considered a sustainable drainage technique, this action plan recognises that discharging clean rainwater to tidal rivers or docks is generally more sustainable than discharging to the combined or surface drainage systems. Other more productive techniques should be used first but residual surface water can be discharged to tidal/large waterbodies, in some cases with no limitation on volumes. Care is needed to prevent scour in the receiving waterbody and potentially to prevent pollution.
Storage tanks	Usually but not necessarily below ground level, they attenuate rainwater for later slow release back into the drainage system. They don't provide the wider benefits of green infrastructure sustainable drainage and can have the disadvantage that pumping may be required to empty the tank into the drainage system, especially if the tank is at basement level.
Geocellular storage	Similar to Storage tanks except that the volume is made up from multiple units rather than a single tank.
Oversized piping	Using larger than necessary pipework creates additional space to store rainwater. Potentially more sustainable than storage tanks/geocellular storage if the pipes drain by gravity and do not require pumping but also lack the wider benefits of the green infrastructure based techniques
Design for exceedance	This involves designing areas such that they will flood and hold water during rare storm events (typically with a frequency of once in 10 years or longer)

International Experience of Sustainable Drainage

A number of cities around the world have developed long-term plans to increase the use of sustainable drainage techniques, including several cities in the US. One of the earliest adopters was Portland, Oregon, which has a sustainable drainage plan dating back to the early 1990s that has been shown to be a great success (Environmental Services City of Portland 2010). Philadelphia has a 25 year plan, complemented by a range of financial incentives and changes to water bills. Whilst this plan is relatively recent (it was adopted in 2011), the first years of implementation have shown significant success in the implementation of a more sustainable drainage regime (American Planning Association 2015). New York City has recently embarked on a programme of installing thousands of small-scale raingardens to collect rainwater, primarily from streets. However, it should be noted that the US context is very different to the UK. In the US, there are generally fewer organisations responsible for rainwater management, with drainage responsibilities largely remaining with municipal city governments.

In Copenhagen, Denmark, severe thunderstorms over recent years have caused serious flooding in parts of the city. This has led to a re-think of rainwater management in the city, the use of more sustainable drainage, and the use of specific areas (such as local streets and surface car parks) to temporarily store relatively shallow depths of rainwater. The development of the Copenhagen Cloudburst Plan is a good example of planning to manage severe thunderstorm events.

In Australia, Melbourne has undertaken a wide range of sustainable drainage retrofit projects across the city, with the dual aims of improving water quality and reducing flood risk. These projects have also resulted in improvements to the public realm and to urban streets.

International experience suggests that two key elements are required for any large-scale sustainable drainage programme to be successful. First, it must be integrated into city governance and the planning departments. Second, it must have clear cross-cutting political support.

The Case for Sustainable Drainage in London

Thames Water's modelling (Figure 2) will be used to help prioritise certain areas or sewer catchments for future improvements to the existing drainage system. However, given the interconnected nature of London's networks, more sustainable drainage is required across all of London. The implementation of this Action Plan will seek to ensure that rainwater run-off is either slowed down or removed from this system, such that in 50-100 years there will be no need to replicate or extend the TTT.

In outer London, during heavy rainstorms, London's tributary rivers absorb large volumes of rainwater from the drainage systems. This is a natural part of our drainage system but significant quantities of polluting matter and litter can be washed into the rivers from streets, pavements and road gullies. In extreme cases, the deluge of pollution can lead to fish kills in the rivers. Sustainable drainage measures can help tackle this water quality problem by holding back the peak rainwater volumes and reducing the "flushing" effect on the drainage system. Some sustainable drainage techniques, such as reed beds and filter drains, can be specifically designed to remove pollutants. Furthermore, because sustainable drainage systems slowly release water back to the streams and rivers, they can increase the un-naturally low base flows that most urban rivers experience and help the overall quality of these

watercourses. Sustainable drainage techniques can therefore have a wide range of water quality benefits; indeed, in the USA and Australia it is these water quality benefits that are often the main reason for implementing sustainable drainage.

It is also clear that adding green infrastructure sustainable drainage (as opposed to hard-engineered techniques) has many other benefits, such as reducing air pollution, reducing noise, creating pleasant amenity areas, improving biodiversity, and reducing summer urban heat island effects. These benefits remain challenging to incorporate into cost-benefit analyses. As a result, sustainable drainage techniques can sometimes appear to be less cost-effective than traditional engineered drainage solutions. However, two approaches offer potential solutions to this problem:

- CIRIA has undertaken work at a national level to demonstrate the relative costs and benefits of different sustainable drainage options and the Benefits of SuDS Tool (BeST) is an easy to use means of assessment (https://www.ciria.org/News/CIRIA_news2/New-tool-assesses-the-benefits-of-SuDS.aspx).

- The natural capital approach involves the economic valuation of natural assets, and the services we derive from them (such as clean water and flood risk reduction), for use in decision-making. A range of tools exists to value different natural assets and ecosystem services. For example, iTree Eco estimates the value of some of the ecosystem services provided by individual trees, such as carbon storage and sequestration. There is as yet no tool available to calculate the economic value of the many different benefits offered by sustainable drainage techniques. In addition, some of the information that feeds into such tools may be unavailable. However, such tools and data may become available in future.

Sustainable Drainage Vision

The use of sustainable drainage systems in London is still at a low level, although anecdotal evidence suggests that it is steadily increasing. The challenges that London faces in terms of surface water flooding, combined with the co-benefits that sustainable drainage can provide, mean that the Mayor is clear a step-change in the amount of sustainable drainage in London is needed:

By 2040, London will manage its rainwater more sustainably to reduce flood risk and improve water security, maximising the benefits to people, the environment and the economy.

Current Sustainable Drainage Planning and Delivery in London

This vision will be delivered through the planning system and retrofitting initiatives, in collaboration with a number of key partners. Both current planning policy and existing key partners and programmes are described in the following sections.

National Planning Policy

Proposals to increase the use of sustainable drainage techniques are in line with England's planning policies, as set out in the National Planning Policy Framework (NPPF). Sustainable drainage is seen as a means by which developments can avoid increasing the risk of flooding elsewhere. Following the Government's consultation "Delivering Sustainable Drainage" (Defra & DCLG 2014), the Guidance that supports the NPPF has been strengthened with respect to sustainable drainage.

Since April 2015, Planning Authorities have been responsible for the approval of sustainable drainage designs for all major planning applications in consultation with the Lead Local Flood Authority (LLFA). In London, the relevant borough is the Local Planning Authority and the LLFA.

The London Plan

The London Plan's Policy 5.13 (Box 1) is aimed at ensuring that sustainable drainage techniques are utilised wherever practical for new developments. This policy has remained broadly unchanged since 2004 and is understood to be working well for large-scale development. It is anticipated that in any future London Plan the broad thrust of the policy will remain.

The Policy requires developers to aim for greenfield run-off rates. However, it also recognises that in such a densely built-up city as London this may not always be possible, particularly given that the vast majority of development is targeted on brownfield sites.

The policy contains a hierarchy of drainage methods, with a preference going to methods that make active use of any rainfall captured, for example for irrigation or other non-potable uses such as vehicle cleaning. The policy also places a preference for sustainable drainage measures that retain water in surface features over methods than store water below the surface. The Policy recognises that the discharge of rainwater directly to tidal rivers or docks can be a sustainable method of managing rainwater, rather than requiring sustainable drainage features to be incorporated into the development. The Sustainable Design and Construction Supplementary Planning Guidance (GLA 2014) gives further detail on the implementation of this policy.

New development will be a particularly important aspect of future sustainable drainage delivery, and a dedicated section and series of actions relevant to the planning system is provided in the Action Plan.

Box 1: London Plan Policy 5:13 Sustainable Drainage

Planning decisions

A. Development should utilise sustainable urban drainage systems (Sustainable drainage) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:
   1 store rainwater for later use
   2 use infiltration techniques, such as porous surfaces in non-clay areas
   3 attenuate rainwater in ponds or open water features for gradual release
   4 attenuate rainwater by storing in tanks or sealed water features for gradual release
   5 discharge rainwater direct to a watercourse
   6 discharge rainwater to a surface water sewer/drain
   7 discharge rainwater to the combined sewer.

   Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

LDF preparation

B. Within LDFs boroughs should, in line with the Flood and Water Management Act 2010, utilise Surface Water Management Plans to identify areas where there are particular surface water management issues and develop actions and policy approaches aimed at reducing these risks.

Drain London

In 2008, the Greater London Authority (GLA), Thames Water and the Environment Agency commissioned a short scoping study to check the RFRA findings and to suggest ways of improving surface water flood risk management. This confirmed that London is at high risk, and suggested that undertaking surface water risk mapping across London and producing a Surface Water Management Plan (SWMP) would be an important next step. This scoping study coincided with the Government receiving the Pitt Review into the 2007 flooding events, which identified 14 London boroughs amongst the top 15 local authorities most at risk of flooding, including surface water flooding.

The GLA then bid to Defra for funding to undertake a new project, known as Drain London, which would model surface water flood risk, and map and produce SWMPs for London. £3.2 million was allocated by Defra on the basis that this work would cost approximately £100,000 per borough. The GLA allocated a Project Manager for Drain London and Defra delivered the funding in 2010. The project was split into 3 sections, or tiers (see Figure 3 and Table 1).

Tier 1 (2010-12)

- Established the modelling and mapping standards.
- Split London into manageable surface water catchments, loosely based on borough boundaries.
- Gathered all known existing data and purchased any missing data (e.g. Lidar and Geological datasets).

- Set up a Web Portal to share and transfer data and to view mapping results.
- Established the borough groupings (originally there were 8 groups, but groups 1 and 2 have merged and groups 7 and 8 have re-modelled themselves slightly).

Figure 3: Current Drain London Groupings

Credit: Greater London Authority

Table 2: Current Drain London Group Members

Group	Borough
1&2 NW London	Barnet, Brent, Ealing. Harrow , Hillingdon, Hounslow
3 Central London	Camden, City of London, City of Westminster, Hammersmith & Fulham, Islington, Kensington & Chelsea
4 Lee Valley	Enfield, Hackney, Haringey, Newham, Tower Hamlets, Waltham Forest
5 NE London	Barking & Dagenham, Havering, Redbridge

Group	Borough
6 SE London	Bexley, Bromley, Greenwich, Lewisham
7 London South Central	Lambeth, Southwark
8 SW London	Croydon, Kingston , Merton, Sutton, Richmond, Wandsworth

With the introduction of the Flood and Water Management Act 2010 and the creation of boroughs as Lead Local Flood Authorities, it was felt important that each borough and the City of London should have its own surface water mapping and SWMP.

Tier 2 (2011-2012)

This Tier undertook the surface water modelling itself and worked with borough officers to produce SWMPs. The work was split into 8 contracts, one for each of the Drain London Groups. The work also delivered Preliminary Flood Risk Appraisals (PFRAs) for each London borough which became a requirement of the EU Flood Directive 2009. The modelling identified areas of flood risk, which contain a range of critical infrastructure and over one million properties (although most of those properties are at a fairly low level of risk).

Tier 3 (2012- 2014)

This Tier examined in detail the areas that the Tier 2 work highlighted as being at high risk of surface water flooding. Nearly 30 high flood risk areas and a range of important infrastructure have been investigated to date. A further four demonstration projects in four boroughs have been part-funded by Drain London to show how surface water can be managed more sustainably. Drain London funding has also been used to monitor the water attenuation performance of experimental and conventional greenroofs at London Underground's Ruislip depot.

Over the five years of the Drain London project, a much improved understanding of surface water flood risk has been established and a number of approaches to mitigate those risks have been tested. These approaches demonstrate that sustainable drainage techniques suitable for all parts of London can help address London's surface water flood risk. With sustainable drainage having been proven to deliver substantial benefits in a London context, the aim now is to drive the delivery of the sustainable drainage approach forward. The Drain London Interim Report (to be published shortly) gives further detail on the Drain London project and its outputs.

Partner Support

The GLA alone cannot implement sustainable drainage on a widespread basis; it will require an integrated approach from a wide range of partners. The Environment Agency, Thames Water and London Councils have all supported the GLA in drawing up this Action Plan and have committed to support a range of the Actions. Further advice has been taken from a number of London boroughs and their support will be critical to the success of the Actions.

Thames Water

Thames Water owns and manages London's sewerage systems. Rainwater is deliberately designed to flow into the combined sewer system that covers most of central and inner London, but in parts of outer London rainwater is also accidentally and incorrectly connected to the foul sewerage system. There are some areas where the sewer system has limited capacity and, with the projected significant growth of London's population through to at least the middle of the century, capacity will come under further pressure. The removal of rainwater from the sewer system would free up capacity for foul water flows and delay, or even remove, the need for what could be expensive and disruptive upgrading of parts of the sewerage network.

In recognition of the potential benefits of removing rainwater from foul and combined sewers, Thames Water has allocated funding in the period 2015-2020 for projects that can remove surface water from the combined or foul sewerage system across its operational area. The programme is known as "Twenty4twenty" and aims to stop at least 20 hectares of drained land from discharging rainwater into the sewers. The programme applies not just to London but across the Thames Water operational area, so some projects may be developed in other towns and cities. However, due to the extent of combined sewers in the Capital, at least 50% of the available funding will be put to use in London. This Action Plan supports this initiative and is keen to see its success used to demonstrate the need for similar funding beyond 2020.

Environment Agency

The Environment Agency is an executive non-departmental public body, sponsored by Defra. It has principal responsibilities in England to protect and improve the environment, and to promote sustainable development. It takes a strategic overview of all sources of flooding, including surface water flooding. Over £12 million of government investment has been allocated to support London boroughs in managing surface water flood risk in 35 projects over the next six years.

London Boroughs

As awareness of sustainable drainage projects grows, more schemes are being developed that incorporate sustainable drainage techniques. Many boroughs are now undertaking localised projects. Most of these follow a similar approach to this Action Plan, with the project being woven into wider objectives of upgrading facilities or improving the appearance and function of buildings and public spaces. The GLA has launched a register to record such examples across London, which it is anticipated will form a body of evidence about good practice and opportunities.

Transport for London

TfL is the organisation that implements the Mayor's transport strategy. It owns around 2,300 hectares of land across London, including buildings, land attached to Tube stations, railways and highways. This makes TfL one of London's largest landowners, and it has demonstrated some early sustainable drainage projects across London. Examples include greenroofs at stations and depots and raingardens in the public realm.

PART 2. THE SUSTAINABLE DRAINAGE ACTION PLAN

The Sustainable Drainage Action Plan

This document's purpose is to set a long-term strategy for increasing sustainable drainage implementation. The emphasis of the strategy is to use whatever technique – or combination of techniques best suits particular buildings, developments, land or neighbourhoods. This Action Plan should not be used to suggest that particular techniques can or can't be used. The Action Plan is intended to commit a wide variety of organisations to actions that will increase the use of sustainable drainage over a long time period. To account for longer-term uncertainties, the Plan makes firm shorter term commitments for and sets a direction for the longer term. The implementation of the Action Plan will be monitored and reported on annually and progress will be reviewed, and if necessary, actions amended or new actions introduced.

Indicators

The Action Plan will be monitored, and progress reported on, an annual basis to allow trend analysis and exploration of new opportunities. The number of known sustainable drainage retrofit projects will be reported. Measuring the net impact of the Action Plan on surface water flooding, however, is recognised as a difficult task. The multiple variables of weather, new development patterns, economic trends, water consumption behaviour and investment in sewerage and drainage infrastructure will all affect the net flows in sewers. Nevertheless, in the interests of having a simple and reliable metric to report, the GLA will work with Thames Water and others to determine a useful measure of the average and/or peak flows at key points in the sewer network, which will be monitored to determine the overall success of the programme.

Target

Determining a target to aim for has been equally challenging as there is limited evidence upon which to base a realistic target. In the interests of establishing a general quantum to aim for, a 1% reduction per year has been stated as the target, to achieve a 25% reduction in comparison with today's flows by 2040. It is generally expected that this will be difficult to meet in the early years as the programme establishes itself, but if successful in engraining sustainable drainage into normal practice, it is expected that the 1% reduction per year target can be met in the medium term. Actions to establish a baseline position and reliable monitoring methodology are set out as specific Actions.

To achieve a 1% reduction in surface water flows in the sewer network each year for 25 years, resulting in a 25% reduction in flows by 2040.

Glossary

Throughout this Action plan, the suggested lead organisations and partners for Action delivery are listed in tables. The abbreviations for these organisations are listed in Table 3.

Table 3: Action Plan Abbreviations

Abbreviation	Lead Organisation / Partner
GLA	Greater London Authority
TW	Thames Water
TfL	Transport for London
LA	Local Authority
LB/s	London Borough/s
LC	London Councils
CIRIA	Construction Industry Research and Information Association
EA	Environment Agency
LoDEG	London Drainage Engineers Group
LU	London Underground
DLR	Docklands Light Railway

Understanding the Opportunities and Benefits of Sustainable Drainage

There is a wide range of opportunities to manage rainwater more sustainably, and these should be taken where feasible. There are, however, often-quoted reasons why sustainable drainage techniques either cannot be implemented or are limited, including the presence of clay soils, sub-surface utilities and high groundwater. As a result, the Drain London project has commissioned consultants to map the opportunities for sustainable drainage at a London-wide scale. The project should also highlight any particular locations where there are either very good, or much more limited, opportunities.

It is also worth investigating whether there are any limits on the amount of sustainable drainage that should be implemented. For example, a concentration of infiltration techniques could lead to long-term changes in ground moisture levels, and lots of small-scale storage tanks requiring pumps to release rainwater following a storm will have an increasing energy requirement. This will be considered in future reviews of the Action Plan. However, the position at the outset of this Action Plan is that a significant increase in the use of sustainable drainage is required, and in no way should implementation of existing opportunities be put on hold or resisted awaiting longer-term research.

The actions outlined in this part of the Action Plan are aimed at understanding these wider and longer-term implications, and establishing a monitoring framework.

Table 4: London-Wide Actions

No.	Action	Lead Organisation	Partners	Timescale
1	Publish the results of the London-wide Sustainable Drainage Opportunity Model	GLA	TW EA LC	2015
2	Compilation of evidence on the full range of benefits of sustainable drainage	CIRIA		BeST published 2015 Sustainable Drainage Guidance to be published shortly
3	Deliver a programme of sustainable drainage projects through the "Twenty4twenty" initiative	TW	LBs	2015 - 2020

Delivering Sustainable Drainage through New Developments via the Planning System

This is an area of the Action Plan where there is already significant activity. This is not surprising as implementing sustainable drainage on new development is often cost-neutral and can even offer cost savings compared to conventional drainage techniques. Furthermore, as mentioned in Part 1, national and London-wide planning policies have promoted and required sustainable drainage for many years (the London Plan has contained a Sustainable Drainage Hierarchy since 2004).

Anecdotal evidence from the strategic planning applications that are referred to the Mayor indicates that the vast majority of those applications over recent years have included proposals to significantly reduce rainwater discharge, often to greenfield run-off rates and usually by at least 50 per cent. The relatively small proportion of development that is proposed on greenfield sites has generally been able to retain greenfield run-off rates. There is a lack of monitoring of smaller-scale development proposals, but it is expected that these would show generally fewer proposals for sustainable drainage, particularly at the household level.

With the changes to the NPPF Guidance in April 2015, the delivery of sustainable drainage for major new development is set to increase significantly. This means that planning applications for major new development are now referred to Lead Local Flood Authorities for their comments. Developers have to give increased attention to the drainage arrangements for these new developments, and there is a general expectation that sustainable drainage techniques will be used unless there are clear viability grounds for not doing so.

The London Plan

The GLA will undertake research with Drain London partners, and the development and drainage industries, to test whether any changes are required or would be desirable in order to inform future reviews/replacement of the London Plan. Of particular relevance to this research is the current production of a revised National SuDS Manual by CIRIA. This is due to be published shortly and will contain specific guidance relating to sustainable drainage measures for large urban areas.

Much of the new development in London will be dispersed in small-scale developments, which will be individually dealt with through the normal planning process. There will also be significant concentrations of new development within the London Plan Opportunity Areas. These areas offer the scope for strategic level redesign of drainage regimes, to include sustainable drainage systems within a wider Water Sensitive Urban Design approach. This Action Plan commits the GLA to examine each of the Opportunity Area Development Frameworks, as they come forward and identify the most appropriate drainage strategy for those areas. For some Opportunity Areas where there are particularly important opportunities to improve the sustainability of the regime, for example the Nine Elms, Battersea, or Old Oak Common Opportunity Areas, a more detailed Integrated Water Management Plan should be delivered.

This section of the Action Plan aims to support London boroughs in their planning role and to co-ordinate experiences and monitoring of sustainable drainage delivery so that best practice can be established and shared.

Figure 4: The London Plan

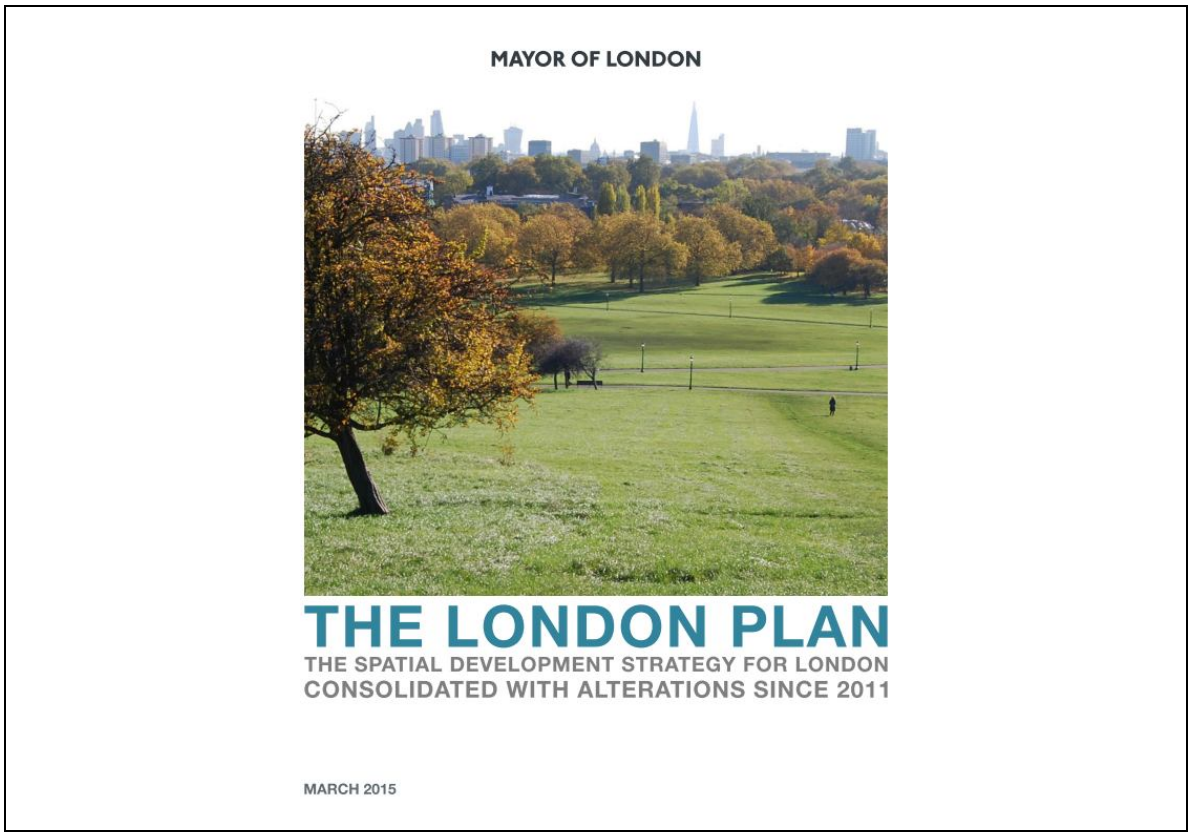


Table 5: Actions

No.	Action	Lead Organisation	Partners	Timescale
4	Maintain a strong London Plan policy lead supporting sustainable drainage	GLA		On-going
5	Produce updated National SUDS Manual	CIRIA		2015
6	Provide strategic guidance on sustainable drainage requirements for London Plan Opportunity Areas	GLA	Partner LBs TW EA	On-going
7	Provide detailed Integrated Water Management Plans for specific Opportunity Areas	Development partners	GLA EA TW LBs	On-going

Retrofitting Sustainable Drainage across London

Through the planning system, new development will deliver steady incremental increases in the amount of sustainable drainage techniques implemented across London. However, new development typically affects only around 0.5 per cent of land each year. Therefore, any step change in the use of sustainable drainage requires that existing land and buildings are retrofitted with more sustainable drainage measures.

The remainder of this Action Plan examines a range of key land uses in the public and private sectors. Different elements of the public sector own, manage and control enormous amounts of land, buildings and infrastructure throughout London. The main sectors are examined below but include central government, local government, the health, education, housing and transport sectors. In addition, large commercial sector ownership and management is hugely significant across London. This Action Plan seeks to influence those organisations controlling larger plots of land, such as major commercial owners and large format shops and businesses. Whilst sustainable drainage measures should be considered by all property owners/managers, this Action Plan must target efforts, and at present working with larger organisations is the main focus. This could be reviewed in future years.

It is fully recognised that all public sector organisations are under tight budgetary control, and commercial organisations will need to demonstrate a good business case for investment. There is little to no funding specifically available to undertake measures such as retrofitting of sustainable drainage as a one-off project. Instead, this Action Plan proposes to offer guidance and influence existing expenditure plans that public sector and commercial organisations will already have.

The expectation is that where opportunities arise to incorporate sustainable drainage as part of other required maintenance, repair, refurbishment or replacement of facilities, sustainable drainage options are duly considered and implemented where practical. There may still be some initial additional cost involved in such measures, but this will be marginal in most cases and there may be opportunities for some sustainable drainage options to offer cost-savings, either at installation stage and/or in terms of on-going maintenance and operational requirements. Sustainable drainage opportunities will also often present the ability to integrate drainage with a range of other objectives, such as greenspace management, water demand, noise reduction, or improved visual appearance.

In order to realise the opportunities that do or will exist, organisations must be aware of the importance of sustainable drainage and its relevance to their operations. It is also necessary for the relevant organisations to share, at least at a general level, their planned investment programmes. This will allow opportunities to be identified with enough lead-in time that sustainable drainage techniques can be incorporated without significant additional cost or time implications.

Each broad land use sector is now considered in turn.

Education Sector

Figure 5: Coppetts Wood Primary School SUDS for Schools

Credit: Wildfowl & Wetlands Trust

Table 6: Education Sector Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Green/brown roofs	Major roof repairs, refurbishment or building extension
Raingardens and downpipe diversion	School extension or refurbishment, or some minor works
Permeable surfacing	Resurfacing of car parks or hard surfaced playgrounds
Rainwater harvesting	School extension or refurbishment, or some minor works

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Swales, bio-retention	Playing field/landscaping enhancements
Ponds	Within landscaping around the school. Ponds can provide valuable educational opportunities.

The education sector has a wide range of buildings and premises, including primary and secondary schools in both the public and private sector, and higher and further education establishments. A high proportion of these buildings have flat roofs, which may prove suitable for greenroof technologies. Perhaps most significantly, many schools, colleges and universities have outdoor playgrounds, playing fields, and/or car parking areas, which offer the potential for significant surface water storage and infiltration via a range of possible techniques. In general, education premises in outer London tend to have more significant external spaces and therefore a wider range of sustainable drainage retrofit opportunities than schools in more densely built-up parts of London, and for some schools/colleges there may be limited opportunities.

It is notable that with London's continued growth, there will be significant growth in the education sector. The London Infrastructure Plan is projecting the equivalent of up to 550 new schools and colleges in London by 2050. In reality, much of this capacity may be accommodated by expanding existing schools/school sites. This presents both a challenge and an opportunity for introducing more sustainable drainage. On the one hand, more densely developed school sites will mean that current areas of open space (whether hard surface or soft landscaping) will be reduced and some scope for sustainable drainage may be lost. On the other hand, the capital investment in those premises provides exactly the mechanism necessary to change the drainage regime of the school site. If planned and designed as part of an overall upgrade or extension of the school, the implementation of sustainable drainage measures can be achieved at minimal, or even zero, additional cost. The provision of greenroofs has the additional benefit that the long-term maintenance and repair costs of the roof should be reduced.

Drain London has already worked with a number of secondary schools across London that are at risk of surface water flooding. This work has demonstrated that there are significant opportunities for surface water storage or diversion through the use of greenroofs, raingardens, swales, detention basins and wetlands.

In addition the "SuDS for Schools" programme (delivered by the Wildfowl & Wetlands Trust in partnership with the Environment Agency and Thames Water: http://sudsforschools.wwt.org.uk/) has delivered a range of sustainable drainage techniques at 10 schools within the London Boroughs of Barnet, Enfield and Haringey. This has demonstrated not only that schools have significant potential

for sustainable drainage measures, but that the implementation of these measures can be linked to water cycle topics on the national curriculum and provide good examples for pupils to study. One of the important conclusions from this work was that even where external space was limited, there was still some scope for measures, such as raingardens.

Over recent years, the Water for Schools Programme (delivered by the London Sustainable Schools Forum: http://www.londonsustainableschools.org/water-for-schools.html) has implemented two pilot rainwater harvesting schemes that have captured water for use in the school toilet systems, leading to savings on water bills. This work also demonstrated that taking a comprehensive look at water supply systems in schools is a good opportunity to identify leaks, faulty and inefficient plumbing appliances. The repair and upgrade of these plumbing systems led to significantly greater water savings and notable cost savings on annual water bills. On their own, such rainwater harvesting systems would take several years to pay for themselves. However taken as part of a wider refurbishment or extension of a school, this should be an incremental cost with payback in a shorter time period.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the education sector to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes. Once opportunities have been identified with the large education sector providers, other smaller-scale opportunities will then be examined.

Table 7: Education Sector Actions

No.	Action	Lead Organisation	Partners	Timescale
8	Produce guidance and good practice examples of sustainable drainage applicable to the education sector	GLA	TW EA	2016
9	Establish school/education authority development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Local authority education depts.	2016

No.	Action	Lead Organisation	Partners	Timescale
10	Establish higher education providers' development proposals, as well as capital and revenue investment programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Higher education providers	2016
11	Establish private sector education providers' development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Private sector education providers	2017

Housing Sector

Figure 6: Groundwork estate retrofit project in Hammersmith & Fulham

Credit: Groundwork

Table 8: Housing Sector Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Green/brown roofs	Major roof repairs
Raingardens/diversion of downpipes	Landscaping enhancements
Rainwater harvesting	Major refurbishment programmes for larger buildings/estates.
Some scope for permeable surfacing	Resurfacing of footpaths, hard surfaces or car parks

With over 4 million homes, the housing sector represents a large proportion of London's total surface area. Recently, the number of new homes has been growing at around 30,000 per year. However, it is generally recognised that this needs to increase significantly to around 50,000 per year in order to keep up with continued population growth and with the backlog of demand that already exists.

A key consideration for the housing sector is that properties tend to have a long life span. There are still a large number of Victorian brick-built homes in use today, which are well over 100 years old and make up some of the most sought-after properties in London. A considerable number of the early public sector housing estates constructed after the First World War are now approaching 100 years of age, and the large tracts of outer London built during the inter-war years are now 80 years old and look set to remain a key element of London housing for the foreseeable future. This longevity means that it is important to get sustainable drainage measures built into the design of new housing but also means that if sustainable drainage can be retrofitted to existing stock, it should provide benefits for the long-term. Conversely, the fact that buildings are generally long lasting is an indication that they can be maintained without the need for frequent major repairs, and therefore the opportunities to retrofitting sustainable drainage will generally occur infrequently.

An initial distinction should be made between properties with pitched roofs and those with flat roofs. Flat-roofed properties may be suitable for a green/brown roof. Such roofs can have valuable benefits in improving the insulation of the buildings, keeping them both warmer in winter and cooler in summer. A well designed green/brown roof can also reduce long-term maintenance and repair costs of flat roofs.

Addressing the retrofit of London's housing stock is likely to be challenging given the diversity of ownership and management. A large proportion of the housing stock is owned either by individuals/families, or by owners of small and dispersed property portfolios. There is a range of relatively easy measures which can be applied to such properties, especially those with garden areas and these are addressed under the "What you can do" section. This section focuses on the larger providers of housing, namely the housing associations, local authority social housing and large-scale private rented sector providers.

For many municipal or housing association residential estates, there are relatively generous areas of communal open space. These can often provide good opportunities for retrofitting rain gardens and diverting downpipes into those raingardens. For example, the Neighbourhoods Green initiative aims to raise the profile of open space for social housing residents, and works with social landlords to raise the quality of their design, management and safe use. Sustainable drainage is considered as part of this work (National Housing Federation 2011).

However, care is required to avoid areas too close to the buildings themselves, to avoid the risk of damp or changes to the ground conditions surrounding foundations occur. Also, areas that are likely to contain numerous services should generally be avoided due to the significant increase in costs that moving or protecting such services is likely to incur. The architectural design of some estates included the provision of concealed downpipes, i.e. it is not clear exactly where the downpipes are as they are hidden beneath the facade of the building. In such cases, alterations to divert such downpipes will be slightly more complex and costly, but in general this should not present an insurmountable difficulty.

Nevertheless, there are still likely to be significant opportunities for the construction of raingardens in communal housing areas. A study undertaken by Drain London and LB Haringey for the Campsbourne Estate in Hornsey identified numerous locations for raingardens where implementation

was relatively inexpensive at approximately (£400/m^2). Such schemes can be used not only to divert rainfall from downpipes but to provide more diverse and attractive landscaping for the residents or potentially small food growing areas.

For residential locations adjacent to the River Thames, tidal rivers or docks, a relatively easy approach is to divert rainwater into the river or dock. Whilst this is not normally considered to be a form of sustainable drainage, for the heavily urbanised areas of London it is a more sustainable approach to managing rainwater that would otherwise be conveyed into the combined sewer system. This method of rainwater management is usually relatively easy to introduce together with other renovations of a building, but will need to accommodate the regular tidal fluctuations and there may be a need for storage or discharge to the surface water sewer in such cases.

The GLA runs the RE:NEW programme which is primarily aimed at improving energy efficiency in London's housing stock but could also consider opportunities to improve water and drainage efficiency too.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the housing sector in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes. Once opportunities have been identified with the larger social landlords, other smaller-scale opportunities will then be examined.

Table 9: Housing Sector Actions

No.	Action	Lead Organisation	Partners	Timescale
12	Produce guidance and good practice examples of sustainable drainage applicable to the housing sector	GLA	TW EA	2016
13	Establish future plans for housing improvement and repair across London, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Housing associations LA housing depts. GLA Re:New	2016

Transport Sector

Figure 7: Derbyshire Street pocket park, Tower Hamlets

Before **After**

Credit: Greysmiths Associates

Table 10: Transport Sector Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Rainwater diversion from gullies to street trees or swales	Maintenance of road gullies/drainage
Street Trees	New or replacement street trees
Permeable surfacing for car parks	Resurfacing of car parks
Swales	Landscaping enhancements
Rainwater harvesting	Refurbishment of bus/rail depots, especially where there is a requirements for water for cleansing
Raingardens	Landscaping enhancements around buildings and transport assets
Green/brown roofs	Refurbishment of buildings and depots

Most of the transport sector's linear assets (roads and railways) offer limited scope for sustainable drainage. Rail and tube lines can often run in cuttings, making it difficult to divert rainwater away from them: indeed such cuttings are often at some level of flood risk due to their low topography.

Similarly, major road underpasses can often be prone to flooding. Perhaps the only realistic options for heavily urbanised roads are the creation of permeable parking areas and the diversion of rainwater into street tree pits. Some good examples of such "Stockholm" Tree Pits have recently been constructed in London. It is generally accepted that permeable surfacing is not suitable for any but the lightest trafficked road surfaces. However, Transport for London (TfL) is undertaking a permeable road surfacing trial during 2015 on a section of the A127 in east London and it will be important to consider any future techniques or material that would enable greater use of porous road surfaces.

Some linear assets, however, have significant tracts of land alongside them, such as road verges and trackside vegetation. In the case of rail and road routes through outer London, there are often areas of parkland, greenbelt, or indeed farmland alongside several miles of road or railway. These offer the potential for rainwater to be diverted into such areas for sustainable drainage, thereby reducing flood risk to the transport asset and potentially to the wider neighbourhood.

Diffuse pollution from transport infrastructure is a significant factor affecting the quality of London's rivers, with major roads likely to generate significant amounts of pollutants that can be washed into receiving drains and waterbodies during heavy rainfall. The ability to treat surface water from road or rail corridors using infiltration or bio-retention sustainable drainage techniques therefore presents a good opportunity to reduce the pollution loading for watercourses and groundwater.

In common with many other buildings, transport sector buildings can lend themselves to green/brown roofs and also realise the benefits of insulation and reduced long-term maintenance. London Underground has constructed a greenroof at its Ruislip Depot. Where such buildings are being upgraded or extended, there are likely to be opportunities to incorporate some sustainable drainage measures at little additional cost.

There are often reports of surface water flooding at main line rail termini, given the size of the roof area of these stations. However, it should also be noted that these and some other transport buildings may be of historical and architectural significance, and so may not be suited to greenroofs and or other sustainable drainage techniques.

More modern or utilitarian buildings may be more suited to green/brown roofs, and buildings such as maintenance depots or bus garages can be well suited for rainwater harvesting schemes for vehicle cleansing, thus reducing water bills. The West Ham bus depot is a good example, as it incorporates a greenroof with a rainwater harvesting system that is used to supply water to wash the bus fleet.

Many outer London rail and tube stations have station car parks. These areas may be suited for permeable surfacing or sub-surface storage if the car parks are resurfaced or redeveloped.

Actions

This Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the transport sector, in particular with the Mayor's own lead agency TfL, in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that

retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes.

Once opportunities have been identified with the main sector providers, other smaller-scale opportunities will then be examined.

Table 11: Transport Sector Actions

No.	Action	Lead Organisation	Partners	Timescale
14	Produce guidance that includes good practice examples of sustainable drainage in the streetscape public realm	TfL	GLA TW EA LoDEG	2016
15	Prepare a standard for retrofitting green infrastructure	LU		2015
16	Establish future plans for transport improvement, repair and new transport projects, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	TfL LU DLR London Overground	On-going
17	Establish highway authorities' future capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Highways authorities Highways Agency	2016

Health Sector

Figure 8: Greenroof at Springfield Hospital, Wandsworth

Table 12: Health Sector Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Green/brown roofs	Major roof repairs, refurbishment or building extension
Raingardens and downpipe diversion	Hospital extension or refurbishment, or some minor works
Permeable surfacing	Resurfacing of car parks
Swales, bio-retention	Extension or major refurbishment where hospital has extensive undeveloped grounds

The NHS, and indeed private sector health providers, has a wide range of premises across London. Some of these are relatively small, for example some doctors surgeries, and offer only limited scope for sustainable drainage. However, other premises such as major hospitals are large buildings offering a range of opportunities for sustainable drainage, both at roof level and within the grounds. There is a high proportion of health sector buildings with flat roofs that may prove suitable for green/brown roof technologies, with the potential added benefits of improving insulation and reducing long-term maintenance costs. In some parts of London, hospitals are set in extensive grounds and have large car park areas. Such sites offer considerable opportunities for the storage, infiltration or diversion of rainwater away from sewers, and even have the capacity to absorb rainwater from surrounding streets and neighbourhoods. There is also evidence that pleasant natural surroundings correlate with improved health and recovery (MEBIE2 study: Natural England 2014).

Drain London has worked with 11 major hospitals to assess surface water flood risks. This has illustrated some ways in which flood risk can be mitigated, at the same time as improving the resilience of the hospital's operation, for example by locating critical equipment and utilities above potential flood levels or by diverting potential flood water away from the most sensitive areas. This work also highlighted that there are opportunities for greenroofs, permeable car parking areas and rain-attenuating landscaping to be incorporated into periodic major maintenance. It is difficult to imagine that there are opportunities to utilise very much rainwater within a hospital's daily functions, and so rainwater harvesting opportunities may be limited.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the health sector in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes.

Once opportunities have been identified with the large health sector providers, other smaller-scale opportunities will then be examined.

Table 13: Health Sector Actions

No.	Action	Lead Organisation	Partners	Timescale
18	Produce guidance and good practice examples of sustainable drainage applicable to the health sector	GLA	EA TW	2016

No.	Action	Lead Organisation	Partners	Timescale
19	Establish future NHS hospital development proposals as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	NHS Trusts	2016 -18
20	Establish private sector health providers' (possibly including care homes) capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Health providers	2018 onwards

Retail Sector

Figure 9: Green wall and greenroof on an M&S store, Sheffield

Credit: Marks and Spencer

Table 14: Retail Sector Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Green/brown roofs	Major roof repairs, store extension or refurbishment
Raingardens and downpipe diversion	Roof repairs, minor alterations
Permeable paving and car parks	Resurfacing of car parks and pedestrian areas
Tree pits	Street tree planting, landscaping of car parks

Supermarkets and large-scale retail units have large, generally flat or shallow sloping roofs. There may be good opportunities to introduce green/brown roofs onto some stores, although it is generally anticipated that these will be limited, since the relatively lightweight retail unit roof construction often lacks the structural support required for a green/brown roof. However, a new lightweight greenroof technology will be tested by London Underground that is 40% lighter than conventional greenroofs. These may be appropriate for the retail sector in future.

More likely opportunities are the potential to divert downpipes into raingardens or rainwater storage areas within the grounds or car parks of the stores. These measures could be incorporated into the resurfacing of a car park or into improved landscaping for stores. Resurfacing of car park areas also offers a good opportunity to store or infiltrate rainwater. Permeable supermarket car parks have been introduced in a number of locations nationally with very positive results. However, care will be needed where stores have been built on previously contaminated ground and it is generally unlikely that retrofitting sub-surface storage tanks or geocellular structures is likely to be cost-effective. It is also unlikely to be practical to introduce permeable surfacing to delivery yard areas due to the likely damage caused by the manoeuvring of delivery vehicles.

Shops in town centres are generally of smaller footprints and not surrounded by large car park areas. There will therefore be limited opportunities for significant sustainable drainage retrofitting here. Instead, sustainable drainage must generally await more comprehensive re-development, where opportunities will be picked up through the planning system. Whilst the density of development expected in a town centre means that opportunities may be limited, town centre and high street improvement/landscaping programmes may offer opportunities to introduce sustainable drainage and "Stockholm" Tree pits.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the retail sector in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes.

Table 15: Retail Sector Actions

No.	Action	Lead Organisation	Partners	Timescale
21	Produce guidance and good practice examples of sustainable drainage applicable to the retail sector	GLA	TW EA	2017
22	Establish supermarket development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Supermarkets LBs	2017

No.	Action	Lead Organisation	Partners	Timescale
23	Establish DIY and other large format retailers' proposals for capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	DIY stores and other large format stores LBs	2017
24	Establish retail estate owners' capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Retail estate owners	2017

Recreational Land / Other Open Space and Sports Stadia

Figure 10: Swales installed at Mayesbrook Park, Barking and Dagenham

Credit: Greater London Authority / Environment Agency

Table 16: Recreational Land Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Swales	Maintenance of grounds
Detention ponds	Upgrades to facilities
Rainwater harvesting	Re-modelling of landscaping
Green/brown roofs	Resurfacing of car parks
Permeable surfacing for car parks	Tree planting
Tree pits	Refurbishment of buildings and depots
Storage tanks/geocellular storage	For large roof or paved areas

The Public Sector owns and manages large areas of open space and recreational land, such as parks, gardens, sports pitches, and (in outer London) a number of golf courses. These help form part of London's 'green infrastructure' (see Box 2 for a definition). Much of this land will drain naturally,

either via infiltration or to tributary streams. However, where these open spaces are particularly heavily used, the ground can become compacted and rainwater runs off at high rates, not unlike hard surfacing. Nevertheless, these land uses may offer good opportunities to absorb or hold more rainwater from adjoining areas and potentially to improve the quality of the water entering these watercourses. During upgrading or remodelling works, these spaces could be designed to hold more surface water using relatively natural means.

Box 2: Definition of green infrastructure

A network of green spaces - and features such as street trees and green roofs - that is planned, designed and managed to deliver a range of benefits, including: recreation and amenity, healthy living, mitigating flooding, improving air quality, cooling the urban environment, encouraging walking and cycling, and enhancing biodiversity and ecological resilience. (Green Infrastructure Task Force 2015)

Besides the London boroughs, there are a number of other agencies that own and/or manage open space in London. The City Corporation owns iconic areas, such as Hampstead Heath, Epping Forest and a range of Commons. The Royal Parks Agency owns and manages the eight Royal Parks in London, and the Lee Valley Regional Park Authority owns and manages a significant amount of land in the Lee Valley. These agencies can all play an important role in improving the management of rainwater in London.

A range of open spaces is also owned and managed privately either by not-for-profit sports clubs and associations, or on a commercial basis. Again, golf courses in outer London are relatively common but there are also many other sports facilities that offer sustainable drainage opportunities. Even where playing surfaces are impermeable, there are often large surrounding areas capable of storing/infiltrating surface water.

Major sports grounds have a combination of hard surfaced stadia, circulation space and car parks, as well as the playing surfaces themselves. Here, a technique worthy of consideration is rainwater harvesting, since the pitches will require irrigation and there is a requirement to flush large numbers of toilets. This could offer reduced water bills and there are examples in use, such as Arsenal's Emirates Stadium and Tottenham Hotspur's training facility in the London borough of Enfield.

Open spaces are unlikely to require the kind of maintenance and repair programmes that buildings periodically require. As a result, the opportunities to introduce sustainable drainage may be limited, yet they can be particularly effective. Nevertheless, open spaces are occasionally re-modelled and there are a range of grant programmes aimed at funding improvements and changes to such open spaces. When these programmes are being considered, there is a good opportunity to design in sustainable drainage measures and locations to retain and infiltrate rainwater.

The GLA manages the All London Green Grid, which is a policy framework to promote a network of 'green infrastructure' across London. The Mayor has also recently established a Green Infrastructure

Task Force, which is exploring how a more strategic and long-term approach to green infrastructure investment and delivery can be encouraged. There are also a number of non-governmental organisations that promote a more sustainable water environment, including sustainable drainage, such as Thames21, Groundwork and London Wildlife Trust. These organisations provide important networks through which to promote sustainable drainage opportunities.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the open space/recreational sector in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes.

Table 17: Recreational Land Actions

No.	Action	Lead Organisation	Partners	Timescale
25	Produce guidance and good practice examples of sustainable drainage applicable to the open space/recreational sector	GLA		2017
26	Establish scope of future open space improvement and maintenance proposals, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Royal Parks Corporation of London Lee Valley Regional Park Authority London Boroughs Major sports /stadia owners	2017

Other Public Sector Buildings

Figure 11: TfL offices at 55 Broadway, Westminster

Credit: Greater London Authority

Table 18: Other Public Sector Land Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Green/brown roofs	Building extension or refurbishment
Raingardens and downpipe diversion	Major roof repairs
Permeable surfacing	Resurfacing of car parks
Rainwater harvesting	Refurbishment, may also be worthwhile as a standalone investment

Whilst certain public sector functions have been highlighted earlier, both national and local government, as well as a range of other public agencies, own and/or manage a significant number of

other buildings and areas of land. These are typically offices, but may also include supplies depots, waste management sites, vehicle depots, museums, galleries and community centres/halls.

The guidance and best practice proposed for other sectors is likely to cover the range of other public sector buildings and land. For example, there are likely to be opportunities for green/brown roofs to be incorporated into some buildings, particularly those with flat roofs. This would offer additional insulation and reduced maintenance costs. For offices and other buildings with high occupancy rates or high non-potable water demand, the installation of a rainwater harvesting system may prove cost-effective, particularly for toilet flushing. For depots, some waste management sites and vehicle holding sites, the use of rainwater harvesting for site, plant or vehicle washing purposes may prove cost-effective.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the wider public/governmental sector in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes.

Given that this Action Plan already contains a range of engagement activities with other public sector agencies, the actions here are delayed for some years, however, those other discussions may in due course, reveal a range of public sector opportunities.

Table 19: Other Public Sector Land Actions

No.	Action	Lead Organisation	Partners	Timescale
27	Examine local authority development proposals, capital and revenue programmes for sustainable drainage opportunities	GLA	LBs	2018
28	Establish central government departmental and Quango proposals for capital and revenue investment programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Central Government depts.	2018

Commercial Office Sector

Figure 12: Rain garden at John Lewis Headquarters, Victoria

Credit: Greater London Authority

Table 20: Commercial Office Sector Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Green/brown roofs	Major roof repairs, office extension or refurbishment
Raingardens and downpipe diversion	Roof repairs, minor improvement works
Direct discharge to tidal rivers or docks	Roof repairs, minor refurbishment work, resurfacing work
Permeable car parks, tree pits	Resurfacing & landscaping of car parks
Rainwater harvesting	Refurbishment, may also be worthwhile as a standalone investment

Commercial offices face many of the same opportunities and constraints as public sector offices. However, there is a key distinction to be made between offices in town centre and central London locations where sustainable drainage opportunities will generally be limited due to the density of

development, and offices in out-of-centre business parks where numerous opportunities are likely to exist in their surrounding car parks and landscaped grounds.

Given the density of employees, most offices should consider the potential long-term benefits of reducing water supply costs by utilising rainwater harvesting systems to supply toilets, which are likely to prove financially viable in many cases.

For office locations adjacent to the River Thames, tidal rivers or docks, a relatively easy approach is to divert rainwater into the river or dock. Whilst this is not normally considered a form of sustainable drainage, for the heavily urbanised areas of London it is a more sustainable approach to managing rainwater that would otherwise be conveyed into the combined sewer system. This method of rainwater management is usually relatively easy to introduce alongside other building renovations but will generally only be applicable for tidal waterbodies and so there may be a need for storage during high tide conditions.

For offices in less densely built-up areas (typically along arterial roads or within business parks) there are likely to be significant opportunities to introduce green/brown roofs, to divert rainwater downpipes into raingardens or permeable areas, and to introduce permeable surfacing to car parks. Together, such measures can provide a significant reduction in rainwater run-off and, if combined with other works (such as a wider refurbishment programme, re-roofing, or resurfacing of car park areas), can be delivered at minimal additional initial cost. It is recognised that in many outer areas of London, the office sector is shrinking. This may mean that there are fewer opportunities for retrofitting, but it may also mean that any conversion to residential premises provides a good opportunity to introduce more sustainable drainage. Any major redevelopment will be expected to provide sustainable drainage through the planning system.

For offices in more built-up locations it is likely that the only options may be the introduction of green/brown roofs when major roof repairs are required, or the introduction of a rainwater harvesting system.

Actions

This section of the Action Plan recognises that this is a more diverse sector than some others, and so the timescale for engagement is slightly later than other sectors. The likely guidance and good practice examples will be similar to those for some other sectors so no specific guidance is proposed.

Table 21: Commercial Office Sector Actions

No.	Action	Lead Organisation	Partners	Timescale
29	Establish major office owners' and occupiers' development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Major office owners / occupiers	2018

Industrial Sector and Major Utilities

Table 22: Industrial Sector and Major Utilities Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Green/brown roofs	Major roof repairs, premises extension or refurbishment
Raingardens and downpipe diversion (potentially to tidal rivers or docks)	Roof repairs, minor works
Permeable car parks, tree pits	Resurfacing or landscaping of car parks and yard areas
Detention ponds, swales, bio-retention	As part of remodelling work, where land permits
Rainwater harvesting	Refurbishment, may also be worthwhile as a standalone investment

It is widely recognised that London's industrial sector has shrunk over past decades. However, in several parts of London there is an important remaining industrial sector, some of which is now expanding and intensifying its activities. Businesses such as distribution and storage facilities should be considered here too. This section also addresses the premises of the major water, energy and telecoms utilities. These utilities often have large-scale sites, many of which are likely to remain as long-term land uses in London. It is recognised that there may be more rationalisation of the telecoms and mail sector land over the future years given the changes in that industry.

Industrial premises often have large buildings. In common with other large buildings, these may offer the opportunity for a green/brown roof. However, the construction is often relatively lightweight and may not be able to support a vegetated roof (depending on the availability of lightweight greenroof technologies in the future). The diversion of downpipes to raingardens, swales, and detention ponds is likely to be generally feasible, although particular attention will need to be paid to the potential for rainwater to come into contact with contaminants and to consider the possibility of previous ground contamination.

Resurfacing or landscaping of car park and yard areas will present the opportunity to introduce sustainable drainage measures, such as permeable parking surfaces, at relatively low additional initial cost. However, if HGVs are likely to use parking or servicing areas, it may not be appropriate to use permeable road surfacing due to the risk of damage to its surface.

There are a large number of industrial and utility premises in the London parts of the Thames Gateway. These may also offer the opportunity for rainwater to be discharged to the Thames or the Royal Docks.

For any industrial premises that use large volumes of water as part of their processes, such as for cleansing or cooling, then rainwater harvesting schemes may prove cost-effective in reducing long-term water bills.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the industrial/utility sector in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes. Once opportunities have been identified with the large industrial sector providers, other smaller-scale opportunities will then be examined.

Table 23: Industrial Sector and Major Utilities Actions

No.	Action	Lead Organisation	Partners	Timescale
30	Produce guidance and good practice examples of sustainable drainage applicable to the industrial sector	GLA		2017
31	Establish Thames Water's development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	TW	GLA	2016
32	Establish power companies' proposals for capital and revenue investment programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Utilities companies	2018

No.	Action	Lead Organisation	Partners	Timescale
33	Establish telecoms providers' capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Telecoms companies	2019
34	Establish the Environment Agency's capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	EA	GLA	2016

Agricultural Sector

Table 24: Agricultural Sector Options and Opportunities

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Swales	Land management grants
Storage ponds	Changes to agricultural practices
Rainwater harvesting	Wherever, cost-effective

Although London is a relatively densely built-up city, it does have some quite extensive areas of agricultural land between the urban area and the London boundary, most of which is protected from development by the Metropolitan Green Belt.

Whilst much of this land will drain and infiltrate naturally, modern farming practices can lead to increased rates of rainfall run-off. Since many of London's tributary rivers originate or flow through these agricultural areas, agricultural drainage practices can lead to rainwater rapidly running off the land into local watercourses and lakes/ponds. This can carry a significant pollutant load from livestock, and from fertilizers and pesticides applied to crops. As a result, sustainable drainage measures are valuable tools on agricultural land, and can be used to add biodiversity value to farmland, improve water quality in watercourses, and hold back potential flood waters before they reach urbanised parts of London.

There are likely to be relatively easy opportunities to implement sustainable drainage in agricultural areas. However, there are also likely to be fewer potential funding mechanisms to enable such works to take place. Most farms already have rainwater harvesting systems in place to provide water for irrigation or livestock, and green/brown roofs are not likely to be viable on many buildings. Instead, the general focus should be on land management practices. The management of flood risk through the use of natural measures is becoming an increasingly important aspect of catchment-wide planning and modern agricultural practice.

Actions

This section of the Action Plan sets out a programme of activities to engage with, advise and lobby the key decision makers in the agricultural sector in order to promote and deliver more sustainable drainage throughout the sector. The key theme is that retrofitting sustainable drainage should form part of already planned maintenance, repair and improvement programmes. Given the limitation of the range of measures and general outer London location, these actions are focused towards the end of the engagement programme.

Table 25: Agricultural Sector Actions

No.	Action	Lead Organisation	Partners	Timescale
35	Investigate opportunities for agricultural sustainable drainage/flood risk management measures to be implemented	GLA	Farming representatives	2020

What Can You Do? Delivering Sustainable Drainage through Domestic and Local Neighbourhood Measures

Table 26: Options and Opportunities for Individuals

Likely sustainable drainage options	Likely opportunities to implement sustainable drainage
Water butts	Garden improvements
Raingardens and downpipe diversion	Roof repairs, extensions, community landscaping projects
Green/brown roofs	Major roof repairs, extensions
Permeable driveways	Resurfacing of driveways

The previous sections have focused on the land uses, owners and occupiers of larger buildings, sites and areas of land in London. Yet the largest area of land coverage is that of single/small blocks of individually occupied residential homes. Each specific home or apartment block can only make a small contribution to improving the sustainability of London's drainage system. However, collectively they could make a significant contribution.

Sustainable drainage measures can readily introduced in individual homes at minimal cost. Perhaps the most common example is the installation of water butts. These can easily be installed as a DIY project in most houses, and can reduce water consumption when irrigating gardens or washing vehicles. Typical water butts cost under £50 and contain approximately 200 litres, but smaller versions are also available and multiple water butts can be linked to provide additional storage. There is a growing market for more bespoke water butts that also act as decorative features, garden benches or planters. For larger gardens, there are also options to install more industrial-scale products. For a water butt to be effective in rainwater management it must have the capacity to absorb the flow from a storm, i.e. it must not be full. One way of achieving this is to have an overflow from the water butt discharging to a flower bed or pond within the garden.

With careful design considerations, some roof downpipes can be diverted into ponds or flower beds around individual homes. Care is needed not to introduce permanently damp conditions adjacent to buildings or to change the load bearing characteristics of the soil structure around buildings. This is particularly important for older houses, which tend to have relatively shallow foundations compared to homes built under modern Building Regulations.

Over the past few decades, there has been a trend of paving over front, and to an extent rear, gardens (London Assembly 2005, London Wildlife Trust, GiGL & GLA 2010). This has led to a significant

increase in the area of land draining into public sewers. However, recent planning changes that require planning permission for new impermeable areas of front gardens should see this issue controlled, and there is a growing availability of highly permeable hard surfacing. However, that leaves a large number of paved garden areas. It is difficult to see a widespread change to these areas in the near future, but as the paving systems become older, more consideration will be given to renewing them and this is an opportunity to encourage, and possibly incentivise, the re-introduction of more sustainable drainage.

Some houses and many apartment blocks have flat roofs. When the time comes for a major refurbishment or repair of those flat roofs, there will be opportunities for the introduction of a green/brown roof, with the associated benefits of improved insulation and long-term reductions in maintenance costs. This opportunity is covered under the earlier section for the housing sector, which is aimed at large-scale housing providers.

The Drain London partnership is leading a series of urban greening demonstration projects to highlight how streets and neighbourhoods can be modified to provide for more sustainable drainage, whilst improving the look and amenity of residential areas. The lessons learned from these early pilots will be communicated into further programmes over the lifetime of this Action Plan.

There may also be opportunities to divert rainfall into small areas of landscaping or under-used land in and around local streets and estates, areas such as road and footpath verges. This Action Plan will consider the need for a Fund for local people to suggest such areas and bid for funds to enable such areas to become more sustainably drained. It is important to remember that not all such areas may be suitable for retrofitting sustainable drainage measures, and that the landowner's consent will be required.

Table 27: Actions for Individuals

No.	Action	Lead Organisation	Partners	Timescale
36	Produce guidance and good practice examples of sustainable drainage applicable to the individual homes, small apartment blocks or local neighbourhoods	GLA		2016
37	Implement at least 5 Green SuDS trial retrofits of sustainable drainage measures	GLA TW EA		2013-2016

No.	Action	Lead Organisation	Partners	Timescale
38	Consider a grant/incentive scheme to encourage individuals or local communities to implement their own sustainable drainage scheme	GLA		2016

Funding Opportunities & Regulatory Incentives

The emphasis in this Action Plan so far has been to identify opportunities and techniques for implementing sustainable drainage techniques that have limited financial impact. As a result, the emphasis has been on identifying situations where other relevant works are likely to be undertaken such that any additional drainage works will only be a marginal component of a wider project. In some cases, it has been noted that there may be opportunities to save money either in direct drainage infrastructure provision or over a longer timeframe through reductions in water bills, reductions in energy costs to heat/cool buildings and/or reductions in maintenance requirements.

There is currently a little-known mechanism where a direct financial benefit can be gained by water bill customers for disconnecting their property from mains drainage. For Thames Water domestic customers who can demonstrate that are completely disconnected from the local surface water drainage system, there is a discount available on the sewerage element of the water bill of approximately 5%. It appears that this provision is little known amongst water customers and take-up in London is minimal. A significant issue is that in a densely built-up city like London, it is generally challenging for many sites to be able to store, infiltrate or use all of the rainfall that falls on the site during a heavy storm. In such a case, there will be some discharge of rainwater to the surface water system. There is no proportional incentive for a partial disconnection from the drainage system.

During 2015, the Government undertook a consultation on the Charging Guidance for OFWAT (Defra 2015). This considered the whole charging regime for water supply and wastewater, as well as for surface water. The consultation recognised the need to manage surface water more sustainably and supported the idea of cost-reflective charging to incentive this. However, it also recognised that some premises with low rateable values, high public benefit, and/or large buildings could be adversely impacted by a charging system that is based on the area drained, including community halls, places of worship, schools and hospitals. Further work is clearly needed and there should be a mechanism available to cushion the impact on such premises, whilst incentivising commercial premises to install more sustainable drainage and achieving an overall cost-neutral change to charging.

International experience suggests that for the retail and commercial sectors in particular, the use of such financial incentives can be very effective. The downspout disconnection programmes of Portland and Philadelphia (US) and Toronto (Canada) suggest that significant investment in sustainable drainage can be justified once the bill payer is faced with significantly higher charges to discharge rainwater.

Philadelphia, for example, introduced a new drainage fee based on the surface area of a building or area of land. This means that any property with a large surface area, such as a supermarket, that drained to the local drainage system would be faced with a significant additional charge. For such cases, this approach has made it more viable to invest in sustainable drainage techniques.

Other public policy/regulatory interventions may also have implications for the management of surface water. For example, there is anecdotal evidence that the increasing use of parking restrictions and Controlled Parking Zones, combined with increases in vehicle ownership, may have led to increased numbers of front gardens being paved over. A review of wider public policy interventions is warranted to consider whether there are any indirect methods of encouraging more sustainable drainage in future, or whether existing policies are unintentionally reducing the take-up of sustainable drainage techniques. This will be considered as part of future reviews of this Action Plan.

There is also likely to be an increasing role for the non-governmental sector in promoting and encouraging the use of sustainable drainage techniques. This is expected to increase over the lifetime of this Action Plan, as the issues become more widely understood and accepted. Similarly, it is an aim of the Action Plan to ensure that future projects funded by the GLA Group will check for the inclusion of measures to make drainage systems more sustainable.

Table 28: Funding Actions

No	Action	Lead Organisation	Partners	Timescale
39	Examine methods of encouraging more sustainable drainage take-up through adjusting Water Bill Incentives	GLA	TW EA	2015 onwards
40	Lobby for sustainable drainage to be included in project funding criteria	GLA Group	TW	2016-2020

Monitoring

This Action Plan sets out an ambitious series of actions to address a topic that is not widely understood or promoted. Achieving meaningful results will be challenging and it will take several years to demonstrate real progress. It is therefore important that regular monitoring and reporting of progress is undertaken and the GLA commits to producing an annual update on each of the Actions. If necessary, the strategy will be updated in line with the results of the annual monitoring, with actions amended or new actions introduced.

Table 29: Monitoring Actions

No.	Action	Lead Organisation	Partners	Timescale
41	Produce an Annual Monitoring Report	GLA		2016 onwards
42	Determine appropriate monitoring methodology and baseline position to measure progress against the Target of a 1% per year reduction in flows in the sewerage system	TW	GLA EA	2016

APPENDIX 1: Action Plan by Year

This table shows the same actions already detailed by Sector above, but breaks actions down by year.

No.	Action	Lead Organisation	Partners	Timescale
Current/on-going actions				
1	Publish the results of the London-wide Sustainable Drainage Opportunity Model	GLA	TW EA LC	2015
2	Compilation of evidence on the full range of benefits of sustainable drainage	CIRIA		BeST published 2015 Sustainable Drainage Guidance to be published shortly
4	Maintain a strong London Plan policy lead supporting sustainable drainage	GLA		On-going
5	Produce updated National SUDS Manual	CIRIA		2015
6	Provide strategic guidance on sustainable drainage requirements for London Plan Opportunity Areas	GLA	Partner LBs TW EA	On-going
7	Provide detailed Integrated Water Management Plans for specific Opportunity Areas	Development partners	GLA EA TW LBs	On-going

No.	Action	Lead Organisation	Partners	Timescale
16	Establish future plans for transport improvement, repair and new transport projects, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	TfL LU DLR London Overground	On-going
37	Implement at least 5 Green SuDS trial retrofits of sustainable drainage measures	GLA TW EA		2013-2016
39	Examine methods of encouraging more sustainable drainage take-up through adjusting Water Bill Incentives	GLA	TW EA	2015 onwards
2015				
3	Deliver a programme of sustainable drainage projects through the “Twenty4twenty” initiative	TW	LBs	2015 - 2020
15	Prepare a standard for retrofitting green infrastructure	LU		2015
2016				
8	Produce guidance and good practice examples of sustainable drainage applicable to the education sector	GLA	TW EA	2016

No.	Action	Lead Organisation	Partners	Timescale
9	Establish school/education authority development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Local authority education depts.	2016
10	Establish higher education providers' development proposals, as well as capital and revenue investment programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Higher education providers	2016
12	Produce guidance and good practice examples of sustainable drainage applicable to the housing sector	GLA	TW EA	2016
13	Establish future plans for housing improvement and repair across London, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Housing associations LA housing depts. GLA Re:New	2016
14	Produce guidance that includes good practice examples of sustainable drainage in the streetscape public realm	TfL	GLA TW EA LoDEG	2016

No.	Action	Lead Organisation	Partners	Timescale
17	Establish highway authorities' future capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Highways authorities Highways Agency	2016
18	Produce guidance and good practice examples of sustainable drainage applicable to the health sector	GLA	EA TW	2016
19	Establish future NHS hospital development proposals as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	NHS Trusts	2016 -18
31	Establish Thames Water's development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	TW	GLA	2016
34	Establish the Environment Agency's capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	EA	GLA	2016

No.	Action	Lead Organisation	Partners	Timescale
36	Produce guidance and good practice examples of sustainable drainage applicable to the individual homes, small apartment blocks or local neighbourhoods	GLA		2016
38	Consider a grant/incentive scheme to encourage individuals or local communities to implement their own sustainable drainage scheme	GLA		2016
40	Lobby for sustainable drainage to be included in project funding criteria	GLA Group	TW	2016-2020
41	Produce an Annual Monitoring Report	GLA		2016 onwards
42	Determine appropriate monitoring methodology and baseline position to measure progress against the Target of a 1% per year reduction in flows in the sewerage system	TW	GLA EA	2016
2017				
11	Establish private sector education providers' development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Private sector education providers	2017

No.	Action	Lead Organisation	Partners	Timescale
21	Produce guidance and good practice examples of sustainable drainage applicable to the retail sector	GLA	TW EA	2017
22	Establish supermarket development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Supermarkets LBs	2017
23	Establish DIY and other large format retailers' proposals for capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	DIY stores and other large format stores LBs	2017
24	Establish retail estate owners' capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Retail estate owners	2017
25	Produce guidance and good practice examples of sustainable drainage applicable to the open space/recreational sector	GLA		2017

No.	Action	Lead Organisation	Partners	Timescale
26	Establish scope of future open space improvement and maintenance proposals, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Royal Parks Corporation of London Lee Valley Regional Park Authority London Boroughs Major sports /stadia owners	2017
30	Produce guidance and good practice examples of sustainable drainage applicable to the industrial sector	GLA		2017
2018				
20	Establish private sector health providers' (possibly including care homes) capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Health providers	2018 onwards
27	Examine local authority development proposals, capital and revenue programmes for sustainable drainage opportunities	GLA	LBs	2018

No.	Action	Lead Organisation	Partners	Timescale
28	Establish central government departmental and Quango proposals for capital and revenue investment programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Central Government depts.	2018
29	Establish major office owners' and occupiers' development proposals, as well as capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Major office owners/ occupiers	2018
32	Establish power companies' proposals for capital and revenue investment programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Utilities companies	2018
2019				
33	Establish telecoms providers' capital and revenue programmes, and identify opportunities for simultaneous sustainable drainage retrofit	GLA	Telecoms companies	2019
2020				

No.	Action	Lead Organisation	Partners	Timescale
35	Investigate opportunities for agricultural sustainable drainage/flood risk management measures to be implemented	GLA	Farming representatives	2020

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Chinese
如果需要您母語版本的此文件，
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Hindi
यदि आप इस दस्तावेज की प्रति अपनी भाषा में चाहते हैं, तो कृपया निम्नलिखित नंबर पर फोन करें अथवा नीचे दिये गये पते पर संपर्क करें

Vietnamese
Nếu bạn muốn có văn bản tài liệu này bằng ngôn ngữ của mình, hãy liên hệ theo số điện thoại hoặc địa chỉ dưới đây.

Bengali
আপনি যদি আপনার ভাষায় এই দলিলের প্রতিলিপি (কপি) চান, তা হলে নীচের ফোন্ নম্বরে বা ঠিকানায় অনুগ্রহ করে যোগাযোগ করুন।

Greek
Αν θέλετε να αποκτήσετε αντίγραφο του παρόντος εγγράφου στη δική σας γλώσσα, παρακαλείστε να επικοινωνήσετε τηλεφωνικά στον αριθμό αυτό ή ταχυδρομικά στην παρακάτω διεύθυνση.

Urdu
اگر آپ اِس دستاویز کی نقل اپنی زبان میں چاھتے ھیں، تو براہ کرم نیچے دئے گئے نمبر پر فون کریں یا دیئے گئے پتے پر رابطہ کریں

Turkish
Bu belgenin kendi dilinizde hazırlanmış bir nüshasını edinmek için, lütfen aşağıdaki telefon numarasını arayınız veya adrese başvurunuz.

Arabic
إذا أردت نسخة من هذه الوثيقة بلغتك، يرجى الاتصال برقم الهاتف أو مراسلة العنوان أدناه

Punjabi
ਜੇ ਤੁਹਾਨੂੰ ਇਸ ਦਸਤਾਵੇਜ਼ ਦੀ ਕਾਪੀ ਤੁਹਾਡੀ ਆਪਣੀ ਭਾਸ਼ਾ ਵਿਚ ਚਾਹੀਦੀ ਹੈ, ਤਾਂ ਹੇਠ ਲਿਖੇ ਨੰਬਰ 'ਤੇ ਫ਼ੋਨ ਕਰੋ ਜਾਂ ਹੇਠ ਲਿਖੇ ਪਤੇ 'ਤੇ ਰਾਬਤਾ ਕਰੋ:

Gujarati
જો તમને આ દસ્તાવેજની નકલ તમારી ભાષામાં જોઇતી હોય તો, કૃપા કરી આપેલ નંબર ઉપર ફોન કરો અથવા નીચેના સરનામે સંપર્ક સાધો.