CLEVER Cities

CLEVER Cities CiBiX Workshop London

Summary Report

Exploring the potential of a nature-based solutions-centric non-potable water network for Thamesmead

May 2021

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This document has been prepared in the framework of the European project CLEVER Cities. This project has received funding from the European Union's Horizon 2020 innovation action programme under grant agreement no. 776604.

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1. Introduction

Water stress is a rising challenge for the Greater London area as the gap between supply and demand widens. Rising water demand, aging infrastructure and the increased likelihood of droughts and storm surges due to climate change are increasingly compromising Greater London's water security. Maximizing the reuse of water by increasing the collection and use of non-potable water could empower local districts to find innovative solutions and have a more impactful role in managing their water resources. Hence, developing a non-potable water supply network at the neighborhood-scale can help improve the overall resilience of the city's water system.

This approach holds potential in Thamesmead, a district in Southeast London. The current transformation of this residential district is expected to deliver a considerable number of new homes and job opportunities. Originally designed for land drainage and recreation, Thamesmead's central canal network is currently under-used and suffers from water quality issues. Investment in a non-potable water system offers promising opportunities to not only serve new development but to also improve the state of the canal network. Thereby, the Greater London Authority (GLA) seeks to go beyond traditional, grey infrastructure measures. Specifically, the GLA is interested in the feasibility of implementing a non-potable water system that is centered on nature-based solutions.

2. CLEVER CiBiX Workshop for London

As part of the CiBiX workshop series for CLEVER Cities, ICLEI and the GLA hosted a virtual roundtable titled "***Exploring the potential of an NBS-centric non-potable water network for Thamesmead***" on 30 March 2020. The roundtable brought together 20 participants encompassing representatives from local and national government agencies, Thamesmead's public housing developer, private water companies, New Appointment and Variations water companies, multi-disciplinary consultancies, academia and environmental NGOs.

The GLA wanted to investigate whether a non-potable water network that integrates a nature-based solutions approach would be a realistic project to implement in Thamesmead. More specifically, they were interested in uncovering the technical, regulatory and practical challenges, potential barriers to delivery and the measures to unblock these.

To this end, participants were provided with background information on London's Integrated Water Management Strategy and the opportunities identified for the district of Thamesmead. In addition, a detailed account of the current state and foreseen development activities for the district, as well as information on the canal network and the adjacent sewage treatment works were provided. This was followed by a moderated discussion along a series of questions that would help identify feasibility, capacity and deliverability, whilst considering funding sources. The workshop was concluded with a brief summary and outline of next steps.

This CiBiX outcome report presents a summary of and learnings from the roundtable as well as further input received via email following the roundtable discussion.

About

CLEVER Cities

The CLEVER Cities project uses NBS to address urban challenges and promote social inclusion in cities across Europe, South America and China. Through its city-centric approach, the project aims to tackle the challenges of urban regeneration and foster sustainable and socially inclusive urban renewal both locally, in Europe, and globally. Within the project, three front runner European cities: Hamburg (Germany), London (UK) and Milan (Italy) are making nature-based interventions in key districts of their cities.

CiBiX workshop series for CLEVER Cities

CiBiX – City Business Accelerator – ICLEI's service model for city-business collaboration, supports early-engagement collaboration between cities and businesses to explore opportunities and overcome challenges on NBS investment and implementation. Additionally, this exchange enhances the participation of the business sector, as part of stakeholder interaction in the development and implementation of the CLEVER Cities project.

Image: Paul Upward

3. Setting the scene

3.1. London's Integrated Water Management Strategy & Water Reuse Opportunities for Thamesmead

The southeast of England is already classified as seriously water stressed. The Mayor's London Environment Strategy calls for more action on demand management measures alongside new strategic water resource development. Water reuse at a range of scales from the building, development or even catchment scale must form a greater part of the solution. Strengthened policies in the draft New London Plan aim to drive and mainstream the inclusion of reuse systems in new development and the London City Resilience Strategy includes actions, which specifically reference the role of reuse systems in contributing to water resilience.

To this end, London's 2017 Integrated Water Management Strategy (IWMS) identified a range of opportunities around water and specifically the potential of a non-potable water reuse scheme for Thamesmead. It has partly been classified as such for three reasons:

- Thamesmead is situated in close proximity to one of London's major strategic treatment works and constitutes a Mayoral Opportunity Area that will see a significant amount of growth;
- It encompasses a unique surface water canal drainage system, which runs through large parts of the area connecting various sub-sections of Thamesmead;
- It is not situated within the London ring main (distribution loop) and will therefore likely require a reinforcement of its existing water supply network along with its expansion plans.

According to the IWMS, an increase in water demand of 3,045 Ml/yr is anticipated for Thamesmead and the adjacent Abbey Wood growth area, 500-600 Ml/yr (i.e. 19%) of which are assumed to be required for non-potable water usage.

Instead of simply turning to conventional, grey infrastructure, however, the GLA is interested in exploring whether blue-green infrastructure elements – referred to as nature-based solutions (NBS) – could constitute at least part of the solution due to their wider benefits in terms of amenity, recreation, water quality and ecology. In addition, the GLA views it as an opportunity to pilot a number of NBS and in this case specifically looking at different wetland treatment options.

The NBS-centric concept proposed by the GLA foresees taking some of the treated effluent from the sewage treatment works, returning it back inland, treating it further through the use of NBS and finally discharging it into the canal network for distribution as a non-potable water resource.

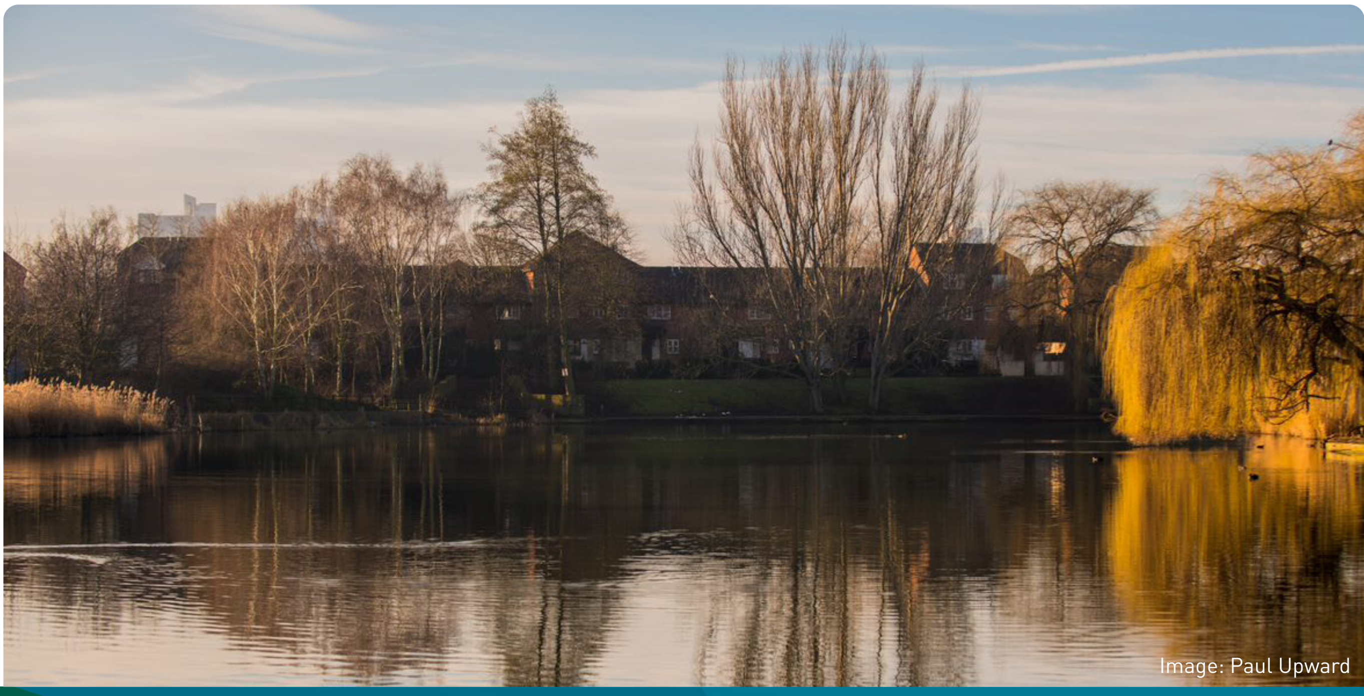


Image: Paul Upward

CLEVER Cities

3. Setting the scene

3.2. Thamesmead: From "New Town" to "Whole Place Approach"-based Regeneration

Situated on the River Thames to the southeast of central London, Thamesmead was built in the 1960s by the then-existing Greater London Council (GLC) as a New Town to address the city's emerging housing shortage. Initially imagined as the "town of tomorrow", its design is based on the modernist concrete architectural ideals of the time: Concrete terraces and blocks of flats combined with elevated walkways. Over the years, additional housing and infrastructure elements were added resulting in what is now an area of 7.5 km^2 housing 45,000 inhabitants.

65% of the land and 5,200 of the 16,000 households are owned by Peabody, one of London's oldest housing charities, which acquired the Thamesmead housing estate in 2014. Peabody has made a long-term commitment to Thamesmead and is devoted to revitalizing the area, which has suffered from urban decay with its elevated walkways perceived as unsafe to walk and its concrete buildings deemed outdated and unattractive. In order to realize Thamesmead's full potential, Peabody has embarked on a 30-year journey that will not only deliver improvements to existing residential and commercial properties but also see the development of 20,000 new homes and other urban infrastructure required for new developments.

Instead of merely focusing on its core development activities, Peabody is taking a "whole place approach" that aims at, amongst others, enhancing the quality and use of its natural assets. To this end, Peabody has outlined a Green & Blue Infrastructure Strategy for the neighbourhood. While Thamesmead is already home to an extensive network of green and blue assets – 150 hectares of publicly-accessible greenspace spanning five neighbourhood parks, 53 hectares of woodland, 5 kilometres of Thames waterfront as well as a system of lakes and canals – many of these are at present in a degraded state and under-utilized. With respect to its blue infrastructure, it is mainly used for angling by a number of fishing clubs. Overall, Peabody envisions for the man-made canals and lakes to provide rich wild habitat for species and to become an attractive space for various types of outdoor recreation, such as kayaking and swimming.

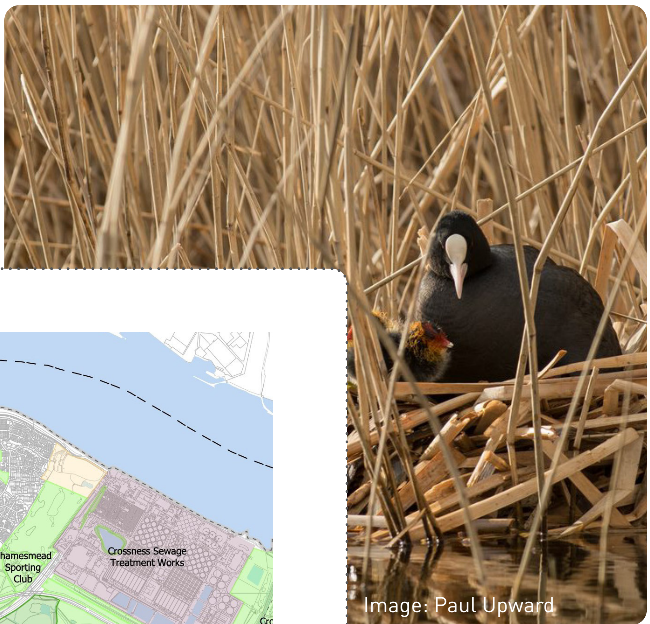
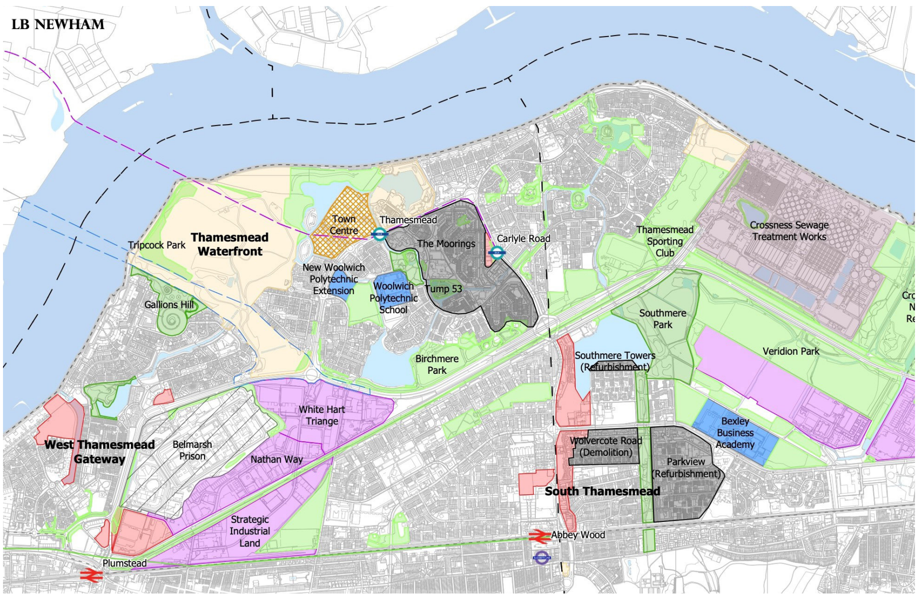


Image: Paul Upward



Thamesmead spatial plan. Image: Peabody/David Lock Associates

3. Setting the scene

3.3. Thamesmead's Lake and Canal System

Thamesmead was built on low-lying marshland. Five lakes and a system of canals made from pre-fabricated concrete were devised to drain the marsh. In total, the man-made water body makes up an area of 32 hectares. Seven kilometres long, the canal network constitutes London's largest sustainable urban drainage system oftentimes spanning 6-7 meters across with a depth of less than a meter. As such, it offers a substantial amount of capacity to deal with significant stormwater events.

Water in the Thamesmead canal network comes from a number of sources, namely the general landscape, roofs, roads as well as from plumbing misconnections that channel wastewater directly into the canal network. Apart from the latter, rainwater flow creates the only hydraulic gradient in the otherwise flat and bathtub-like water body. It is assumed that the water currently discharges via gravity for half of the time and that it needs to be pumped the other half of the time. However, climate change and the associated increase in stormwater events will result in a greater need for pumping as intense rainfall entering the canal system will need to be pumped into the Thames at higher tide levels.

Thamesmead's lake and canal system's water quality and ecological state are fairly poor. It suffers from a high level of siltation due to the very low flow rate: As debris and vegetation drop into the canal network, they simply tend to settle resulting in a build up of methane and other gases. In addition, seasonal flash floods result in large amounts of nitrate and phosphate entering the system which in turn cause algal bloom, and the growth of blue-green algae in particular. It is anticipated that the proposed concept would be able to help address the siltation and water quality issues through the introduction of a steady reliable inflow of water into the canal.

Image: Paul Upward

3. Setting the scene

3.4. Crossness Sewage Treatment Works

Owned and operated by Thames Water, Crossness Sewage Treatment Works is one of London's major strategic water treatment facilities spread across 70 hectares of land with a daily treated sewage effluent discharge capacity of 500 Ml. It is situated on the south bank of the Thames to the east of the main development area of Thamesmead.

The sewage treatment works encompass a separate discharge system for stormwater and final effluent. Built back in 1865, however, they only perform very rudimentary treatment services due to their basic technology base. Consequently, neither tertiary treatment nor phosphorous removal are undertaken on the final effluent.

4. Challenge definition

The proposed NBS-centric concept for a water reuse scheme for Thamesmead poses a number of questions requiring careful deliberation. In particular, the GLA was interested in exploring the technical and regulatory feasibility of the proposed solution and viable financial mechanisms. Questions that were raised and discussed included the following:

- Is it possible to redirect a small portion of the treated sewage effluent discharge towards Thamesmead (because the full volumetric discharge of Crossness is very large)?
- Can the flow of the treated sewage effluent be flexible to allow for any seasonal variations (increased rainfall, algal bloom, maintenance, etc.)?
- Can NBS alone treat the treated sewage effluent to the standard required to discharge into the Thamesmead canal network?
- Is there sufficient space available for the type of NBS treatment requirement?
- Are there additional opportunities within the Thamesmead catchment to help improve the canals' water quality through NBS?
- Could catchment permitting be a potential option here?
- Has Thames Water invested in NBS approaches for water management and treatment before? What was the financing process?
- What information is needed to demonstrate economic feasibility using a future perspective?
- Which stakeholders would be needed to focus in depth on financing needs if another workshop were held?


Image: Paul Upward

5. Barrier identification and potential solutions

5.1. Technical feasibility

The discussion on the technical feasibility centered around the requirements in terms of grey infrastructure upgrades, effluent treatment and the type and size of NBS-interventions, as outlined below in line with the steps of the proposed solution.

5.1.1. Re-directing treated effluent towards Thamesmead's lake and canal system

In terms of re-directing some of Crossness' treated effluent discharge into Thamesmead, it was pointed out that there would likely be a pumping requirement. At present, all treated effluent is immediately discharged into the Thames estuary. However, the treated effluent would need to be lifted at Crossness in order to channel it into the lake and canal system. The proposed concept foresees the introduction of a steady flow of Crossness' treated effluent into the system. While it would constitute only a small fraction thereof, it would be important to understand whether the network would be able to cope with the additional inflow during periods of increased rainfall and particularly at high tide. From a volumetric perspective, it was noted that there should be no storage capacity constraints due to the considerable size of the conveying channels and the system's low-lying and bathtub-like properties. However, all of this could be modelled once the volume of the anticipated inflow was determined. In addition, it was noted that it would always be possible to turn off the incoming flow if deemed necessary.

In addition, participants discussed the ecological implications of introducing treated effluent into the water body. Not only is the treated effluent considerably warmer (≥15°C) compared to the water in the lake and canal system, its nutrient load is also considerably higher – both of which would need to be addressed to prevent an aggravation of existing water quality issues as well as from a permitting perspective.

With respect to the temperature, channeling the discharge into a wetland prior to having it enter the lake and canal system could constitute a viable solution. Alternatively, it was suggested to consider running the final effluent through a heat exchanger, using waste heat, which could simultaneously provide an alternative energy source.

With respect to the nutrient load, participants stressed the importance of gaining a better understanding of


Image: Paul Upward

5. Barrier identification and potential solutions

the concentration. At present, there is no tertiary treatment and no requirement to remove or even measure the phosphorous levels of Crossness' final effluent prior to discharging it into the Thames estuary due to the massive size of the receiving water body. It would be crucial to measure these in order to understand the extent to which further treatment is required. This would, in turn, have implications on the type of solution necessary to achieve the required nutrient load standard.

5.1.2. Using nature-based solutions for treatment

In order to determine the feasibility of using nature-based solutions for tertiary treatment, participants emphasized that it would be crucial to understand not only the current nutrient concentration but also the anticipated water demand in terms of volume and type of usage (e.g. for agricultural, residential or industrial purposes). While channeling the treated effluent through a wetland would indeed help address some of the temperature and nutrient concentration issues, participants pointed out that the volume and type of usage would essentially determine whether the NBS would be able to achieve a suitable water quality. In addition, it would dictate the size of the wetland and thus determine whether sufficient space was available in Thamesmead.

Next to the creation of a wetland for pre-treatment, it was suggested to explore in-channel wetland treatment as an additional measure. This could be part of wider canal naturalization efforts, thus providing further benefits in terms of amenity.

In addition to solely looking at NBS for the treatment of final effluent, participants recommended to also look at NBS for helping to resolve some of the other pollution sources identified around the catchment. NBS features could, for example, be installed along the highway to capture plant debris and remove pollutants from stormwater events. Indeed, part of the wider development strategy for Thamesmead envisages the integration of various types of NBS such as green roofs in order to further decentralize rainwater management and address the lake and canal system's water quality issues.

When deciding between different NBS features, the GLA was cautioned to investigate any potential adverse

Image: Paul Upward

5. Barrier identification and potential solutions

impacts on the water quality prior to installment. For example, it was pointed out that some NBS media are capable of increasing pH-levels and leeching metals under certain conditions.

5.1.3. Providing treated effluent as a non-potable water resource

The final step of the proposed concept foresees the provision of treated effluent as a non-potable water resource for Thamesmead's new development area. In order to determine the infrastructure and treatment procedures required for onward distribution and abstraction, participants again stressed the importance of gaining a better understanding of the demand characteristics.

With respect to the required infrastructure upgrades, it is assumed that there would be no pumping requirement for moving the water around the canal network due to the hydraulic gradient. However, pipework would need to be installed to transport the non-potable water to its end users. The respective demand and location of end users would influence the amount of pipework and number of abstraction points needed to serve them. For example, it was pointed out that it would only be feasible to have a single point of abstraction, and thus a single final disinfection system, if the non-potable water supply were to primarily serve one large user. If it were to serve users in multiple locations, however, it would probably be more cost-effective to install a number of abstraction points instead of installing additional pipework to transport the disinfected water onward, particularly as not all users may require the same level of disinfection to meet their non-potable water needs.

5.2. Regulatory considerations

From a regulatory perspective, participants agreed that permitting would constitute the biggest barrier that would need to be overcome in order to render the proposed concept feasible.
At present, Thames Water's environmental permit for its Crossness Sewage Treatment Works allows them to discharge a specified amount of final effluent at a pre-defined quality into the Thames estuary. Operationalizing the proposed concept, however, would not only necessitate modifying its existing permit, it would also require obtaining a permit for a new discharge into the lake and canal system. While the former should not pose much of an issue, participants stressed that sending final effluent to a new location, and in particular to a Water Framework Directive water body already grappling with water quality issues, would require a lot of engagement with the UK Environment Agency.

Moving from the traditional environmental permit scheme to catchment-based permitting was put forward as a promising solution. Instead of having to meet a certain water quality level at the point of discharge into the lake and canal system, catchment-based permitting would allow for nutrient load variations within the catchment, as long as overall quality targets are met. To this end, the negative impact of discharging final effluent into the water body could potentially be offset, or ideally be exceeded, by the positive impact of tertiary wetland treatment, introducing a steady flow of water and implementing additional NBS for rainwater management (e.g. green roofs and reedbeds along the highway).

In contrast to other sites where catchment-based permitting was put into practice, however, Thamesmead's water body is fairly small in size, with a limited amount of pollution sources. The feasibility of being able to use catchment-based permitting would thus require further investigation.

5.3. Financial mechanisms

Financial resources would need to be identified and unlocked in order to implement the proposed concept, and maintain all measures in the long run. To this end, participants pointed out that it would be crucial to understand who the beneficiaries would be, thereby also looking beyond the users of the non-potable water resource. This would help in quantifying the anticipated social and ecological value of the planned interventions for different user groups. For example, fishing clubs would likely benefit from an improved water quality, and thus improved fishing experience throughout the lake and canal system. Equipped with this type of information, different opportunities could then be explored from setting up a sponsorship association to joining already established programmes such as Thames Water's Smarter Water Catchment approach.

6. Alternative suggestions

Given the various challenges and unknowns of the proposed solution, participants suggested alternative schemes that could additionally be investigated.

The GLA could, for example, explore a rainwater-based non-potable water scheme. Instead of using final effluent, locally-generated rainwater run-off from roofs and roads could be leveraged, using NBS (e.g. green roofs and reedbeds) for treatment and grey infrastructure for storage and onward distribution. Crossness' final effluent could still serve as a back-up in dry weather conditions. This scheme would require less intensive treatment due to the more favorable nutrient concentration of rainwater while also helping to reduce the impact of stormwater events on the lake and canal system.

Participants pointed out that treating the final effluent at Crossness and directly supplying it via a dedicated non-potable water network to the new development would likely constitute the most cost-effective and technically-feasible option. Most importantly, this would allow for the highest degree of control.

However, neither of these options would be as comprehensive as the proposed concept in terms of the wider anticipated social and ecological benefits for Thamesmead's lake and canal system.

7. Outcomes and opportunities for further action

To some extent, the CiBiX workshop raised more questions than it was able to answer. It provided the GLA with a first assessment of the feasibility of the proposed concept. Most importantly, however, it equipped the GLA with a list of action items. Specifically, participants recommended to:

- Analyse the composition and concentration of Crossness' treated effluent
- Understand the demand characteristics for a non-potable water resource for Thamesmead's new development
- Investigate the availability of land for wetland construction
- Explore the feasibility of applying for catchment-based permitting
- Identify the potential beneficiaries of the proposed concept in terms of wider social and ecological outcomes

While the work has been paused to focus on Covid-19 recovery efforts, the GLA would be able to integrate the above information to conduct a more thorough analysis. This could encompass looking at various demand scenarios (e.g. few large users vs. many small users; WC flushing vs. garden irrigation) and testing them against a range of treatment options in order to understand the implications on wetland size and pre-treatment requirement.

Image: Paul Upward

Further reference links

Please follow the links below to find out more about:

CLEVER Cities Project – London:
https://clevercities.eu/london

Peabody's Plan for Thamesmead 2018-2023:
www.thamesmeadnow.org.uk/media/3094/peabody-plan.pdf

Thames Water's Water Resources Management Plan (2019):
www.thameswater.co.uk/about-us/regulation/water-resources

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 776604.