

Integrating what and for whom? Financialisation and the Thames Tideway Tunnel

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Abstract

The Thames Tideway Tunnel (TTT), often referred to as the Thames super sewer, is currently one of the largest infrastructure projects underway in any European city. Costing an estimated £4.2 billion, the sewer connects London's Victorian sewerage network with the Thames Wastewater Treatment Works at Beckton. The latter facility has been described as the UK's Water–Energy–Food nexus poster child, for its combination of desalination facilities, green energy generation and wastewater treatment. While physically connected to the Beckton plant, the TTT is, paradoxically, designed with an apparent disregard for the water–energy nexus. If the Beckton plant represents a nexus-based vision of integration – what Macrorie and Marvin (2016) refer to as Mode 2 Urban Integration – the TTT harks back to a view of urban integration carried from the Victorian era through to the present moment. What unites the two projects, and what undergirds the transformation of the hydrosocial cycle, is a financial model more focused on the extraction of rents from Thames Water's consumers. Thames Water's dismissal of genuinely integrated alternatives appears guided more by the financialisation of the urban integrated ideal than by what is needed to respond to London's broader environmental needs. Contesting the project, therefore, will involve slicing through the various claims to integration, going beyond the many proposals for evidence-based alternatives, and capturing the transformations being wrought by finance's entry into infrastructure provision.

Keywords

financialisation, London, rent extraction, urban integration, water infrastructure

摘要

通常被称为泰晤士河超级下水道的泰晤士泰德韦隧道 (TTT) 是目前欧洲最大的城市基础设施项目之一。该下水系统成本预计为 42 亿英镑, 连接了伦敦的维多利亚式污水处理网络和贝克顿的泰晤士污水处理厂。后者的设施将海水淡化设施、绿色能源发电和废水处理相结合, 被称为英国“水-能源-食品”之间联系的代表。TTT 在物理上连接到贝克顿工厂的同时, 在设计中又悖论式地未考虑这种“水-能源”联系。如果说贝克顿工厂代表了以联系为基础的一体化愿景——Macrorie 和 Marvin (2016) 称之为“城市一体化模式二”——, 那么 TTT 代表了从维多利亚时代至今的那种城市一体化模式。将两个项目联接起来、支撑水-社会循环转型的, 是一个更关注从泰晤士水务公司消费者中抽租的金融模式。泰晤士水务公司放弃了真正的一体化方案, 看来所受的引导更多是城市一体化理想的金融化, 而不是应对伦敦更大范围的环境需求。因此, 质疑这一项目, 将涉及梳理各种一体化主张, 超越众多主张而找到基于证据的替代性方案, 并且捕捉到金融进入基础设施供给所带来的变革。

关键词

金融化、伦敦、城市整合、抽租、水利基础设施

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Introduction

London's hydrosocial cycle is undergoing the largest transformation in over a century. Infrastructure has been bundled and unbundled in a range of projects that re-engineer and re-integrate flows of water, wastewater and energy. Thus, in 2012, the first major desalination plant in the UK was constructed at Beckton, just downstream from the Thames Barrage. Then, in January 2016, Mayor Boris Johnson opened the Lee Tunnel, the deepest tunnel ever constructed in London and, at the time, the most ambitious infrastructure project ever embarked on by the privatised water industry in the UK. Far surpassing both of these schemes in scale and ambition is the £4.2 billion plan to construct a 16-mile 'super sewer' underneath the Thames. With a diameter equivalent to the width of three double decker buses, this vast tunnel will transport storm-water runoff and raw sewage from Acton to Abbey Mills, enabling the combined sewage to be carried through the Lee Tunnel to Beckton. Construction began on this super sewer, known officially as the Thames Tideway Tunnel (TTT), in 2016 and is expected to last for 7–8 years.

When viewed through the lens of the Beckton plant, Thames Water – and the infrastructural changes it is pushing through – resembles the multi-utility firms re-emerging in other parts of the world (see Florentin, 2016). In its desalination plant, the utility has therefore addressed concerns around the Water–Energy–Food nexus through ensuring that fats, oils and greases can supply part of the energy needed for the purification of saltwater or even, perhaps in

the future, greywater. Drinking water can, in short, be made from waste. Drawing on Macrorie and Marvin's (2016) typology, the Beckton plant can be interpreted as a site for Thames Water's experiments in Mode 2 Urban Integration (UI) where formerly separate infrastructure types are bundled together through a new vision of the smart utility. However, while physically linked to and dependent on the Beckton plant, the TTT appears to be in sharp contrast, relying more on the Victorian engineering legacy of Joseph Bazalgette, and a heavily criticised model of top-down, infrastructure-heavy responses to complex needs.

Both the nexus style Mode 2 UI at Beckton and the top-down Mode 1 UI in the TTT would not have emerged were it not for the process of financialisation that has profoundly influenced London's hydrosocial cycle (Allen and Pryke, 2013; Loftus and March, 2016). This process mirrors other trends identified by Halbert and Attuyer (2016) around 'the financialisation of urban production' (see other papers in the Special Issue of which Halbert and Attuyer's is a part). We will therefore argue that there is no necessary causal relationship between financialisation and Mode 2 Urban Integration: indeed if finance can guarantee stable revenue streams it is just as likely to favour older visions of UI as it is to favour Mode 2 nexus visions. In slight contrast to Williams et al. (2014), for whom 'the burgeoning popularity of the nexus concept illustrates a broader trend towards the increasing internalisation of environmental externalities into the processes of urbanisation and capital accumulation',

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our argument is that under financialisation the question of environmental externalities is a relatively peripheral concern. While nexus-style arguments may be appropriated to argue in favour of one form of infrastructure over another, the more important consideration for investors is how best to expand the terrain over which rents can be captured. The demand is therefore for more and larger infrastructure rather than for necessarily smarter infrastructure. The arguments for more integrated, smarter alternatives to the TTT have in fact been summarily dismissed in spite of gaining the support of some high-profile individuals, from the former head of OFWAT to the chief project assessor to the TTT. There appears little doubt in our mind that cheaper and better solutions to the TTT exist. That these alternatives have not been pursued appears to be down to the particular manner in which financialisation has rejuvenated an earlier model of Urban Integration and enabled a continuation of the supply side Hydraulic Mission that many thought had collapsed at the end of the 20th century.

We begin by more clearly outlining the different types of urban integration detailed by Macrorie and Marvin (2016) before contextualising the Thames Tideway Tunnel within the various planning decisions that have given rise to it. Next, we look at the integration of Bazalgette's legacy into a programme of Urban Integration that resembles Macrorie and Marvin's Mode 1 Urban Integration. In contrast Mode 2 alternatives, which build on the principles of Integrated Water Resources Management, appear to have been rejected in spite of strong evidence favouring their development. The decision to construct what the Chair of the Public Accounts Committee, Margaret Hodge, describes as 'a great, big, honking tunnel' appears to have been guided more by the needs of finance than by the needs of Londoners and the hydrosocial cycle of which they are a part. We, therefore,

conclude by questioning what is being integrated through the Thames Tideway Tunnel and for whom.¹

Mode 1 and Mode 2 Urban Integration

As demonstrated by the papers in this issue, cities in the Global North and Global South are witnessing a shift towards more integrated solutions to infrastructure provision. Many utilities now work across multiple domains, enabling 'diverse ecological, financial, operational and institutional interactions, overlaps, interdependencies and hybridisations between the different infrastructure domains that shape urban development, environments and metabolism' (Monstadt and Coutard, 2016). This trend can be distinguished from earlier forms of integration represented in 'the modern infrastructural ideal' (Graham and Marvin, 2001). Macrorie and Marvin (2016) refer to the former as Mode 1 UI, a 'dominant ideal of modern planning in the West [which] idealised the concept of the orderly unitary city'.

Such a model of the unitary city was plunged into crisis at the end of the 20th century for a variety of political, cultural and economic reasons, as well as due to changing planning practices, and transformations in the technologies themselves. The splintering urbanism, so brilliantly captured in Graham and Marvin's (2001) work of the same name refers precisely to the break-up of Mode 1 UI. For water and sanitation provision, the implications of this breakdown in the unitary city ideal were many. Demand-side solutions began to replace supply-side solutions as the Hydraulic Mission to keep increasing supplies appeared to falter. Furthermore, privatisation and corporatisation undermined the abilities of municipally owned utilities to provide a coherent service within defined regions.

It might have seemed unlikely, given the splintering of the unitary city ideal, that integration would once again become the guiding maxim for organising cities. Nevertheless, as the papers in this special issue demonstrate, such a return to the integrated ideal has indeed occurred. Integration in the current moment, however, needs to be distinguished from the forms that preceded it. No longer is the unitary city the model for integrated infrastructures, rather integration is guided by the efficiency savings that might be made, and the ecological imperatives that necessitate such a shift. The need for greater resiliency in the face of declining resource availability, as well as the financial gain to be made by using resources more efficiently (Williams et al., 2014), appear to have shaped this most recent shift. Mode 2 UI according to Macrorie and Marvin (2016) clusters around three specific techniques of integration: *nexus*, *systems*, and *agglomeration* all of which can be seen to differ from the Mode 1 integration that preceded it.

When Utility Weekly referred to the Thames Water Desalination Plant – and the attendant green energy generation and wastewater treatment plant – as a poster child for the Water–Energy–Food nexus in the UK, it captures the ability of Thames to move towards such Mode 2 UI through integrating concerns around the nexus (for a lengthier discussion of the plant see Loftus and March, 2016). Thames Water thus appears something of a pioneer in Mode 2 integration; however, while physically connected to the Beckton plant, the TTT, in contrast, appears to run counter to many of the principles guiding the new wave of integration. Whether or not it represents a return to Mode 1 UI or not becomes an interesting question that we explore in greater depth below, before turning to the financial model underlying the Special Purpose Vehicle created to deliver the TTT.

We begin with a brief contextualisation of the TTT in which we consider the various debates surrounding its construction.

The Thames Tideway Tunnel in context

On the surface, the need for the Thames Tideway Tunnel appears obvious. The Victorian sewerage network designed by Joseph Bazalgette is now overburdened. London's population has expanded well beyond Bazalgette's projections, and large storm events frequently trigger overflows at various points along the River Thames when combined flows of storm water and raw sewage spill over a small dam within the sewer at specific points and then enter into the river. These discharges take place at specific points along the Thames and are referred to as Combined Sewer Overflows (CSOs). According to the Department for Environment, Food and Rural Affairs (DEFRA) (2015a) raw sewage discharges occur around 50 to 60 times per year, causing an annual average overflow of 39 million tonnes of untreated wastewater to enter the Thames River in London. With the volume of storm water runoff growing because of an increase in soil sealing – as well as an increase in the frequency and intensity of storm events – many argue that the problem of CSO discharges will become even more serious. The moral, ethical and aesthetic arguments for a cleaner Thames are legion: legislation from the European Union has only added a further financial imperative in that fines will be imposed on the national government if CSOs continue. Summarising these arguments, Thames Water (2012) draws attention to the environmental and public health risk of sewage, to the fines amassed when contravening the EU's Urban Wastewater Treatment Directive. The company goes on to dismiss alternatives as either too expensive or too ineffective.

According to an updated cost-benefit analysis carried out by eftec and commissioned by the Department for Environment, Food and Rural Affairs (DEFRA, 2015a, 2015b; eftec, 2015) the projected benefits from the project will largely exceed the costs (based on a 120-year economic life of the project). While whole life costs are calculated to be around £4.1 billion, the whole life benefits are expected to range between £7.4 and £12.7 billion. These benefits were calculated (in 2006 and updated in 2015) through a 'willingness to pay' of households in the Thames Tideway such as reducing adverse impacts of dissolved oxygen on fish, reduced sewage litter and odour or better health outcomes for river users. The costs include: construction, operation and maintenance costs, as financed by Thames Water customers; the 'expected' value of any contingent support from the exchequer in respect of certain project risks; and traffic congestion and environmental costs during construction (DEFRA, 2015b: 2). Plus, there are, according to DEFRA (2015b: 9), other unquantifiable benefits including reduction in sewer flooding risks, reputational issues, potential difficulties in attracting investment, the protection of habitats and species or employment and regeneration benefits. Among the benefits not included in the cost-benefit analysis (CBA), DEFRA (2015b) talks about removing future development constraints (of some 40,000 homes) linked to sewerage capacity over the next 20 years.

When the problem of CSOs first came to be looked into, a tunnel was, nevertheless, only one of several options being considered. Most of the alternative proposals consisted of smaller changes, often combining upgrades to sewage treatment works with more modest solutions. The full range of options was explored most thoroughly in the *Thames Tideway Strategic Study* (Thames Water, 2005). Initiated in 2001, the study was chaired by the respected engineering

consultant Chris Binnie and brought together Thames Water, the Environment Agency, DEFRA, as well as the Greater London Authority (GLA). OFWAT – the economic regulator for the water sector – participated as an observer. The group's findings, published in 2005, recommended a series of improvements to London's sewerage system. First, it recommended upgrades to five of London's tidal sewage treatment works. Second, it recommended constructing the Lee Tunnel to avoid the worst CSO. Finally, the group recommended construction of the Thames Tideway Tunnel (TTT).

Although published in 2005, little progress was made on the TTT until November 2011 when the Abbey Mills route was finally released for public consultation. Then, in February 2013, a full planning application was submitted. Based on the recommendations of the planning inspectorate (although overriding some of its concerns) the UK government approved plans for the TTT on 12 September 2014.

If the need for a solution to CSOs is clear, it is less obvious why alternatives to the TTT – alternatives that might provide more integrated responses to the needs of London – have been so summarily dismissed, in spite of growing criticisms of the scale, risks and cost of the project. Most of the research into alternatives was carried out as part of the earlier *Thames Tideway Strategic Study*, which recommended for the TTT, so it comes as something of a surprise to find that the author of the study – Chris Binnie – is now one of the more high-profile critics of the tunnel. In something of a Damascene conversion, Binnie claims that the arguments he and others had put forward for the tunnel are now redundant: the steps already taken by Thames Water enabled the worst cases of CSO discharge to be avoided. Increasing the capacity at existing sewage treatment works, as well as increasing the capacity within the network through constructing the Lee

Tunnel, has reduced discharges to much lower levels than expected. According to Binnie, the River Thames now meets the most stringent criteria of the EU Wastewater Framework Directive. Binnie has gone on to brand the TTT ‘a stupendous waste of taxpayer’s money’ before stating ‘I do not know why there is such a bandwagon rolling’ (Griffiths, 2014). Such fierce invective from one of the scheme’s original supporters is surprising; however, Binnie insists that the original modelling used in the 2005 *Thames Tideway Strategic Study* was incorrect and that the decision to push ahead with the tunnel is therefore based on erroneous data (Gayle and Taylor, 2016): ‘There is doubt about quite a lot of the quoted spill frequencies. I don’t believe the model is robust, nor do the people who actually verified the model’. Significantly, in his own 2014 rebuttal of the case for the tunnel, Binnie (2014: 11) notes that the original cost-benefit analysis (CBA) produced in favour of the tunnel included the Lee Tunnel. Given that this tunnel has now been completed it seems wrong to ascribe the benefits to the TTT. At the cost of £0.6 billion as opposed to the £4.2 billion forecast cost for the TTT it does seem like the Lee Tunnel may well have been something of a bargain.

Binnie is only one of several high-profile critics of the TTT ‘bandwagon’. Thus, the chair of the Public Accounts Committee in the House of Commons, Margaret Hodge, characterised the project in a similar manner, claiming it to be ‘a big vanity infrastructure project’ (Committee of Public Accounts, House of Commons (CPA HC), 2014: 13, Q109) and a ‘gold-plated solution that will lumber London water tax payers with a £80-a-year extra bill’ (CPA HC, 2014: 12, Q106). Hodge later added: ‘I haven’t a clue – apart from it being a great big infrastructure project – why on earth we are going ahead with it’ (CPA HC, 2014: 13, Q106). Indeed ‘[T]here are other options around that are

much cheaper and that could be done in a more incremental way than a great, big, honking tunnel’ (CPA HC, 2014: 13, Q114).

Some of these criticisms are not new and, as far back as 2006, a report commissioned by OFWAT and undertaken by the consultancy Jacobs Babtie (2016) also rejected the heavy infrastructure solution in favour of a range of less ambitious but no less effective measures.

Even if we are convinced that there could be cheaper and better alternatives to the TTT our intention is not to adjudicate on the different sides to this debate. Instead, what is of greater interest to us are the forms of urban integration found within the TTT project and the broader re-engineering of the hydrosocial cycle in London. Furthermore, we are interested in the conditions of possibility for the TTT, which appear to lie in the novel financing mechanisms developed by a Special Purpose Vehicle (SPV) now responsible for delivering and operating the tunnel. As in the case of the Thames Water Desalination Plant, the financialisation of household water (Allen and Pryke, 2013) makes possible – indeed appears to positively encourage – the construction of large infrastructure projects whether they are needed or not. Both a rejuvenation of forms of Mode 1 Urban Integration and forms of Mode 2 Urban Integration are made possible through the process of financialisation being witnessed in London. When combined with nostalgia for the engineering achievements of the Victorian era, with particular regard for Bazalgette’s heroic constructions, we, therefore, witness the birth of a financialised infrastructural ideal.

The neo-Victorian hydraulic mission: Reinventing Mode I Urban Integration

Behind the rationale of the TTT there are recurrent appeals to the work done by

Bazalgette in the mid 19th century against the backdrop of the ‘Great Stink’ of 1858. Bazalgette’s massive plan to build a sewer network system could be framed as an early example of the modern infrastructural ideal or the Mode 1 UI that characterised 20th century water supply and sanitation in the Global North and in some parts of the Global South.

Many commentators, politicians and engineers have enthusiastically likened the current infrastructural ambition of Thames Water and the TTT to the high-points of the Victorian era. Thus, Stephen Halliday, a historian of Bazalgette’s mid 19th century sewer works argues that the TTT is ‘a necessary extension to the legacy of the Victorians ... (Halliday, 2013). The Thames Tideway Tunnel will be our generation’s legacy to our great-great-grandchildren, just as Bazalgette’s sewers were his legacy to our generation’ (Tideway, 2016). Boris Johnson, former mayor of London, on opening the Lee Tunnel, commented: ‘The Victorians were very ambitious – our generation should be similarly ambitious’. And in a move clearly intended to evoke comparisons with the ambitions of the Victorians, the Infrastructure Provider licensed by OFWAT to construct the Thames Tideway Tunnel has taken the name Bazalgette Tunnel Ltd. Without any irony, the magazine *WaterWorld* (Smith, 2017) simultaneously labelled the former head of Thames Water, Martin Baggs, ‘a modern day Bazalgette’. Where Joseph Bazalgette integrated stormwater and raw sewage networks, thereby freeing up space for a tube network and new public spaces, so Bazalgette Tunnel Ltd and Thames Water appear to be emulating his vision.

Although Thames Water’s broader neo-Victorian vision is often cloaked in claims to be emulating the ambition of the Victorians, the new tunnel is, nevertheless, remarkably unambitious in the range of problems it seeks to address, and it is not too difficult to see through some of the more sweeping

claims around its supposed benefits. While on the surface appearing to integrate various needs of the city and aiming to tackle ecological issues in the River Thames (Tideway, 2016), the TTT fails on numerous fronts to *genuinely* integrate socio-ecological concerns, tackling only one type of pollution through one already outdated infrastructural solution. By failing to address other aspects of the hydrosocial cycle and of the broader water–energy nexus, the tunnel undermines its own credentials. If, as it sometimes appears, the combination of neo-Victorian hubris and financialised infrastructure has trumped the nexus claims made around the Beckton wastewater treatment works, the failure to think through the implications of the water–energy nexus could ultimately bring about the TTT’s downfall. Indeed, the degree to which energy generation at Beckton can keep up with the demands of such large-scale schemes is far from certain.

The dismissal of Mode 2 Integrated Alternatives: IWRM

A fundamentally different vision of integration – one more akin to Macrorie and Marvin’s Mode 2 UI – has been promoted by a coalition of environmentalists, engineers, consultants, politicians and grassroots activists seeking to contest some of the more fanciful claims surrounding the tunnel (TBGE, 2016). The proposals from this coalition are not intended to evoke awe but rather to integrate solutions to a range of different needs and to do so from the bottom up. Central to this more modest vision of integration is an understanding of Integrated Water Resources Management (IWRM) as a necessary solution to the problem of London’s overburdened sewerage network.

The most vocal criticism of the project has come from those advocating for a blue-green

alternative to the infrastructure heavy, engineering-led approach.² Critics have focused on: the environmental implications of the project (Green, 2014); its huge cost (among them, the future energy costs of running the tunnel) (Bell, 2013; Binnie, 2014); the conflict of interest between Bazalgette Tunnel Ltd and Thames Water; the lack of competition during the bidding process; and the morally ambiguous economic model established by Thames Water (Blaiklock, 2013). These critiques reveal the different visions of interconnected infrastructures and sustainable futures as found in both the top-heavy TTT version and the more decentralised vision proposed by advocates of IWRM (Green, 2014). Perhaps the main criticism of the TTT is that it is a Victorian solution to a 21st century problem or ‘an outdated and expensive folly’ as the Thames Blue Green Economy Group refers to it (Ashley, 2014; TBGE, 2016; Water Briefing, 2016). Using Macrorie and Marvin’s conceptualisation of urban integration, Mode 1 UI has been favoured over the development of Mode 2 UI.

The problem of London’s overflowing sewerage network is less a result of increased volumes of raw sewage and has much more to do with the inability of the combined sewer network to cope with increased runoff. The problem, in short, is too much rainwater and not too much sewage (Ashley, 2014). In another refutation of the argument for the TTT, the respected water economist and former Director General of OFWAT, Ian Byatt (2013), argues that the problem lies with Thames Water’s failure to invest in the existing sewerage network leading to groundwater inundation of the existing network.

Even if Thames Water’s diagnosis of CSOs is valid, the degree to which the tunnel will address the problem is questionable, as argued most emphatically by those proposing Sustainable Drainage Systems (SuDS). Bell (2013: 90) summarises SuDS as systems

that ‘aim to manage surface water where it falls, and to store water locally, rather than discharging immediately to sewers and the environment’. Although still regarded as something of a naïve response at the time of the *Thames Tideway Strategic Study*, SuDS have subsequently been adopted to great advantage in many cities around the world (Zhou, 2014). Instead of seeking to divert stormwater runoff to the sewers as quickly as possible SuDS maximise the opportunities for stormwater to be absorbed into the ground. Stovin et al. (2013) and Ashley et al. (2011) argue that SuDS present many benefits over conventional drainage systems, including greater resilience to climate change; better water quality; and improvements to the quality of urban spaces and amenities. Runoff can be delayed through a variety of different means including swales, soakaways, rainbutts, and green roofs and walls (Bell, 2013; Stovin et al., 2013). Although never claiming to be against SuDS (indeed it argues that SuDS is ‘essential’ (Thames Water, 2012)), Thames Water’s argument is that such initiatives will never be sufficient to remedy the problem of limited sewer capacity. Instead, it claims that ‘[t]he maximum practical level of retrofit SuDS would take over 30 years to implement and cost several times as much as the Thames Tideway Tunnel. The cost is estimated to be at least £13 billion and would not solve the problem’ (Thames Water, 2012: 19). The most detailed comparison of the likely costs and benefits of SuDS, a review of all available evidence by DEFRA and the Environment Agency, would appear to concur with Thames’ position. The report concludes somewhat ambiguously: ‘although it is clear from the evidence available that SuDS cannot meet the proposed water quality standards, concern is expressed by a number of organisations regarding the balance of evidence and the lack of proposed use of SuDS to improve water quality in the

Thames Tideway' (Environment Agency, 2013: 34). In short, the evidence does not quite seem to support SuDS yet; but stakeholders should know more about such systems, and should also build the use of SuDS into future proposals. For Bell (2013) part of the appeal of SuDS is that it is a 'low energy' water management option. As she notes, the TTT will depend on far higher energy inputs, required for pumping and treating the large amounts of sewage flowing through the tunnel (Bell, 2013; Binnie, 2014) and could well become too costly to operate. Thus, the water-energy nexus may require less-energy intensive and decentralised interventions in future: the TTT, therefore, risks undermining the progress made in developing renewable solutions at the Beckton wastewater treatment plant.

The arguments against the TTT and in favour of more integrated alternatives are convincing. However, they only provoke one to more forcefully ask the question posed by Chris Binnie (and, similarly, by Margaret Hodge): why is it that the bandwagon for the TTT keeps rolling? One answer, we would suggest, lies in the conditions of possibility for large-scale Mode 1 and Mode 2 UI projects. These conditions of possibility lie in the novel forms of financing and the process of financialisation that has swept through the water sector in the UK. Thus, both Thames Water and Bazalgette Tunnel Ltd epitomise a broader shift in large infrastructure projects. Whereas Thames Water has spent much of the last ten years leveraging securities to sustain high shareholder dividends – often at the expense of decaying infrastructure – now, with the development of novel financing mechanisms, large infrastructure projects appear increasingly attractive to sovereign wealth funds, pension funds, insurance companies and other institutional investors. Coming with inflation-protected guarantees from the central government, new infrastructure projects, such as the Thames Tideway Tunnel or the Nine Elms

extension to the Northern Line (Findeisen, 2016), are packaged in a way that provides stable, guaranteed revenue streams for institutional investors. These revenue streams can then be transformed into assets and traded within secondary markets. Thus, in the following section we turn in greater depth to this process of financialisation, before seeking to answer the question of what it is that is being integrated and for whom.

Financialising infrastructure

Thames Water is now perhaps the iconic example of a financialised water services provider. As Allen and Pryke (2013) demonstrate, the utility's financial model differs in fundamental ways from that of privatised water utilities in the period immediately after divestment of water in England and Wales in 1989. During the period between the release of the *Thames Tideway Strategic Study* and the application for planning permission, several fundamental changes took place in the corporate profile of Thames Water. Crucially, the utility's owner changed from the German energy firm RWE to a collection of investors led by the Australian investment bank Macquarie. The Macquarie Group's purchase of Thames resulted in a fundamental change in the company's business model (Allen and Pryke, 2013; Bayliss, 2015; Loftus and March, 2016): long-term company debt increased from £1.6 billion in 2005 to £10 billion; and over the same period dividend payments totalled £1.875 billion (Plimmer, 2016).³ A complex corporate structure developed in which much of the debt accrued by Thames was acquired through offshore tax havens, and, as can be seen, in which dividend payments to shareholders remained absurdly high given these levels of debt. Furthermore, since its acquisition by Macquarie, Thames Water and its many subsidiaries and parent companies have paid almost no corporate tax to the

UK government (Allen and Pryke, 2013; Bayliss, 2015) provoking considerable anger. Following the publication of its 2012 results, OFWAT's chairman noted that Thames' actions might well be legal 'but some aspects are morally questionable in a vital public service' (Houlder et al., 2013). The repackaging of risk within the company means that the day-to-day operations of abstracting, treating and distributing water appear to be of less importance to the company than profiting through complex financial procedures. While this financial engineering is largely hidden from view, at the base of the model lies the household. Households are, therefore, responsible for providing predictable and sustainable revenue streams.

The process of financialisation that Thames has been transformed by has received considerable attention in recent years (Christophers, 2013, 2014, 2015; Langley, 2003, 2008; Lapavistas, 2013). Although definitions of financialisation vary, there is some agreement that the locus of power in the economy has shifted to some degree from the production of value to the extraction of rents. While there is considerable debate over the degree to which the production of value remains central to profitmaking, as well as the degree to which rent extraction can be divorced from the production of surplus value, there remains some agreement that new actors have proliferated and that the influence of the financial services sector on a range of different aspects of human and non-human life has grown (Loftus and March, 2015). However, water remains a fundamentally uncooperative commodity (Bakker, 2003) and the process of financialisation within the water sector remains uneven and complicated (for the most up-to-date review of recent work on the financialisation of water, see Ahlers and Merme, 2016). Indeed, as Bayliss (2014, 2015) demonstrates, water itself is far less likely to be financialised than water services

or the infrastructure through which water services are provided. A range of financial products has, therefore, developed around both water and its attendant infrastructures, including water-targeted investment funds; structured water products within major investment banks; water indexes; or exchange traded funds.

The so-called Australian model of infrastructure financing pioneered by the Macquarie Group in roadbuilding in Australia in the 1990s and exported to the UK through Macquarie's ventures into the water sector with its purchase of Thames Water has been crucial in transforming water in England and Wales over the last decade (Allen and Pryke, 2013) and it is almost impossible to divorce London's super sewer from this broader shift. Indeed the influence of financialisation can be felt at a range of different scales. Most obviously, by 2010, it was clear that Thames Water no longer had the reserves of capital to be able to construct a tunnel whose cost had also increased massively since the publication of the TTSS. The National Audit Office (NAO) puts it bluntly: Thames Water's difficulties in paying for the tunnel result from a 'recent strategy to increase its borrowing and pay substantial dividends to its owners' (NAO, 2014: 25). Furthermore, even if Thames Water was not so heavily leveraged the TTT is now 'of a size and complexity that could threaten Thames Water's ability to provide services to its customers' (NAO, 2014: 25). It, therefore, became imperative to develop a coherent financing model that could cope with the size, cost and risks associated with the tunnel.

The NAO (2014) summarises the different delivery models that were initially considered to develop the TTT: Thames Water financing; state financing; or the use of an independent infrastructure provider. The first option was rejected outright because of Thames Water's debt levels; the second option,

public sector financing, was considered too problematic in that it ‘could require legislation to take the project outside the existing regulatory framework’ (NAO, 2014: 25). Thus, the third option became the preferred model and an Infrastructure Provider (IP), legally separated from Thames Water, in the form of a Special Purpose Vehicle (SPV) was appointed to deliver the scheme. Allegedly, such a model would ‘help secure the lowest cost of capital and keep costs down for customers’ (NAO, 2014: 26). Somewhat troublingly, however, DEFRA only received two bids for the scheme. Both the winning bidder and the losing one were coalitions of investors, bringing together pension-fund and insurance companies. Eventually, OFWAT awarded the licence to design, build, commission and maintain the infrastructure to Bazalgette Tunnel Ltd. Trading under the name of Tideway, the company is comprised of four shareholders: insurance company Allianz; independent fund management company Dalmore Capital Limited; global infrastructure fund INPP together with the insurance company Swiss Life (managed and advised by Amber infrastructure); and the independent fund management company DIF (Tideway, 2016).

In an arrangement that appears to point to the redundancy of Bazalgette Tunnel Ltd, Thames Water will be the sole supplier of raw sewage to the former and will also be the sole customer when it receives raw sewage at the other end of the tunnel. Bazalgette Tunnel Ltd’s sole function, its ‘special purpose’ as an SPV, is to build a tunnel and to transport sewage from Thames Water back to Thames Water. While the stated cost of the tunnel is expected to be £4.2 billion at 2011 prices, the economic model is hugely complex with a multiplicity of actors interacting through complex financial arrangements. The company shareholders have committed £1.3 billion (Bazalgette Holding

Limited, 2016). Also, a further £1 billion has been committed through a Revolving Credit Facility (RCF). Furthermore, the project has secured a 35-year loan from the EIB of £700 million as well as issuing bonds totalling £350 million (Bazalgette Holding Limited, 2016).

Despite the initial capital outlay for construction coming from the collection of investors making up Bazalgette Tunnel Ltd, the tunnel will eventually be paid for through customer bills. Thames Water’s 13.8 million sewerage customers (over 20% of the UK’s overall population) will, therefore, pay for the tunnel again and again. Many of these customers live as far away as Banbury, almost 100 miles from the CSOs that the tunnel is supposedly a response to. Annual bill increases were initially estimated to be £70–80; however, the financing mechanisms put in place have reduced average increases to roughly £20–25 per annum (DEFRA, 2015b). A £7 surcharge was already included in customer’s 2015 bills to cover project costs incurred by Thames Water (DEFRA, 2015a: 15) and this charge will increase incrementally as the tunnel is constructed. The ‘average increase’ referred to masks large differences, depending on whether or not a household is on a metered supply and, in the case of the latter, the size of that household. With construction already having started, the TTT will eventually use four tunnel boring machines to construct the main spine of the network before connecting the worst CSOs to this spine at different sites along the Thames. All work should be completed by 2023.

Thames Water was no longer in a position to be able to construct a ‘honking great tunnel’ given that the financial model it had developed had essentially starved the utility of necessary resources. While Mode 2 UI poster children, such as the Thames Water Desalination Plant at Beckton could be pursued, Thames Water lacked the ability to

secure financing for a project as ambitious as the TTT. Nevertheless, it had prepared the ground for a new coalition of investors to emulate the financial model rolled out in London, a model imported from Australia through the Macquarie group. Thus, the hydrosocial cycle had been part financialised by Thames, this process was closed by the entry of Bazalgette Tunnel Ltd. While the NAO presents the SPV as the only viable option, its conditions of possibility lie in the process of financialisation embarked on by Thames. The reason why this process of financialisation provided such conducive conditions are several, ranging from the socio-ecological to the rates of return available, from the 'real' to the 'fictitious'.

First, as Byatt (2013) notes, from 2006 onwards the high dividend payments made to shareholders appeared to result in a reduction in investments in the existing network. For Byatt, the fact that Bazalgette's intercepting sewers appear to be running close to capacity even during dry weather implies that the problem could lie in groundwater infiltration of the sewer network. As argued elsewhere in Byatt's paper, the gearing of Thames Water from 2006 onwards has meant that it is in no position to be able to finance the construction of the TTT. Instead, a separate Infrastructure Provider was required. Nevertheless, if that Infrastructure Provider appears separate in name and legal status, it remains utterly tied to Thames.

Second, crucial for these investors is a steady, predictable, annualised rate of return on their investment. A huge tunnel underneath the Thames, taking 7 years to construct and carrying a mix of human sewage and stormwater may not seem a particularly good candidate for making money; however, payments for the tunnel will continue to be made by an increase in household charges, which although increasing incrementally over coming years, has already started to appear. Thus, the tightly regulated sector

ensures that before any digging in the Thames has even started, the Thames Tideway Tunnel is generating returns for the investors involved in the project. As mentioned before, original projections for the likely annual increases to consumer bills were in the range of £70–80, based on OFWAT's calculations of what would be necessary for any firm to satisfy its investors. OFWAT made this calculation on the basis of the Weighted Average Cost of Capital (WACC). It was, therefore, something of a surprise when Bazalgette's bid came in with a WACC that was 1.1% lower than the average granted for water utilities in OFWAT's 2014 price review. The average WACC granted by OFWAT in the 2014 price review was already over 1% lower than that granted in the previous round (3.74% compared with 5.1%), suggesting a gradual erosion of the returns being made to investors across the water sector. In the case of the TTT, the good news for consumers was that this considerably lower WACC meant that average bills were likely to increase by only £20–30 per household. According to the consultancy Oxera (2015) the reasons for this lower WACC appear to be related to the fact that: borrowing costs remain at an all time low (something OFWAT rather catastrophically failed to take into account in the previous price review); Bazalgette is not currently servicing debts, so all new borrowing will be at this lower rate; government backing has ensured that risks are reduced; and OFWAT will provide a variety of 'regulatory shields' enabling Bazalgette to earn a return on next year's spend and enabling it to make adjustments to allow for the cost of debt. The model of using the SPV is therefore considerably advantageous over other forms of financing. Thus, the TTT appears to investors as a low-risk, government-backed and inflation-protected investment. As Merme et al. (2014) and Ahlers and Merme (2016) argue, it is far easier to attract institutional

investors for such projects than it would be to bring about a coalition of investors for the kind of piecemeal – albeit far more integrated – solution proposed by those favouring SuDS.

Third, and finally, perhaps more important than the direct returns to investors made possible by the TTT are the revenue streams which it enables. These revenue streams can be securitised and sold on as assets within financial markets. Thus, under conditions of financialisation, we witness not only a changing makeup of investors profiting *directly* from water infrastructure, we see the emergence of a whole shadow economy that is *not* subject to the formal regulation of OFWAT. A narrow focus on direct returns to investors tells us far less about the forms of rent extraction now animating investment decisions within the sector, which are more focused on the capture of rents than the profits to be generated from the direct sale of water and wastewater services.

Integrating what and for whom?

Writing of the ways in which London has become ‘a city of holes’, Edwin Heathcote (2016), the architecture correspondent for the *Financial Times*, notes:

As the capital grows, it goes through waves of rebuilding, each purporting to address a dominant issue. In the late 19th century it was slum clearance; after the second world war it was the rebuilding of a city devastated by bombing as a physical expression of a new welfare state; in the 1980s the rebuilding was an effort to revitalise the city as a global financial centre. And now – what exactly? ... The chief function of London, today, it would seem, is to convert space into money.

With characteristic eloquence, Heathcote goes on to demonstrate that the conversion of space into money takes place above

and below ground. Holes punched in the surface enable rents to be extracted from the tunnels they facilitate; from the evisceration of the built environments that preceded them; and from the new machines for investment constructed in their wake. The Thames Tideway Tunnel is one crucial part in the remaking of the fabric of London. Nevertheless, London’s super sewer purports to be a necessary response to the multiple challenges facing the city. Cloaked in the ambition of the Victorians, the TTT appears to be the only viable option enabling a clean Thames for future generations.

Nevertheless, as many have pointed out, there are alternatives – more integrated and less costly ones. However, these alternatives do not provide such fertile terrain for rent extraction. Differing visions of integration come to be contested within the differing viewpoints of how best to respond to a polluted Thames. The financial model adopted by Thames Water and now pursued even more effectively by its offspring Bazalgette Tunnel Ltd, however, only appears to provide conditions that are ripe for large infrastructure. It is therefore far harder to extract rents from the more piecemeal proposals for Integrated Water Resources Management. In the case of the Beckton wastewater treatment works, financialisation enabled the construction of a pioneering desalination plant. Although not responding to any clear need in the city, the plant was modelled on a form of Mode 2 UI and could be marketed as a response to the Food–Water–Energy nexus. Once again in the case of that plant, demand-side solutions to growing pressures on groundwater resources were rejected in favour of infrastructure that might better guarantee stable returns – whether used or not. The Thames Tideway Tunnel, in contrast, does not even appear to base its credentials on a form of Mode 2 UI: instead, it heralds a return to the integrated infrastructural ideal of Mode 1 UI (see Macrorie and

Marvin, 2016), albeit one infused with a certain nostalgia for the Victorian past. Rather than a forward-looking vision of integration, for many, the super sewer is an outdated, top-heavy white elephant.

For an answer to the question of why London now has a vast tunnel instead of an integrated response to the problems of the hydrosocial cycle, we therefore need to follow Heathcote (2016) back into the city of holes. Here we find a coalition of institutional investors able to assemble different aspects of London's hydrosocial cycle into a vast machine for making profits. Financial and political interests come to be integrated into an elite fix that will generate returns for the pension funds, insurance companies and sovereign wealth funds now integral to the hydrosocial cycle of the city. Rather than an ambitious project to avoid a polluted Thames, generate clean energy, and build creatively on the challenges of the water–energy nexus, the Thames Tideway Tunnel is a concrete tunnel for extracting rents, a pure financial asset. Viewed in this way, the tunnel is a further blight on the efforts to build a more progressive socio-ecological future for the city.

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Notes

1. The research is based on a thorough review of secondary sources, and is part of a broader

project researching the financialisation of the hydrosocial cycle in London.

2. For many of the contributions penned by different individuals see <http://cleanthames.org>; and <http://bluegreenuk.com/>).
3. Byatt (2013) talks about £2.2 billion for the period 2006–2012.

References

- Ahlers R and Merme V (2016) Financialization, water governance, and uneven development. *Wiley Interdisciplinary Reviews: Water* 3(6): 766–774.
- Allen J and Pryke M (2013) Financialising household water: Thames Water, MEIF, and 'ring-fenced' politics. *Cambridge Journal of Regions, Economy and Society* 6(3): 419–439.
- Ashley RM (2014) It was good enough for the Victorians: We know it works Available at: <http://cleanthames.org/the-controversy/experts-opinion/> (accessed 28 October 2016).
- Ashley RM, Nowell R, Gersonius B, et al. (2011) *Surface Water Management and Urban Green Infrastructure. A Review of Potential Benefits and UK and International Practices*. Marlow: Foundation for Water Research.
- Bakker K (2003) *An Uncooperative Commodity: Privatizing Water in England and Wales*. Oxford: Oxford University Press.
- Bayliss K (2014) The financialization of water. *Review of Radical Political Economics* 46(3): 292–307.
- Bayliss K (2015) The Financialisation of Water in England and Wales. FESSUD Working Paper No. 52. Available at: Available at: http://fessud.eu/wp-content/uploads/2015/03/Case-study-the-financialisation-of-Water-in-England-and-Wales-Bayliss-working-paper-REVISED_annexes-working-paper-52.pdf (accessed 12 October 2017).
- Bazalgette Holdings Limited (2016) Annual report and financial statements. For the 11 month period ended 31 March 2016. Available at: <https://www.tideway.london/media/2617/bazalgette-holdings-limited-group-and-company-annual-report-signed.pdf> (accessed 27 January 2017).
- Bell S (2013) Water supply, drainage and flood protection. In: Bell S and Paskins J (eds)

- Imagining the Future City: London 2062*. London: Ubiquity Press, pp. 85–93.
- Binnie C (2014) Thames Tideway Tunnel: Costs and Benefits Analysis. Available at: <http://cleanthames.org/the-controversy/experts-opinion/> (accessed 28 October 2016).
- Blaiklock M (2013) The Thames Tideway Tunnel: an Engineer's 'Pipe-Dream'? The case for an alternative. Available at: <http://cleanthames.org/the-controversy/experts-opinion/> (accessed 28 October 2016).
- Byatt I (2013) Thames Tunnel: A Critique of a Flawed Project. Available at: <http://cleanthames.org/the-controversy/experts-opinion/> (accessed 28 October 2016).
- Christophers B (2013) *Banking Across Boundaries*. Oxford: Wiley Blackwell.
- Christophers B (2014) Geographies of finance I: Historical geographies of the crisis-ridden present. *Progress in Human Geography* 38: 285–293.
- Christophers B (2015) Geographies of finance II: Crisis, space, and political-economic transformation. *Progress in Human Geography* 39: 205–213.
- Committee of Public Accounts House of Commons (CPA HC) (2014) *Infrastructure Investment: The Impact on Consumer Bills. Fifth Report of Session 2014–15*. London: The Stationary Office Limited.
- Department for Environment, Food & Rural Affairs (DEFRA) (2015a) *Creating a River Thames fit for our future. An updated strategic and economic case for the Thames Tideway Tunnel*. Available at: <https://www.gov.uk/.../system/.../thames-tideway-tunnel-strategic-economic-case.pdf> (accessed 18 October 2016).
- Department for Environment, Food & Rural Affairs (DEFRA) (2015b) *Costs and benefits of the Thames Tideway Tunnel. 2015 Update*. Available at: <https://www.gov.uk/government/.../thames-tideway-tunnel-costs-benefits-2015.pdf> (accessed 18 October 2016).
- eftec (2015) *Update of the economic valuation of Thames Tideway Tunnel environmental benefits. Final Report. For the Department for Environment Food and Rural Affairs (Defra)*. August 2015. London: eftec.
- Environment Agency (2013) An assessment of evidence on Sustainable Drainage Systems and the Thames Tideway Standards. Available at: http://webarchive.nationalarchives.gov.uk/20140328150910/http://www.environment-agency.gov.uk/static/documents/Research/SuDS_and_the_Thames_Tunnel_Assessment_Final_Report_Oct_2013.pdf (accessed 12 October 2017).
- Findeisen F (2016) Financing urban infrastructure in London after the financial crisis. In: Raco M (ed.) *Britain for sale: Perspectives on the costs and benefits of foreign ownership*. Smith Institute: London. Available at: <http://www.regionalstudies.org/uploads/documents/Britain-for-sale.pdf> (accessed 12 October 2017).
- Florentin D (2016) From Multi-Utility to Cross-Utilities: The Challenges of Cross-Sectoral Projects; A German Example. *Paper presented at Interfacing Infrastructures in Cities: Politics and Spatialities of the Urban Nexus. International Roundtable Workshop*, Autun, France, 23–26 August 2016.
- Gayle D and Taylor M (2016) London super-sewer is waste of £4bn, says assessor. *The Guardian*, 14 November. Available at <https://www.theguardian.com/uk-news/2016/nov/14/london-super-sewer-is-waste-of-4bn-says-assessor> (accessed 12 October 2017).
- Graham S and Marvin S (2001) *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*. Abingdon: Routledge.
- Green C (2014) The Thames Tideway Tunnel: A disaster for the environment. Available at: <http://cleanthames.org/the-controversy/experts-opinion/> (accessed 28 October 2016).
- Griffiths I (2014) Planned London super sewer branded waste of time and taxpayer money. *The Guardian*, 27 November. Available at: <https://www.theguardian.com/environment/2014/nov/27/london-super-sewer-branded-waste-time-money> (accessed 28 October 2016).
- Halbert L and Attuyer K (2016) Introduction: The financialisation of urban production: Conditions, mediations and transformations. *Urban Studies* 53(7): 1347–1361.
- Halliday S (2013) *The Great Stink of London: Sir Joseph Bazalgette and the Cleansing of the Victorian Metropolis*. Stroud: The History Press.
- Heathcote E (2016) Construction is turning London into a city of holes. *Financial Times*, 21 April 2016.

- Houlder V, Kavanagh M and Pickard J (2013) Thames Water attacked for paying not a drop of tax. *Financial Times*, 10 June. Available at: <https://www.ft.com/content/f3f20fe4-d1d8-11e2-9336-00144feab7de> (accessed 31 January 2017).
- Jacobs Babbie (2006) *Independent Review to Assess whether there are Economic Partial Solutions to Problems caused by Intermittent Storm Discharges to the Thames Tideway – Phase 1 Final Report*. Office of the Director General of Water Services, Ofwat Ref: PROC/01/0021.
- Langley P (2003) *World Financial Orders: An Historical International Political Economy*. New York; London: Routledge.
- Langley P (2008) *The Everyday Life of Global Finance: Saving and Borrowing in Anglo-America*. New York: Oxford University Press.
- Lapavitsas C (2013) *Profiting Without Producing: How Finance Exploits Us All*. London: Verso Books.
- Loftus A and March H (2015) Financialising nature? *Geoforum* 60: 172–175.
- Loftus A and March H (2016) Financializing desalination: Rethinking the returns of big infrastructure. *International Journal of Urban and Regional Research* 40: 46–61.
- Macrorie R and Marvin S (2016) Repackaging the city: A critical appraisal of three urban integration techniques. *Paper presented at Interfacing Infrastructures in Cities: Politics and Spatialities of the Urban Nexus. International Roundtable Workshop*, Autun, France, 23–26 August 2016.
- Merme V, Ahlers R and Gupta J (2014) Private equity, public affair: Hydropower financing in the Mekong Basin. *Global Environmental Change* 24: 20–29.
- Monstadt J and Coutard O (2016) Interfacing infrastructures in cities: Politics and spatialities of the urban nexus. Paper presented at *Interfacing Infrastructures in Cities: Politics and Spatialities of the Urban Nexus. International Roundtable Workshop*, Autun, France, 23–26 August 2016.
- National Audit Office (NAO) (2014) Thames Tideway Tunnel: Early review of potential risks to value for money. Available at: <https://nonpolitical/report/thames-tideway-tunnel-early-review-potential-risks-value-money/> (accessed 12 October 2017).
- Oxera (2015) The Thames Tideway Tunnel: Returns underwater? September 2015. Available at: <http://www.oxera.com/Latest-Thinking/Agenda/2015/The-Thames-Tideway-Tunnel-returns-underwater.aspx> (accessed 11 June 2017).
- Plimmer J (2016) Macquarie to start sale of Thames Water stake. *Financial Times*, 26 May. Available at: <https://next.ft.com/content/2db37112-2309-11e6-9d4d-c11776a5124d> (accessed 28 July 2016).
- Smith C (2017) Martin Baggs: A modern day Bazalgette? *WaterWorld* 32(1): online. Available at: <http://www.waterworld.com/articles/wwi/print/volume-32/issue-1/headline/leader-focus/martin-baggs-a-modern-day-bazalgette.html> (accessed 13 October 2017).
- Stovin VR, Moore SL, Wall M, et al. (2013) The potential to retrofit sustainable drainage systems to address combined sewer overflow discharges in the Thames Tideway catchment. *Water and Environment Journal* 27: 216–228.
- Thames Blue Green Economy Group (TBGE) (2016) The Case Against the Thames Tideway Tunnel and in favour of Integrated Water Resource Management for the Thames Tideway. Thames Blue Green Economy Group. Available at: <http://bluegreenuk.com/freewater/tbge/References/The%20case%20against%20the%20Thames%20Tideway%20Tunnel.pdf> (accessed 27 July 2016).
- Thames Water (2005) Thames Tideway Strategic Study. Steering Group Report. Available at https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/projects/WW010001/WW010001-001256-8.1.2_Thames_Tideway_Strategic_Study_Steering_Group_Report.pdf (accessed 12 October 2017).
- Thames Water (2012) Why does London need the Thames Tideway Tunnel? Promotional Document. London: Thames Water.
- Tideway (2016) Project Timeline. Available at: <https://www.tideway.london/the-tunnel/history/?v=mobile> (accessed 27 July 2016).
- Water Briefing (2016) Critics once again question case for Tideway Tunnel. Available at: <http://www.waterbriefing.org/home/company-news/>

- item/12344-critics-once-again-question-case-for-tideway-tunnel (accessed 28 October 2016).
- Williams J, Bouzarovski S and Swyngedouw E (2014) Politicising the nexus: Nexus technologies, urban circulation, and the coproduction of water-energy. Available at: <http://www.thenexusnetwork.org/wp-content/uploads/2014/08/Williams-Bouzarovski-Swyngedouw-Politicising-the-nexus-Nexus-Thinkpiece-2014-page-numbers.pdf> (accessed 22 September 2017).
- Zhou Q (2014) A review of sustainable urban drainage systems considering the climate change and urbanization impacts. *Water* 6(4): 976–992.