Department for Environment, Food and Rural Affairs

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Costs and Benefits of the Thames Tunnel

Contents

Introduction

1. This annex sets out more detail on the high-level calculations which have been performed by Defra to update the monetary costs and benefits of the Thames Tunnel first estimated in 2007. It is accompanied by a table breaking down the results of the analysis by cost and benefit category (see Table 1 at the end of the Annex).

Headline results

2. As reported in the main body of the *strategic and economic case* document, the headline cost and benefits of the Thames Tunnel are as follows (discounted Present Value figures and 2011 prices):

Whole life costs:	£4.1bn
Whole life benefits:	Between £3.0bn and £5.1bn
Overall position:	Benefits likely to at least exceed costs, especially considering wider unquantified benefits

General approach and caveats

3. The analysis reported here is only in respect of costs and benefits to which it is possible to attach numerical monetary estimates. For benefits in particular, this is likely to give only a partial view of the economics of the Thames Tunnel. Benefit estimates are restricted to those associated with reduced fish deaths through Dissolved Oxygen impacts, better health outcomes for river users (e.g. rowers) and reduced sewage litter and odour. These were the only benefits for which monetary estimation was possible (through a stated preference "Willingness to Pay" survey). It is thought that there are also likely to be benefits arising in the following areas but it has not been possible to estimate monetary values for these, and they are therefore not included in the analysis:

- Avoidance of damage to London's reputation as a business and tourism centre (especially given similar waste water investments being made in competitor locations);
- Avoidance of any long-term adverse impact on the desirability and value of riverside property;
- Reduced sewer flooding in some locations (or reduced costs for sewer flooding schemes);
- Energy generation from extra volumes of sewage sludge captured at Beckton Sewage Treatment Works (otherwise lost through sewer overflows);
- Short-term employment, economic growth or regeneration impacts related to construction.

4. Furthermore, it should be noted that any financial impact on the UK government arising under a "do nothing" scenario from non-compliance with the Urban Waste Water Treatment Directive (i.e. through fines) has not been accounted for in the analysis.

5. The analysis of costs and benefits should be viewed as high level, with particular uncertainty attaching to benefit estimates, hence the presentation of these as a fairly broad range.

Cost estimates

6. The Present Value whole life cost estimate has been estimated as follows:

a) Latest **project costs** have been taken from Thames Water (version Rev05b dated September 2011). This is made up as follows:

Rev05b base costs:	£3,228m (2008 prices)
Risk estimate & Optimism bias correction*:	£ 831m (2008 prices)
Indexation adjustment**	£ -291m (adjustment to 2011 prices)
Allowance for inflation uncertainty**	£ 291m
Total	**£4,059m (2011 prices)**

Notes:
* The risk estimate is derived at the 80% level ("P80"). This means there is an 80% chance that project costs will come in at or below the figure presented, according to modelling but based on certain assumptions. An adjustment is then made to correct for potential remaining likely optimism bias in the cost estimate.
** Whilst the BCIS All New Construction Index used to determine the indexation adjustment suggests construction prices have fallen since 2008, to remain conservative, this is ignored. As such, the total 2011 price estimate is taken to be the same as the estimate in 2008 prices.

b) For the purposes of the cost and benefit analysis, it has been assumed that the project costs are spread over a 10 year period between 2011 and 2020. Over this period, construction price inflation (over and above general price inflation) is assumed to resume in 2014, at a rate of 1% per annum for the remainder of the project. In reality, the costs will be spread over a longer period (potentially indefinitely if the Tunnel is financed through an "undepreciated" Regulatory Capital Value approach), which could lead to a lower Present Value (discounted) cost. However, any such reduction will tend to be offset by financing charges. Firm analysis of the affects of financing proposals for the Thames Tunnel on its fundamental economics will be conducted when proposals are more developed.

c) In July 2011 Thames Water identified some **additional project costs** arising from extension to the programme to 2022, and changes to the project following Phase 1 and 2 consultations, as well as developing the delivery route. It has been assumed that these costs (totalling £244m in 2011 prices) are not included in the Rev05b base cost update above, and are profiled into the analysis in 2021 and 2022 (accounting for excess construction price inflation as above).

d) Beyond 2022, the ongoing need for **operating and maintenance expenditure** (including capital replacements) has been factored in to provide an analysis of total costs of the Tunnel over its whole (design) life. The latter has been assumed to be 100 years, which is in line with other major civil engineered structures in the water and flood management sectors. Annual ongoing costs have been derived from the 2007 Regulatory Impact Assessment[1] in the absence of more recent evidence and updated to 2011 prices. However, the 2007 RIA figures (equivalent to £13.5m per annum in total, in 2007 prices) related to a project which included what is now the Lee Tunnel (from Abbey Mills to Beckton, now being taken forward separately). As such, the share of ongoing cost applying only to the Thames Tunnel has been estimated, based on its share of total mileage (20 out of a total of 24 including the Lee Tunnel).

e) The 2007 Regulatory Impact Assessment (RIA) also included some **"non-financial" costs** in respect of the Tideway solution then being considered (i.e. including what is now the

[1] *Regulatory impact assessment – sewage collection and treatment for London*, Defra, March 2007

Lee Tunnel). These comprised the costs of Greenhouse Gas (GHG) emissions, valued at the then Shadow Price of Carbon (Defra 2007), plus costs arising from traffic congestion during construction, and the environmental costs arising from the transport and disposal of construction waste. Again, these have been updated to 2011 prices and apportioned to what is now the Thames Tunnel based on share of total tunnel mileage. A further high-level adjustment was made to reduce the total non-financial costs by 50%, to account for the fact that current GHG accounting practice as recommended by DECC is to only monetise GHG emissions which are not covered by the EU Emissions Trading Scheme (ETS). We await definitive advice from Thames Water on the share of any materials not produced within the ETS, but we understand this will be small. For now the 50% adjustment is arbitrary but designed to be conservative.

7. Total undiscounted financial costs of the Thames Tunnel over its whole life are estimated at around £5,625m. In discounted (Present Value) terms the equivalent figure is £4,035m. Adding in the non-financial costs set out at e) above, the total Present Value cost of the tunnel over its whole life is estimated at **£4,061m**.

Benefit estimates

8. The starting point for deriving a revised monetary benefit estimate for the Thames Tunnel was the Present Value (discounted) figure used in the 2007 RIA for what is now the Thames and Lee Tunnels combined, which was £3,935m in 2006 prices[2]. This figure relates to the so-called "Benefits Jurisdiction", i.e. the whole of the UK (albeit with benefit attenuating with distance from the Thames). It therefore represents a "social" ("UK plc") value rather than one accruing to Thames Water customers alone (who constitute the "Administrative Jurisdiction" – for more information see EfTEC 2006[3]).

9. The GDP deflator has been used to update the aggregate Present Value benefit figure from 2006 to 2011 prices – an increase of 10.6%. The resulting estimate of £4,353m has then been apportioned 60% to the Thames Tunnel and 40% to the Lee Tunnel. These proportions are high-level estimates based on the share of overall Combined Sewer Overflow tonnage which will be handled by the two tunnels. Although more definitive modelling would be desirable, this is not yet available. However, the assumed apportionment has been sense-checked against Thames Water advice that the Thames Tunnel will deliver roughly half of the major Dissolved Oxygen benefit, plus more or less all benefits in the areas of health improvements and sewage litter reduction. On this basis, an estimate of 60% of total benefit accruing to the Thames Tunnel does not seem inappropriate.

10. In the 2007 RIA, an appraisal period of 60 years was used for the then Tideway options. This was despite NERA accepting that "the physical life of the major asset of the project (the tunnel) is assumed to be 100 years plus"[4]. In this update of the analysis we have taken the Treasury Green Book recommendation that the appraisal period should be taken as the useful life of the assets. As such, the estimated benefits accruing to the Thames Tunnel have been extended over a 100 year period, by dividing by the cumulative Green Book discount factor for 60 years (26.2285) and multiplying by that for 100 years (29.8125). This gives a 100-year

[2] In turn this figure was derived from *Thames Tideway Cost Benefit Analysis*, NERA for Thames Water, 30 January 2007 (see p.32, figure for Option 1c). NERA aggregated the results derived in a Stated Preference ("Willingness to Pay") survey conducted in 2006 by EfTEC (see next footnote).

[3] *Thames Tideway – Stated Preference Survey*, EfTEC for Thames Water, 22 December 2006.

[4] NERA 2007, p.6. NERA accepted the Green Book recommendation on appraisal periods, but cited uncertainty as a reason to not apply the full appraisal period for Tideway options. In this update we prefer to take the Green Book recommended appraisal period to maintain consistency with other public projects (especially in the water and flood management context), and consider uncertainty separately.

"basic" benefit figure for the Thames Tunnel, in 2011 prices of **£2,969m**. We take this as the lower end of the likely benefits range for reasons set out below.

Range of benefit (all figures Present Values in 2011 prices)

11. Since the 2007 RIA, a number of issues have emerged which suggest a revised view of aggregate benefit of the Thames Tunnel should be taken. These issues generally suggest the original 2007 analysis underestimated benefit. Two of the issues (population and real income growth – see below) might have been foreseen at the time, but given the much lower cost estimate for the tunnel at that point, there was probably a degree to which benefits were seen as "high enough" to demonstrate a good economic case, and the return on further analysis was seen as weak. With the costs of the tunnel now somewhat higher (although it should be noted that the 2007 RIA cost estimates did not include an optimism bias correction), it is now worthwhile to revisit these issues. They are set out as follows, along with a further issue surrounding the baseline environmental conditions:

a) The original RIA analysis did not take account of the impact of **population growth** on benefits. There are two issues here. First, population growth is likely to impact on the baseline CSO spill frequencies and volumes over time, so the benefits of the tunnel may be expected to increase against this baseline (subject to the tunnel's capacity, though separately Thames Water estimate this is not likely to be a constraint given future climate and population forecasts – which *have* informed the design). Secondly, as the population increases, so does the "benefits jurisdiction", i.e. the number of people expected to enjoy the environmental benefit of the tunnel. A "test" has been carried out to see how a modest assumed increase in population might affect the "basic" aggregate benefit figure. We have applied population forecasts for London reported in Thames Water's Water Resource Management Plan[5] (12% by 2021 and 29% by 2035) to annual estimates of benefits, assuming a 1% increase in population increases the benefit by 1% and assuming no further growth beyond 2035 to be conservative. This leads to an overall increase in aggregate 100-year Present Value benefit from £2,969m ("basic" lower bound estimate) to **£3,391m** (an increase of 14% overall). Clearly this is at best illustrative but it does show the impact of fairly modest population growth.

b) Similarly, the original RIA analysis did not take account of the effect of **real income growth** over the life of the tunnel on benefits. In fact, it is common practice in environmental appraisal to uprate "Willingness To Pay" based estimates for public or environmental goods for real income increases. We also understand the uplifting of benefits for real income growth is standard practice in the cost-benefit analysis of other public projects (notably, transport schemes). Real income growth would be expected to increase the benefits of the tunnel – because environmental benefits are observed to have a positive income elasticity (i.e. people value the environment more as wealth increases). The basic benefit estimate of £2,969m has been uplifted to account for real income growth, but assuming only modest growth over the next few years, in line with the current economic situation. ONS GDP estimates have been used for growth to the period to 2010, followed by Treasury estimates of mid-term growth to 2014[6], followed by an assumed return to the long-term real growth rate (2% per annum[7]) beyond. Using this profile leads to an increase in the aggregate Present Value benefit estimate of 33% to **£3,948m**.

[5] *Water: Planning for the Future; Revised Draft Water Resource Management Plan*, Thames Water 2010.
[6] HMT Forecasts for the economy published 18/08/10.
[7] HM Treasury Green Book, Annex 6, Paragraph 9.

c) It has become apparent that the **spill volumes from Combined Sewer Overflows are somewhat worse** under the baseline (no project) case than previously thought. Thames Water now estimate an annual spill volume of 40Mm^3 rather than 32Mm^3 used in the 2007 assessment. Given that the Thames Tunnel reduces volumes to a fixed level consistent with meeting the Urban Waste Water Treatment Directive, the implied benefit of the tunnel is therefore likely to be larger than previously estimated. Accounting for a small change since 2007 in the estimated residual spill volume of the tunnel[8], the net change is a 24% additional reduction in spill volume arising from the project (based on current conditions). Assuming this equates simply to a 24% increase in benefit, the benefit estimate would be **£3,694m**. It should be noted that this estimate does not apply any diminishing marginal benefit in reducing spill volumes however, which may result in an overestimate.

12. A nominal but arguably conservative "upper bound" on the range of revised benefits from the Thames Tunnel has been calculated by combining "tests" a) and b) above (but not c, which may not be robust), which gives a figure of **£5,058m** as a 100-year Present Value figure.

13. As such, the quoted **range of benefit for the Thames Tunnel is now put at between £2,969m and £5,058m**. Whilst it might be argued, for the above reasons, that the upper bound could defensibly form a new "central" estimate, we are cautious about claiming this at this stage, especially given the delicate economic situation and the uncertain impact of this on real income growth in the near term. It might also be argued that any uplift in nominal value in the benefits estimate from 2006 to 2011 could also be questionable given the recession over this period (though not applying the uplift in general prices to the 2006 benefits estimate would reduce it only by around 10%). Furthermore, there is the general uncertainty surrounding benefit estimates of this type (i.e. derived from a survey of Willingness To Pay for essentially unmarketed goods and services). On balance however, we would argue that the benefit is more likely to be in the upper half of the range than the lower half.

Conclusions

14. In conclusion, we present a range of estimated monetary benefit for the Thames Tunnel of £3.0-5.1bn, but without making a strong statement about the most likely point within it. Rather we suggest it is reasonable to assume that benefit will be in the upper half of the range, given some systematic underestimates in the 2007 analysis. Given estimated costs of £4.1bn, this suggests that the Tunnel will be cost-beneficial (i.e. benefits will be at least as high as costs). Furthermore, given the un-quantified benefits set out earlier in this Annex - some relating to London as an economic entity (whose current GDP is broadly £250-300bn per annum) - the broad conclusion that the Tunnel is a net beneficial investment for "UK plc" would appear reasonable.

15. The Thames Tunnel cost and benefit estimates above should be viewed as high-level, to support the ongoing government position on what is ultimately a private sector investment, but will continue to be developed and refined as the project develops.

[8] From 1.7Mm3 to 2.3Mm3.

Table 1

Breakdown of monetary cost and benefit estimates (as at Oct 2011)

(See text for explanations)
£m, 100-year whole life estimates, at 2011 general prices

Item	£m	Remarks
Project costs ("Rev05b")	4,059	Undiscounted. Includes risk/OB
Construction inflation beyond 2014*	116	Undiscounted
Additional project costs*	262	Undiscounted
Ongoing capital maintenance	614	"
Ongoing opex	575	"
Total undiscounted financial costs	5,625	"
Total discounted financial costs	4,035	Discounted (Present Value)
Discounted non-financial costs	26	"
Total Discounted Costs	**4,061**	"
Total discounted benefits:		
Lower bound	**2,969**	No population or income growth - unlikely
With population growth	3,391	
With conservative real income growth	3,948	
Adjusting for 24% worse spill baseline	3,694	Assumes simple 24% benefit increase
Conservative upper bound	**5,058**	With reasonable pop'n & income growth.

* Defra estimates, but may potentially already be included in base TW "Rev05b" figure. To be clarified.

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