

# Management Issues and Implications at the Pre-Construction Stage of a Sewer Tunnel Build in London, UK

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## Abstract

This is a research paper focused on the assessment of a pre-construction phase of a singular tunnelling project relating to Managers/Senior Engineer's perceptions of sewerage project development issues relating to a civil engineering sewer tunnel project in London, UK. In order to consider more implicitly the issues raised, this empirical groundwork utilised an interpretive perspective. The scope for this research was the Client/Contractors of a single civil engineering project. The population for this study was made up of a number of Senior Managers/Engineers (21) located at multi-sites and with direct knowledge of the development of similar engineering projects, where a total of 13 Senior Managers/Engineers were determined as the resultant sample frame.

The outcomes consisted of seven (7) main themes, namely: Stakeholder Management, Project Leadership, Project Administration, Financial, Technical, Project Personnel, and Environmental and sixteen (16) sub-themes raised from a literature embedded research question.

The paper establishes that numerous issues are raised in such a complex project, and that the project outcomes encompasses a myriad number of problems including a materially inadequate bidding process, government interference in the application of EU competition laws, inadequate project governance and possible collusion by the water regulator Ofwat, a Client that created and operated an "unusual company structure" within a clearly defined water monopoly, the creation of a civil engineering design that is comprehensively lacking in engaged engineering and likely to cost the tax-payer more money in the longer term, leading to a design that is inherently flawed by still allowing 2.35Mn tonnes of overflow of sewerage into the Thames River.

Very little research has been conducted in this area in heavy civil engineering projects and the paper exposes tunnel design issues and management corruption, which is previously unexplored in today's demanding UK civil engineering environment.

**Keywords:** Management; Tunnel; Projects; Civil Engineering

## INTRODUCTION

An analysis of many civil infrastructure projects in the UK ordinarily shows that they are primarily implemented through being public funded and are government underpinned (1; 2) to enhance infrastructure management (3; 4). Initial project development requires an evaluation of client needs (5) and builds appropriate physical entities relative to diversified managerial project processes and assessments (6), often leading to a project's success (7).

## LITERATURE REVIEW

This literature review focuses on the background to the project, project management and initiates issues of relevance to the project as the largest civil engineering water resources project ever submitted for construction in the UK.

### *The sewer tunnel project background*

The proposed sewer tunnel project is a 25Km tunnel to be constructed, ranging at depths from 35m - 75m (with 6.2m - 7.5m diameter). At 65m depth, the water pressure is calculated at being 6 Bar; it has a designed storage volume of 1.24Mn m<sup>3</sup>; and is the UK government's preferred solution (8) to over-spillage of sewerage to protect the Thames River (9). The project is broken into three areas - The West, Central and East regions where each region has a separate JV contractor (10). This still appears to be based on 2005 reports (8), and have not been changed even though after a further 11 years, other options and alternatives have been posited to be more beneficial and less costly (11; 12). The project is designed to provide compliance with the EC Urban Waste Water Treatment Directive (13). This project costs £4.2Bn - up from £1.72Bn in 2005 (Tideway £3.144Bn, EIB £700Mn loan and the rest - £400Mn - funded by the project client - Thames Water - through increased water management prices/customer bills) (14). This tunnel levy costs each customer upto £80 extra on their annual bill and may even increase their bills by 57% (15; 16).

Today, 53Mn tonnes on average, of sewerage flow into the Thames River (17). However, the most dumped into the Thames River was 62Mn tonnes was in 2014 (400,000 tonnes in 1 day, killing 100,000 fish in the Thames River), up from

55Mn tonnes in 2013 (18). The figures used by Thames Water of 39Mn tonnes (10), reflect 2005 figures and shows clearly the political nature of furnishing misinformation in line with the government's continuing rhetoric. The ameliorating effects of the sewer tunnel is to reduce this to 2.35Mn tonnes (3, table 2, p.8 - A Low 140) - average 6438 tonnes/day (10), which will only increase as London gets bigger (19; 20) through increased urbanisation (8) and grey construction (21). Thus, the project will not stop the overflow, just reduce it to what it was about 50 years ago (22), and this is designed to last at least another 120 years. In essence, the project is designed to reduce pollution, rather prevent pollution.

When assessed, Thames Water takes on a large risk with the company's liabilities as of 2013 at £10.95Bn and total equity of £3.1Bn through an operating income of £2.01Bn (23; *ibid*, 24) with an operating expense of £1.42Bn and would put an overwhelming stress on the financial aspects of the company (25). However, with direct funding required of £0.4Bn - which is provided at a rate of £50,000,000/year during the project construction - it is difficult to understand how Thames Water was loaned the required funding - see later in terms of bond issues. Further, public risk measures apply here, as they do to banks in order to help nullify the effects of structural risk factors. This has led to the NAO carrying out a critical evaluation of the project (26). There is also the regulatory risk imposed on Ofwat, as the project is designed to be constructed over 8 years, thus moving across multiple regulatory periods (27). Further, an independent CBA of the tunnel project recommended that the fiscal benefit is only £310Mn, as against a significant cost of £7Bn (28), which would be viewed as "excessive cost" under UWWTD (13) contrary to DEFRA (29). Additionally, when assessing the litter benefit, and reduced to only £150Mn, then there is no benefit relating to the Thames tunnel build. This corresponds with the clear indication that Thames Water customers have stated that they only want to pay £10-20 extra (30) - much less than Thames Water wants (31). The project developer BTL assigned as a licensed Infrastructure Provider (IP) by Ofwat (32) does not appear to realise or ignores the issue of independency, as the IP cannot legally make decisions without Thames Water or the UK government's approval. This begs the question, of where the Thames water funding came from and consequently BTL now faces an on-going probe by the National Audit Office over its unusual financial structure (12; 26) and management orientation. To complicate the issue 47year bonds have now gone on sale in London amounting to £50Mn that mature in 2048 and another £50Mn in 2054 (33).

### ***The political aspects of managing the tunnel project***

The success of a project - especially a complex multi-billion-pound civil engineering project - requires a specific orientation towards meeting the project objectives, which are set by the Client. Here, this is not set by the Client, but is put

forward to another - the government - for acceptance through the decision maker - The Secretary of State (8). Therefore, the government states that the intended tunnel project is nationally significant, and will also make a decision on the plans put forward - these decisions appear to be both devoid of independency which is seen to envelop the tunnel project in such acrimony, as the independent "examining authority" (The Planning Inspectorate) can only recommend, not make a final decision. Further, this tunnel project involves water resources, which is normally overseen by Ofwat, which is excluded from the first-level decision-making.

The Client appears to be wrapped around a government directive, directly linked to a private company whose own customers do not want to pay for the project. However, in such a politically motivated project, it is difficult to determine who the real client is. Is the government, the Water Company, or the direct customers (14 Million of them - 34) of Thames Water the client? Is there an issue with the government being Client, Sponsor and Customer at the same time, which raises the legitimacy of Client independency? Other issues related to the adequacy of Ofwat oversight, suggest the UK government is possibly manipulating the situation by making forceful political decisions that could not be done by any other UK body. For most complex civil engineering projects, there is only one Client, and that is the payer and engager of a contractor to carry out the works. On this project, this simple relationship is perhaps made deliberately unclear. However, Bazalgette Tunnel Limited (BTL) is at present the acting entity to manage on behalf of the Client - embodied in Thames Water - the Client - for the tunnel project as the licensed Infrastructure Provider (IP), which has been set up to "finance, build, maintain and operate the tunnel" (35) in August 2015 as designated by Ofwat (32). The IP at handover to the Client must comply with "any environmental permit" (36) - which indicates that Ofwat and the Environment Agency will accept a projected minimum of 2.35Mn tonnes of sewerage being dumped into the Thames River annually (6438 tonnes/day) against European Law and conventional engineering wisdom relating to environmental practices in large new infrastructure build (10).

### ***Project management issues during a civil engineering project start-up***

Project management techniques are now widely used in civil engineering, such that any complex tunnelling project will use the same management techniques because of its efficiency (37). However, bringing with this use is the need to have managers and engineers qualified in project management either through PMI or through university study. Further, how should complex projects be judged a success? One way is to state project success criteria (38). Ofwat's particular criteria for the project's success is that the project is completed on time and at no more cost than it's published regulatory

baseline of £3.144Bn for Tideway - reflecting the traditional Iron Triangle (39) and the governance of the project as a legal entity (40). However, it isn't clear how the various monies are held and the line of fiscal responsibility within the project and together with an overly cautious view on budgeting, this is considered dangerous to the success of the project outcomes (41). In many respects, fixed price projects can be managed more effectively when the project managers are qualified (42) by developing project strategies, and applying tools and methods that will help with the project implementation (43). Further, project managerial intent needs to focus on reducing uncertainty and risk (44; 45), emphasise long-term project planning (46) and provide appropriate leadership (47). However, in this tunnelling project managing uncertainty is vital as the Contractor under NEC3 (48) has been unfairly treated by the use of "exculpatory contract clauses" (49), which does little to enhance contractor trust - especially when employing a fixed price contract (50). This has serious repercussions for cost underestimation (51) possibly leading to continual reassessment through unintended cost escalation (52) as there would appear to be no construction project completed without variation orders (53). This is expected in more resource intensive projects like waste-water environments (54) excluding Force Majeure (52), especially where construction methodologies were considered inadequate for stated purposes (55).

Early primary stakeholder involvement appears to be a mandatory aspect of appropriate project engagement (56; 57) generating value creation (58; 59) often through a joining agreement (60). Further, a positive characteristic of the project management is the notion of integrated project teams (61) that help deliver the project seamlessly to the Client. Building processes to support best practices (62) will aid in the project delivery and provide more effective project outcomes (63). Underpinning this is the need to develop quickly appropriate project maturity measures (64) that enhances project efficiencies to be applied through strategic engagement (65) and leads to more effective use of resources and time (66).

This paper focuses on the pre-construction phases leading to the Contractor involvement in the early stages of a complex civil engineering tunnel infrastructure project in London. This paper takes cognisance of the issue, that the tunnel project is designed to allow 2.35Mn tonnes of sewerage to enter the Thames River annually at minimum (10) after the project completion.

Having raised the literature issues (67; 68), this creates the context for the research question, *What are the managerial issues raised in the development and implementation of a major sewer tunnelling project in London?*

### **Methodology**

To investigate the issues generated within a civil engineering implementation context, a deeper, more involved approach

was considered appropriate that required more personal contact on such critical and important issues. In order to consider more implicitly these generated issues, this empirical foundation exploited an interpretive approach (69; 70). An assessment of management issues which targets personal issues raised out of individual experiences and is therefore an area of interest where qualitative methodology is most appropriate to generate this type of data.

This was an attempt to understand the perceptions of senior managerial experiences in similar civil engineering projects across the UK. Consequently, senior managerial staff were considered specialist knowledge agents and actors (71) as their opinions and experiences influenced their perception of tunnel engineering practices, and the development and application of building appropriate site-based management strategies and goals.

The research used a semi-structured interview conducted with senior Managers/Engineers who provided an appropriate element of context and flexibility (72) and this was further aided by applying an inductive/theory building approach (73). Given the lack of appropriately focused research in this area, this methodology was seen as suitable for generating contextual data underpinning the purpose of forming richer theory development (74). A pilot study was carried out with 3 respondents from the population (these were not used in main interview/data collection process) that allowed changes to language and questions that had more meaning and understanding by the respondents (following 75). This led to a more effective and streamlined question routine and an enhanced communication approach with respondents (76).

The population frame (21) for this study was made up of registered Senior Managers/Engineers who had direct on-site responsibility for managing similar civil engineering programmes and were situated at identifiable locations, which is considered an existing frame (77). This delivered an initial means for appropriate sampling assessment within clear boundaries (78). Given that not all individuals in this working group were available for interview during the project data capture time or were employed in the pilot study, the sampling frame was configured as 18, where all respondents were included (79), and no respondent was considered out of scope relative to the research orientation and requirements (80). Consequently, and in line with a qualitative approach (81), the respondents were chosen through applying the approach of a targeted population of interest (82) and this reflected the criteria of theoretical purpose, relevance and appropriateness (83). This was considered appropriate for this inquiry (84; 85) and empirically adequate (86) but it had no bearing on the research logic and reasoning (87). Additionally, using Glaser's sampling processes (88), a total of 13 industry Senior Managers/Engineers were thus determined as the resultant sample frame - which could also be considered convenience sampling according to Harrel & Fors (89); and meets the

saturation requirements of Guest, Bunce, & Johnson (84) and thus takes the sample frame beyond an empirically expected level.

Each face-to-face interview was audio recorded for future analysis (90). Interviews were conducted in English and took approximately one hour. All interviews were recorded digitally after gaining explicit permission (following 91) and were later transcribed verbatim using NVivo 11 (a qualitative software package) following the approach indicated by Bailey (92). The conduct of the interviews follows a similar process used by Gray & Wilcox (93) and James (94), with each individual being asked the same set of questions – modified through ancillary questioning (probes and follow-ups) in the same way as Balslem (95). To increase the reliability of the data, the actual transcription was returned to each respondent – via e-mail – for comment, correction, addition or deletion and return, which followed the process of validated referral (96). Whole-process validity was achieved, as the respondents were considered widely knowledgeable of the possibilities associated with the context and content of the research orientation (97). Each interview was initially manually interrogated and coded using the Acrobat software according to sub-themes that 'surfaced' from the interview dialogue - using a form of open-coding derived from Glaser (98), and Straus and Corbin (99). This treatment was also reinforced and extended through the use of thematic analysis conducted using NVivo 11 (70). Each interview was treated and coded independently. In this way, no portion of any interview dialogue was left uncoded and the overall outcome represented the shared respondent's views and perspectives through a progressive coding-sequence (100). Various themes were sensed from the use of the software packages, as well as from the initial manual-coding attempts. This multiple form of interrogation was an attempt to increase the validity of the choice of both key themes and sub-themes through a triangulation process (101). NVivo 11 was further used to explore these sub-themes by helping to pull together each of these sub-themes from all the interviews (102). In this way, it was possible to capture each respondent's comments across transcripts (103) on each supported sub-theme and place them together for further consideration and analysis (104).

The structure of the outcome is greatly influenced by the emergence of the key-themes and sub-themes. The preferred strategy for the analysis of the primary data was to use the stated research question, which was used as a guide to providing the outcome (based on Yin, 105; 106). The research methodology used was considered a mixed methodology approach (76) and was determined to create the best possible narrative of the situation in question. The application of the overall research methodology produces construct validity (107) - based upon the realism paradigm and preferring to use the terms of credibility and dependability which are accepted by many qualitative researchers in place of reliability by

applying Guba's constructs (108) and leading to Lincoln and Guba's (109) notion of "progressive subjectivity".

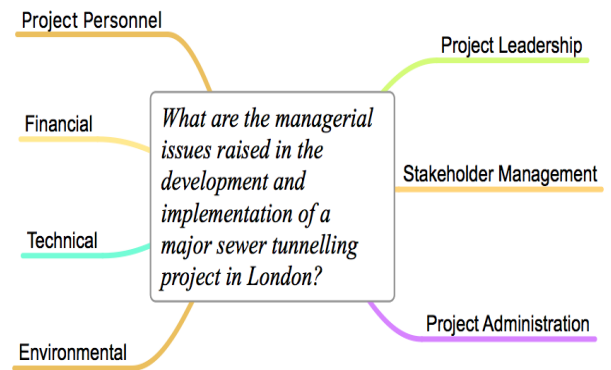


Figure 1: Research Outcomes

### Illustration of Research Outcomes

The outline of the research outcomes for this study is shown in Figure 1 above. The framework supported by appropriate literature, illustrated below in Table 1, consists of seven (7) main themes, Stakeholder Management, Project Leadership, Project Administration, Financial, Technical, Project Design, and Environmental; and sixteen (16) sub-themes. The outcomes are stated below where the discussion focuses on the sub-theme elements within each key theme. The discussion format used in this paper reflects the respondent's voice through a streamlined and articulated approach for reporting. Thus, the style adopted for reporting and illustrating the data is greatly influenced by James (110); Gonzalez (111) and also to a greater extent Daniels et al. (112) and is discussed below, focusing on the raised research question and the resultant themes. Table 1, below illustrates the respondent references for each sub-theme.

Table 1. Research question, themes and references

Research Question	Main Themes	Sub-Themes	No. Refs
<i>What are the managerial issues raised in the development and implementation of a major sewer tunnelling project in London?</i>	Stakeholder Management	Customers	23
		Client	17
		Health Intervention	14
	Project Leadership	Style	22
		Engineering Ethics	1
	Project Administration	Management	21
		Capability	24
	Financial	Project Cost	13
		Project Management	11
	Technical	Tunnel	16
		Management	13
	Project Personnel	Personnel Capability	11
		Choice of Personnel	9
	Environmental	Cost	21
		Design	14
		Sustainability	23

Table 1 above indicates the minimum responses for each identified sub-theme.

**Table 2.** Major themes and respondents

Major Themes	Cited Respondent Number
Stakeholder Management	1, 4, 6, 7, 9, 11, 13
Project Leadership	3, 4, 6, 10
Project Administration	2, 5, 7, 9, 12
Financial	3, 4, 6, 8, 10, 11
Technical	1, 3, 4, 7, 8, 10, 12
Project Personnel	1, 5, 6, 9
Environmental	2, 3, 4, 5, 7, 8, 10, 11, 12

Table 2 above indicates the major themes and cited respondents.

## RESULTS

The results are presented below using the research question as a pointer and supportive empirical evidence through indicated extractions as in Gonzalez, (111). Consequently, considering the research question - *What are the managerial issues raised in the development and implementation of a major sewer tunnelling project in London?* The results are stated here as seven (7) main themes, as indicated in Table 1 and 2 above, where each sub-theme theme is placed with each corresponding main theme.

### Main Theme – Stakeholder Management

In terms of the sub-theme Customers, one respondent (R4) indicated that, *...I see only people who are complaining about the cost. Me included, as I live here. It has not been a good experience. This conspiracy between the government and Thames Water shouldn't have happened. It is unacceptable today...* Another respondent (R11) suggested that, *...The full consequences for the customer have not been realised as yet. We'll end up paying much more. Much more than we anticipated...*

In terms of the sub-theme Client, one respondent (R6) indicated that, *...I am sure that the client is happy because the majority of the payment for this tunnel comes from somewhere else - government, finance companies who are there only to make money in the longer term, and of course from you and I the customer - and let's also not forget about the taxpayer. So we Londoners will pay twice for this...* Another respondent (R9) suggested that, *...What concerns me greatly is that inside closed doors the project management are designing a project that we know nothing about. As an engineer, it is remarkably secret, I want them to share exactly what it is they are designing...*

In terms of the sub-theme Health Intervention, one respondent (R1) indicated that, *...Personal health issues will remain. There is no doubt that this project does little to reduce the risk of health problems for residents after storm overflows. I thought this would be a primary objective of the project, but it will not do that. In fact, I think it will only continue those risks, not abate them...* Another respondent (R7) suggested

that, *...There is evidence to suspect that the project completion will raise pathogen levels in the water in the Thames, rather than make it cleaner and safe because the tonnage associated with the sewerage dumping will be more...* Another respondent (R13) suggested that, *...The level of health benefit of the project as NPV is calculated at £1.5Mn, rather than the £2.4Bn as determined by DEFRA. This is the over-confidence placed on an inappropriate assessment of the benefits of the project to those that will pay for it...*

### Main Theme – Project Leadership

In terms of the sub-theme Style, one respondent (R3) indicated that, *...Coming off the Cross-Rail project, you would think they would do a better job. You can't always tell though... Breaking the whole job into three major contracts, doesn't show much leadership as they couldn't decide who ...was best for the job...* Another respondent (R10) suggested that, *...The way they structured the whole works indicates clearly that this was a project for many companies, not just one. The lack of respectable leadership could cost the project more overall as mismanagement will now be in 3 sectors, not just one, and three JVs to blame...*

In terms of the sub-theme Engineering Ethics, one respondent (R4) indicated that, *...How can Chartered engineers carry on building a demonstrably flawed project, especially when their own charter seeks to ensure that they adhere to best practice...* Another respondent (R6) suggested that, *...I don't understand why the Chartered Institutions don't ban registered engineers from participating in this travesty. It's obviously only all about money and not about good governance...*

### Main Theme – Project Administration

In terms of the sub-theme Management, one respondent (R12) indicated that, *...The project is seen as an extension of the running process from the Cross-Rail project. There is no reason to utilise such a huge undertaking...* Another respondent (R5) suggested that, *...At the moment, they do not know which way to turn. The engineers have hardly any experience with water resource management, and yet the project's management are happy to try and deliver a complex project, made more complex by their demonstrated inadequate management...* Another respondent (R2) suggested that, *...It is not surprising that the management are failing. It takes more effort and capability to withstand dumb engineering practices. It isn't that simple to design and build. But when you talk to them it is like they know it all...*

In terms of the sub-theme Capability, one respondent (R9) indicated that, *...Sadly, the wrong companies and the wrong people are involved in management. It will be an enormous*

*mess once they start going. Then there's no stopping them. They will say there are engineering problems causing delays, but it will be their mismanagement... Another respondent (R7) suggested that, ...Most importantly it is the top management who are to blame. They know this is a flawed project and yet they follow what they are told by the client. They do not show any moral or ethical behaviour as is required by their professional status...*

#### **Main Theme – Financial**

In terms of the sub-theme Project Cost, one respondent (R4) indicated that, *...The costs associated with this project do not add up. This is especially galling since the project does not solve water management issues... Another respondent (R11) suggested that, ...It seems clear to me that Londoners will be paying for something that doesn't help them. It is a bad decision to go ahead with the project, as the costs certainly are more than the benefits. I think its not what people want. Not at this cost... Another respondent (R5) suggested that, ...If they were so world-class, couldn't they afford to do the whole job. Quite astonishing to see that they are sharing. It's just jobs for the boys again...*

In terms of the sub-theme Project Management, one respondent (R8) indicated that, *...I think they are already running into problems with finance as they have already spent £500Mn+ without there being a single foot of tunnel. They also seem to spend on advice, rather than rational engineering outcomes. I don't see anyone overseeing their spend and reporting on it openly... Another respondent (R6) suggested that, ...When I ask what's going on financially, they seem to be a bit hush-hush with it. It doesn't bode well for such a public project, and I am certain that it will run over budget and over-time. Not really good for the customers of Thames water... Another respondent (R3) suggested that, ...There is some work being done in some places. It is rather fractured just like its management and must be costly. I really don't know any more than that, but it looks bad for the management of the project as ordinary people can see money being wasted from the start... Another respondent (R10) suggested that, ...At community meetings, we are told not to question the money aspect. I say that if I am paying too, I want more say on where that money is going. This management does not allow any of us to question this issue. Not good really. Not good at all!...*

#### **Main Theme – Technical**

In terms of the sub-theme Tunnel, one respondent (R1) indicated that, *...They are very quick at using a TBM, perhaps too quick, as this suggests that the design reflects Cross-Rail engineering, because that's all they know... Another respondent (R7) suggested that, ...If only they could design a*

*system that meant no pollution or raw sewerage went into the Thames. Then I am sure people will be behind it. It is a bad design, managed badly and we have to pay for it... Another respondent (R12) suggested that, ...If they are allowed to build this project now, we won't have another for 100 years. It has to be right, and this one isn't... Another respondent (R4) suggested that, ...With the capacity issues, why is the diameter of the tunnel designed limited to 7.2m. This obviously indicates that the tunnel isn't designed to provide an appropriate capacity as run-offs are expected, but not attended to...*

In terms of the sub-theme Management, one respondent (R8) indicated that, *...With so many infrastructure projects going on and all these tunnelling projects together, I just don't trust the project managers to do the job correctly... Another respondent (R10) suggested that, ...Management of the tunnel project lacks the capability for such a project by employing engineers inexperienced in water management - especially since this is the largest ever water resources project in the UK... Another respondent (R3) suggested that, ...The designer has little or no experience with London clays and has made considerable problems with the proposed present design...*

#### **Main Theme – Project Personnel**

In terms of the sub-theme Personnel Capability, one respondent (R1) indicated that, *...Personnel appear to be employed based on their friendship with the project managers. Their friends from the other London projects. This does nothing to build a proper professional undertaking... Another respondent (R6) suggested that, ...Other solutions have been presented in a number of settings and completely ignored by government, where at least some of them are superior in meeting existing objectives and for these two projects, at least 50% of the present cost. What's wrong with these people, they just seem to want to spend our money...*

In terms of the sub-theme Choice of Personnel, one respondent (R9) indicated that, *...Oh, Stride the Project Manager of the project, says that the shafts connecting to the main sewer tunnel is some of the deepest in the world at 65m. He obviously hasn't worked in mining where shafts can go +4Km deep. This indicates the lack of understanding related to tunnel management and reflects mismanagement in the choice of individuals managing the tunnel... Another respondent (R5) suggested that, ...It is fairly obvious that the project go ahead is politically oriented, as the people involved are so intertwined politically, it wouldn't matter what the design capability was, they would build what they want - at our expense...*

## Main Theme – Environmental

In terms of the sub-theme Cost, one respondent (R8) indicated that, *...This project is so costly, yet it doesn't solve the overflow problems - at least 40% will still exist. It's a waste of money. It still does not do anything more than what Bazalgette did in the 1860s. That's not progress is it?...* Another respondent (R11) suggested that, *...The present design is not sustainable, if sewerage goes into the Thames at any time. Why accept a design to do the same as before, when we should design to eradicate the problem, not mirror it...* Another respondent (R4) suggested that, *...Sludge removal from the system used now will increase the capacity of the present system, so we will not need this new project for a long while...*

In terms of the sub-theme Design, one respondent (R2) indicated that, *...I think the project stinks because the central idea should be to separate sewerage and rainwater and treat them differently. We already had this model running for a long time and of course millions of tonnes of sewerage enters the river [Thames] every year. The same will occur after this project has been built...* Another respondent (R7) suggested that, *...I am fed up already with the kinds of inane disruption caused by the project. I work in London and my commute is hampered, and when I get home I find they are working at night. Total disruption, through noise, smells, dust, traffic congestion and we have to suffer when they get their deliveries wrong. It's not acceptable today. And it will go on for years...* Another respondent (R10) suggested that, *...Their design parameters do not meet the EU requirements for sustainability nor does it provide for dealing with all the water run-off. They even stated that they could store 3 days worth of water in the tunnel. Just doesn't seem valid...*

In terms of the sub-theme Sustainability, one respondent (R12) indicated that, *...This is not a green sustainable design. It is just the same as before - a mixing system that when full will flow its contents into the Thames and polluting London just as badly as now. It is a design constraint. A bad design constraint. It's that simple...* Another respondent (R3) suggested that, *...It would seem like the government has made a very big error. Environmentally, it is a disaster that continues to happen. What happens when other tunnels collapse?...* Another respondent (R5) suggested that, *...This new works does not really meet the environmental standards, and so much cost!...*

## DISCUSSION

In order to take this inquiry forward, the discussion concentrates on the raised question to help address the outcomes. Consequently, the main focus for this discussion are the characteristics revolving around the main themes - Stakeholder Management, Project Leadership, Project

Administration, Financial, Technical, Project Personnel, and Environmental, as:

### Stakeholder Management

Thames Water customers appear to recognise that they are paying directly for the project without having appropriate material benefits from the project - especially when local/small sewers are not being repaired or updated to be more efficient in their functional use. This is a major issue that has not been resolved and even ignored by Thames Water and is at odds with stakeholder best practices (113) but which appears to be accepted as the norm in such infrastructure projects (114). The government provides a fiscal guarantee, which would often be seen as a major success factor for the project (115) but in this instance illustrates the inequity of the direct effect of politics representing a single major stakeholder's preferences in the UK infrastructure project decision-making process (116). This somewhat biased influence on the construction project (117) shows a lack of fairness to the ordinary paying customer as another critical stakeholder by forcing on them additional costs, having ignored their legitimate reactions to the project (118; 119) in contradiction of their forthright sustainability agenda and perceptions (120). This further suggests that the project management - PMC and Contractor - operate as an inconsiderate "constructor" (121) and also exposes the whole project to underperformance claims by displaying ineffective corporate social responsibility (122) through an inadequate project design leading to continuing sewerage flows into the Thames River.

Further, client project requirements were sealed early by the UK government as an itinerary of what was required from an engineering standpoint. For example, the funding provided by the UK government for the project has not changed in 10 years. Most engineering scope had already been determined by the Client of the project - as adopted by Bazalgette Tunnel Limited (BTL) - and firmly directed by the scheme Client - Thames Water on behalf of the UK government. The initial design was presented in the bidding documents, but it still didn't remedy the flaw in the project design - that of preventing overflows from reaching the Thames River. The project's major flaw comes directly from the client requirements and is seen as a deliberate ploy to underemphasise or even conceal specific project uncertainties (118) relating to cost.

The health of users/customers of the Thames River is still going to be affected because the tunnel project does not resolve pollution overflows (contrary to 29; 123), and therefore does not prevent or mitigate previously raised health issues for those individuals using the Thames River (124). This is seen as a non-financial yearly cost of £28Mn by Defra (29) and since Defra accepts that only 60% of the benefits will

be realised (29), then this figure would ordinarily be £39.2Mn. This outcome also indicates that some important stakeholder's opinions were at best ignored during the initial design of the tunnel project (113) and provided limited project value for most independent "non-key" stakeholders (125; 126) as the risks associated with lowered overflows were still present (127).

### ***Project Leadership***

Project leadership is required to take the tunnel project forward - between Client and project managers - and to apply and deliver what is essentially the best-practice methods to ensure the project is managed within budget, is on-time, with the quality required and matches the Client requirements (128). The present leadership style appears to be bureaucratic in engagement (129) similar to Chaebols in Korea (130) reflecting the main project sponsors style of managing, leading to speculation of the lack of engagement (131). However, levels of project manager risk management further indicates that knowingly accepting enhanced risks - that of not preventing the sewer overflow issue and of only addressing 44% of the pollution incident rates - leaves the project in a clear lose-lose predicament and transforms this to face considerable risk of project failure (132; 2).

Consequently, there would also appear to be demonstrable lack of leadership in creating sustainable urban drainage (133) which is essential to ensure positive and unified project outcomes, as 52% of pollution incidents are not covered by the tunnel project (134) - leaving customers still being affected by raw sewerage consequences. Lack of appropriate project leadership appears to have resulted in ordinary stakeholders being "lost" (113) reflecting the temporary make-up of the joint ventures (135), perceived by respondents to have little direct engagement in the social/functional aspects of London. This also has implications for the on-going build (136) and the management of the sewer system post-construction through an antiquated 150-year-old hybrid system dealing with storm-water.

Ethical leadership does not appear to have a rational professional identity within the project so far (137) as project management who influence strategy and processes do not appear to show the level of ethical values or standards (138) expected of senior engineers (139) within a publicly funded project.

### ***Project Administration***

Project administration reflects the accomplishment of project specific goals and strategies through the application of knowledge, skills, tools and management techniques (128). This project has been officially reviewed by a variety of independent groups (140; 141; 142; 143 and updated by

Defra, 29). Many experts have indicated their resistance to the project (144), but there appears to be only one single pro-government funded review (145) and also reviews where some authors have changed their mind (123). It would appear that politician's, who fund the build for the Client directly, lead the project. The data would further suggest that the project shows a level of inadequate management experience that raises concern not only for the continuing project strategy (146) and scheme (147), but also for the on-going project mission (148). Further, the limited level of management experience also presents as cheaper staff, leaving the project to pay less HR costs (contrary to benefits associated with Defra, 29) and also provides lowered support for appropriate engineering supervision (149).

### ***Financial***

One of the identified issues include whether the tunnel funding is legal, as the UK government uses taxpayer money to build a sewer project in isolation of most engineers/advisor's sponsorship (11) and in contradiction of OCED's justification claim (4). The project does not appear to represent the best-value option, as it does not materially solve specific green solutions for the water resources industry. In order to partly assess this, the NAO has started an investigative review (12; 26), even though an earlier review had also been conducted in 2014 (9).

It is likely that the government sponsorship of the tunnel is embodied in the statement (8) that is part of the defence against the EU (compliance with the European Union's 1991 Urban Waste Water Treatment Directive (13) in proceedings associated with the European Court of Justice (November, 2011) (18) and that the tunnel is de Facto evidence of the UK government's defence of dealing with the sewerage discharge issue into the Thames River. In essence, the UK government appears to support the tunnel construction for political reasons and further exacerbates good engineering practices with a defence that requires its go-ahead. In effect, the tunnel build is a political solution, not an engineering solution. Further, the government states clearly that "*Thames Water continues to explore alternative designs and routes for the Thames Tunnel to deliver the environmental objectives with the least disruption and cost*" (8). It is unclear when the UK government closed this out, as this point is conveniently ignored by the government and raises concern as to why this section was not utilised in light of other developments for supporting viable alternatives to this tunnel in other reports since 2012, such as NOA (9) and TBGE (11) at lower costs.

### ***Technical***

In terms of the construction industry, every major contractor in civil engineering today will adopt portfolio project



management techniques (150) to manage their responsibilities. It is difficult to understand how construction companies holding major project portfolios determine that constructing a flawed project (151), with subsequent impacts of high risk and uncertainty in the engineering design (152), is in their best interests. There is also an emotive effect on their reputation as a consequence (153; 40).

When designing a complex civil engineering project, the Client requirements are always to be designed into the project scope through an intimate assessment of client needs by utilising design criteria to align business objectives with the developing project strategy. As a design flaw example, more than 20 shafts are designed into the project and one of the ventilation shafts is placed in the middle of an upmarket “artisan village” (154) raising an intervention by respected architects as the tunnel provides “*no diversity, improved amenities, [Or] improvements in air and water quality...*”.

A pertinent issue directly related to volume is why a choice was made for a specific diameter of 7.2m? This aspect was raised in the TTSS report (140) and stipulated “at least” 6m for unclear reasons related to pumping and screening capacity - but would unlikely “choke during filling” (140) - which does little to reassure people that the design is effective and based on good engineering and mathematics. However, the final diameter now appears to be 7.2m from many sources, which is the same diameter as for the Lee tunnel, and would indicate that the TBMs for that project will be used on the Tideway tunnel project - but no statement has been issued indicating the savings made from their reuse. Further, the same launch site as for the Lee tunnel will be used - again suggesting that Thames Water is possibly massaging/manipulating the financial aspects of the project as this saves £120Mn. The diameter was introduced by the Client, at a point in the project of least data (before 2005), which subsequently still provides an inadequate amount of storage volume for storm-water run-off as the tunnel storage design still provides for the expulsion of 2.35Mn tonnes of sewage into the Thames River (3, table 2, p.8 - A Low 140). However, there is the stated notion that the volume of the tideway tunnel would be 1.5Mn m<sup>3</sup> (155), which conflicts for example with the NPS determination of 1.24Mn m<sup>3</sup>, (8) and the NEC3 determination of 1.6Mn m<sup>3</sup> (48). Given that in 2014 (last data set available) 62Mn m<sup>3</sup> of CSO, and 50 discharges/year, this suggests that at best the tunnel will be at 82.6% capacity for nearly half of its time (1.24/1.5 held for 3 days) and will result as its “normal capacity”. This may not meet the environmental requirements such as target oxygen levels and health risk days (142) as opposed to the statement in TTSS (table 2, p.8 - A Low 140). Unfortunately, this does mean that the tunnel capacity is insufficient for the purposes indicated by BTL and the TTSS as the EA indicate that only 5 discharges would be unsatisfactory in any year (142) (as opposed to once per week) and that there will be 3 discharge events (estimated at 2.28Mn tonnes - table 2, p.8 - A Low 140). Further, the 1.5Mn

m<sup>3</sup> as indicated by BTL, cannot be realised as the tunnel can only be completely filled with 90% CSO run-off. Thus, the available capacity over the “norm” is just 7.4% - 111000 m<sup>3</sup> which gives little room for increases in sewerage or storm-water through the on-going social development of London. However, in a wet year the CSO can be over 100Mn m<sup>3</sup> as stated by Stryde - Head of London Tideway Tunnels (156). In this respect, in a wet year the tunnel capacity would be consistently overwhelmed leading to unjustified CSO overflows of undue proportions and effects - the same as today without the tunnel project construction. So again, why choose a specific diameter of 7.2m for the sewer tunnel? Further, the tideway tunnel does not off-set the 48% pollution incidents (134) that are not directly related to storm-water occurrence and consequently, there is a substantial oversight as to how the tunnel project could enhance the specific and general pollution events known to occur in London.

A developing tunnel issue was the option of the separation of sewer system (8; 142; 140) and refers to the notion that “most new developments” in England separate out surface water drainage from sewerage and comprise at least 40% of the wastewater management installations in England (8). Thus, the government mandates a retrospective construction design, which is in opposition to this modernisation approach and signifies clearly the negative influence of politicians in the management of large infrastructure projects.

Further geotechnical issues remain. For example, it has been recognised by Defra (142) that the risk of unforeseen ground remains high, while no stipulated methodology has been developed by the Client nor the Contractors to off-set this issue. To date, only a contingency financial plan (15%) (8) has been put forward and this further suggests that the financial risks associated with the tunnel project have been largely ignored, leading to the possibility of cost-inflation, overly ambitious and risky management plans and raising the issue of engineering ineffectiveness.

The use of segmental tunnel lining as part of the narrative of Thames Water to provide objective evidence of cost-savings (8) is nullified as this is an accepted cost-effective tunnelling methodology. However, other options to the use of the TBM machine such as NATM techniques have not been discussed or presented elsewhere for this project. The importance of NATM has been ignored, and is especially relevant as all connections to other sewers, surface, river and storm-water drains must be carried out through NATM.

### **Project Personnel**

Further, the evidence points to a lack of managers/engineers who are qualified in project management or even graduate studies contrary to expected best practices (157; 158), leading to issues relating to the sustainability of project’s control and governance (159; 128).

Further, the status of the BTL has been brought into dispute, through an unusual business venture that creates difficult notions surrounding ethical practices – financial, personnel, and business - in a large infrastructure project through observable malfeasance supported by the UK government. This can also be viewed in terms of the unethical connections related to conflict of interests – government officials, DEFRA, BTL management, the owners of Thames Water – The Macquarie Group, and the strong engineering issues raised in such a flawed project. It becomes clear that corruption is a major activity in the project which is contrary to even the most modest operating business in terms of financial ethics, negative business influence, and transparency. For example, the fact that the UK DEFRA Minister overseeing the acceptance process for the tunnel when retired became a Director for Thames Water suggests that there is an alarming convoluted influence of many “independent” actors – PwC directors, Ofwat directors, EA top management, have taken high paying jobs in BTL and there are also members of the boards for the Contractors teams is an overly arrogant, incestuous relationship thus attacking the integrity of the 31 other water companies in England who have to manage rigorously, transparently and independently as regulated companies who supply water under a licence, through the Defra regulatory framework (160). Therefore, the JVs appear not to be independent – horizontally or more importantly vertically, but influenced directly by Thames Water and the UK government – augmenting the influence proposition of BTL through arranged, clandestine measures. It is this issue that the NAO (26) have introduced an assessment of the potential irregularities in its financial structure and management disposition. The flaw in the project is not just an engineering one, but an ethical financial/management one, that unfortunately leads straight to the UK government.

### **Environmental**

An unequivocal issue was the environmental impact - not only in its operation, but also in its construction, perceived and reported by many respondents as leading to a demonstrated lack of green infrastructure (161). This is especially contentious when considering the level of unnatural pollution incidents (134). Of real concern for most respondents was the project's inability to stop the pollution of the Thames River through the abatement of storm-water expulsion into the Thames River - contrary to The Flood and Water Management Act (162) and 163). There is also the issue of the risk to local flooding caused by ineffective storm-water management (as no material changes are made to this system during this project) combined with the pollution effects of a CSO system. Further, this grey infrastructure does not contribute to groundwater recharge and other ecology developments (164). There is therefore an obvious environmental issue that the project does not go far enough to prevent known pollution

issues. Further, since the project contains only about 48% of the pollution incidents (134), then this could be seen as being unnecessarily expensive as well as not adhering to appropriate pollution standards. The EU regulations on pollution of the Thames River are therefore being ignored and there may also be further fines coming from the EU for the UK government as a consequence of Thames Water continuing to contravene UWWTD (13). To further characterise this point, Thames Water was fined a record £1Mn in January 2016 (165) and another £380,000 in March 2016 (166) for two separate pollution incidents on the Thames River.

Environmental concerns abound in the project, not only because of the construction but also resulting from the mismanagement of the process of its construction. However, most respondents reject the chaos that would be brought to bear on London, through a flawed project - which would necessitate further suffering and anxiety at some future point as local/small sewer systems are repaired which is the focus for 52% of the pollution incidents (134).

### **CONCLUSIONS**

The project design does not help to enhance confidence in the project manager's capability of managing storm-water flow across London. This causes a negative perception of managerial led design flaws, with the spend of £4.2Bn, without solving a critical issue - that storm-water and sewerage meets underground, as it did some 150 years ago. This tunnel build is thus a flawed engineering project, with an ineffective design that leads to the perception that it is about spending money, rather than creating critical infrastructure to reduce environmental issues in a green, positive way. The tunnel project therefore exacerbates the environmental issues that it is supposed to solve at a cost to London's residents. At best, the present design reflects a short-term focus on a severe long-term problem. The government's major influence on the management of the project reflects inequities, lacks a proper engineering position and solution through an inappropriate design, underestimated costs, and leaves residents still needing an appropriate, optimal, and green solution that does not affect their social or health needs.

From a *technical position*, the project fails to fulfil the requirements to provide the best engineering solution to a specific and definable problem as is required from good project management governance practices. In this respect, the project technical outcomes do not meet appropriate technical requirements as it fails to stop the overflow of storm-water in the system, does not ameliorate the issue of sewerage flows into the Thames, and does not therefore make a sustainable, green project.

From a *financial position*, the project fails to meet UWWTD requirements (13) in not being able to provide the best technical knowledge without sustaining excessive cost.

Another issue that is raised is the support of the taxpayer's money to support a private water company, which continues to have a monopoly on water management/provision for most of London. Thus, Ofwat's duties of protecting consumers by promoting effective competition (167) does not seem to "hold water", especially when the bidding process resulted in a lack of bidding competition (11; 160) and therefore lacks appropriate choice and fails the "competitive bidding" test. Consequently, this is also against EU regulations on the government support of one company, being materially against open-governance and also directly against EU competition law (Article 102, 2016 affecting consumers 168) - being a financial contribution such as a grant as in this case. Further, the huge cost of the project, committing customers of Thames Water to a continuing additional yearly cost of upto £85 on top of their normal water bill, therefore does not provide fitness for purpose (see 169) whilst Thames Water still pollutes the Thames River.

From a *legal position*, the project is funded mostly by taxpayer's money through Ofwat (£3.1Bn) and directly from Thames Water and is thus a selective financial measure to give an unfair advantage to Thames Water as a private company over other water companies and amounts to illegal state aid under EC rules. Further, the project does not appear to fulfil the UK government's responsibility under the EC Urban Waste Water Treatment Directive (13) to prevent pollution - especially pollution aspects it is aware of, as the project is seen by the UK government as helpful to prevent EU fines (170).

The outcome of the government's singular instruction through DEFRA's to Ofwat (160) to continue with the bidding process after it was perceived as operating against EU competition rules, and award BTL the project (145; Article 102, EU competition law 168) even when the process resulted in little competition (contrary to HM Treasury, 171) underpinning the project's bid process scope which was deemed as "non-competitive" (11). This resulted in a controlled, non-credible and monopolised judgement (8; 172). This further reflects Ofwat's failure to adequately impose regulation 4(1) of the SIP regulations that the project is part of its normal duties under s37 or s94 of The Flood and Water Management Act 2010 (162). This project therefore represents a failure of the Regulator and government Minister in charge to oversee appropriate development related to the sewerage undertaker - Thames Water - as part of the conditions of the operating licence managed by Ofwat. When applying strategic project management - the first notion is to build an appropriate business case (146). At present, the business case assessment fails and therefore applying any kind of overall strategic project management audit means the project would also fail.

The sewer tunnel project is not designed to provide infrastructure repair or remediation to an estimated additional 21000Km of small street sewers. This is why 52% of the

pollution incidents (Thames Water, 2014 134) will not be solved through the Sewer Tunnel project. This is a major on-going concern of the process used to ameliorate pollution incidents generated by Thames Water. Irrespective of the impact of the reduction of overflows, Thames Water was fined £443,000 in 2014 for pollution incidents and has already been fined £1.38Mn in 2016 (to March). Of further concern is that less than 48% of the pollution incidents were recorded as coming from wet weather situations (134). This ultimately means that the Sewer Tunnel build reduces less than 44% of the pollution incidents in London and still punishes the Londoners and the Thames River with direct inflow of an estimated 2.35Mn tonnes of raw sewage (3).

From an *environmental standard* this is not a project to show the application of "World Environmental Standards" and this is one of the major failings of the sewer tunnel project. Design decisions, ignoring the environmental effects of CO<sub>2</sub> have been made based on basis that "*The project is considered to be an infrastructure scheme of national significance... which cannot be compromised.*" (173).

No engineering concern sets out to build an innovative infrastructure design and then limits its functioning capability or fail to address core environmental issues in a project it should be designed to protect against. Thames Water is the highest water polluter in the UK, and is also the company that has been fined the most for a single pollution event. However, if the Thames Water has "...signed up a team of world-class contractors..." (168), then this leads to a singular question as to why is the design ineffective in providing sustainable construction for the main objective to prevent sewerage overflow for the duration of its intended life - 120 years (29). Overriding these - financial issues and project objectives - is the notion of project failure factors, which includes "inadequate basis for project" (37) - which indicates that the flaw in the design may be a contributory factor in its ultimate failure.

In terms of the *UK government*, this research outcome indicates clearly that politics, large funding measures and a critical need do not provide the UK government with the appropriate understanding to disproportionately influence ways of conducting large project infrastructure processes. However, it further shows that the UK government has possibly acted illegally - through funding and process manipulation. Further, the outcome of the project has a negative effect on public credibility of sewer construction and management (22). This is reinforced by Pelling who questioned "...whether in the twenty-first century, discharges of combined foul sewage and rainfall into the Thames is appropriate..." (174), thus questioning the extremely narrow view of London as an exemplary and sustainable, world city (175).

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