Business Case for Refurbishment of the Greenwich and Woolwich Foot Tunnels

1. The Scheme

The scheme is for a major refurbishment of the foot tunnels at Greenwich and Woolwich. The tunnels are over 100 years old and suffer from an increasing amount of water penetration, unreliable lifts and an uninviting walking environment. Despite this, they are well used both by local residents and, in the case of Greenwich, by tourists. Their unique contribution to London's transport network is the provision of a 24/7 opportunity to cross the River Thames by foot or cycle.

The refurbishment scheme will provide:

- Total replacements of the lifts
- Refurbishment of the domes above the lifts
- Enhanced CCTV coverage of the tunnels and help points with 24/7 monitoring
- Enhanced lighting within the tunnels
- A better quality environment within the tunnels with refreshed tiling and improved cleaning
- Improved signing to the tunnels
- Provision of real time information

The outcomes of the scheme are:

- Reliable lifts
- A facility which can be consistently used by all sections of the community including disabled and elderly people
- The preservation of the tunnels by controlling the rate of water penetration
- The preservation of the Grade II listed buildings by control of water penetration.
- A significant increase in journey ambience through the tunnels, together with increased lighting and security, 24 hours a day.

2. Costs

Capital Costs

Do-minimum

Without the scheme, the tunnels will still remain open for a while. The lifts will continue to operate with one member of staff per lift from 7am to 9pm. The lifts will however become increasingly unreliable. As parts fail there are delays in mending the equipment as many parts are now obsolete and one off replacements needs to be manufactured in order to undertake a repair. It is considered likely that after about 5 years a rising number of breakdowns would mean a minor refurbishment of the lifts would have to be undertaken. This would cost around £1.4 million in today's prices in order to replace the electronic controls, motors and lift gears.

Despite this work the lifts will continue to struggle with reliability due to water ingress and heat stress. Fifty years ago the lift shafts were still completely dry but there are now signs of significant water penetration. This will continue at an exponential rate. In addition, the current glazing of the domes above the lift shafts creates a greenhouse condition in the lift shafts. The high heat causes failure in the electronic components of the lifts. Local fans are currently used to help mitigate this but the rising average summer temperature in London will reduce the effectiveness of these measures.

The tunnel engineers are of the opinion that the increasing rate of water penetration mean that the tunnels will have to be closed in about 15 years time, around 2023 to 2025. The tunnels would be filled with pulverised fuel ash and sealed.

The cost of sealing off the tunnels is £2.2 million, including preparation and supervision costs, in today's prices. This includes filling the tunnels, demolishing the domes and other surface structures and landscaping the area. If the tunnels were not filled it would each cost well over £200,000 a year at first just to keep them safe but closed.

Scheme

There are no land costs for the scheme as there is no additional land requirement for the scheme. Assuming an approximate allocation of costs between lifts, domes and tunnel works the construction costs for the scheme are:

- Preliminaries and mobilisation £ 1.3 million
- Tunnels £ 5.5 million
- Lifts £ 2.2 million
- Dome £ 1.4 million

A full breakdown of these costs is provided in table 1 below. This shows the costs if both tunnels are refurbished at the same time. Table 2 shows the costs for Greenwich tunnel if it is refurbished alone and table 3 shows the costs for refurbishing Woolwich tunnel on its own. There are costs savings of around £1.5 million if both tunnels are refurbished under the same contract.

Table 1: Scheme Capital Costs, Both Tunnels

Item	Capital	Prep	Supervision	Total
Preliminaries and Mobilisation	1320.0	79.2	66.0	1465.2
Civil and Structural Engineering				
- tunnel	4200.0	252.0	210.0	4662.0
- shaft	336.0	20.2	16.8	373.0
- lift pits	240.0	14.4	12.0	266.4
- topworks buildings (domes)	1368.0	82.1	68.4	1518.5
- ancillary steelworks	288.0	17.3	14.4	319.7
Mechanical and electrical	480.0	28.8	24.0	532.8
Lift engineering	960.0	57.6	48.0	1065.6
Communications	480.0	28.8	24.0	532.8
Architecture, landscaping, lighting	720.0	43.2	36.0	799.2
Total	10392.0	623.5	519.6	11535.1

Table 2: Scheme Capital Costs, Greenwich Tunnel alone

Item	Capex	Prep	Supervision	Total
Preliminaries and Mobilisation	1200.0	72.0	60.0	1332.0
Civil and Structural Engineering				
- tunnel	2040.0	122.4	102.0	2264.4
- shaft	144.0	8.6	7.2	159.8
- lift pits	120.0	7.2	6.0	133.2
- topworks buildings (domes)	768.0	46.1	38.4	852.5
- ancillary steelworks	144.0	8.6	7.2	159.8
Mechanical and electrical	211.2	12.7	10.6	234.4
Lift engineering	480.0	28.8	24.0	532.8
Communications	300.0	18.0	15.0	333.0
Architecture, landscaping, lighting	540.0	32.4	27.0	599.4
Total	5947.2	356.8	297.4	6601.4

Table 3: Scheme Capital Costs, Woolwich Tunnel alone

Item	Capex	Prep	Supervision	Total
Preliminaries and Mobilisation	900.0	54.0	45.0	999.0
Civil and Structural Engineering				
- tunnel	2760.0	165.6	138.0	3063.6
- shaft	192.0	11.5	9.6	213.1
- lift pits	120.0	7.2	6.0	133.2
- topworks buildings (domes)	600.0	36.0	30.0	666.0
- ancillary steelworks	144.0	8.6	7.2	159.8
Mechanical and electrical	268.8	16.1	13.4	298.4
Lift engineering	480.0	28.8	24.0	532.8
Communications	300.0	18.0	15.0	333.0
Architecture, landscaping, lighting	180.0	10.8	9.0	199.8
Total	5944.8	356.7	297.2	6598.7

Operating costs

Do Minimum

The current operating costs of the tunnels are around £670,000 a year which is met by the London Boroughs of Greenwich, Tower Hamlets and Newham. The boroughs would continue to cover the operating costs under the scheme proposals.

The annual current, do minimum, operating costs are:

- Staff, £300,000
- Term contractor for cleaning etc £200,000
- Replacement bulbs, £38,000
- Power, £72,000
- Contingency e.g. vandalism, £60,000

It is assumed in the business case that the tunnels close in 2024 so operating costs are incurred for 13 year (2011 to 2023 inclusive). This gives a total operating cost of £8.7 million.

Scheme

Under the scheme the annual operating costs would fall from £670,000 to £540,000.

The staffing costs would fall from £300,000 to £225,000 as staff would no longer be needed to man the lifts. They would be replaced by staff monitoring both tunnels 24 hours a day from the CCTV control room. These staff will be able to monitor the whole of the tunnel and its approaches on CCTV cameras, change the messages carried on the variable message signs and speak out verbal messages to people in the tunnels through a speaker system. They could also speak individually to people who use the help points provided.

Power costs are anticipated to fall by 20% due to the use of more energy efficient lift equipment and lighting. The allowance for the term contractor, which mainly covers cleaning, will also fall by 20% because the refurbished tunnel will have more power points for cleaning equipment and a revised cleaning and lamp replacement schedule.

Over a 60 year project life the total of operating costs amount to £32.5 million.

The annual operating costs for the Do_Minimum and the scheme are summarised in table 4 below.

Table 4: Annual operating costs, 2008 prices

Item	Do-Minimum	Scheme
Staff	£300,000	£225,000
Term Contractor	£200,000	£160,000
Replacement bulbs	£38,000	£38,000
Power	£72,000	£58,000
Contingency	£60,000	£60,000
TOTAL	**£670,000**	**£541,000**

Maintenance Costs

Do-Minimum

In the do-minimum scenario the annual maintenance costs of the pumps, ventilation, electronics equipment and lifts are £85,000 a year. This is because many of the components required are specialist, one-off orders. It is assumed in the business case that the tunnels close in 2024 so maintenance costs are incurred for 13 year (2011 to 2023 inclusive). This gives a total maintenance cost of £1.1 million.

Scheme

With the scheme, the annual maintenance cost of the pumps, ventilation, electronics equipment and lifts is reduced to £50,000 a year. Over a 60 year project life this gives a total of maintenance costs of £3 million.

Summary of Costs

A summary of capital expenditure costs is shown in table 5 below. These are all in today's prices and include preparation at 6% and supervision costs at 5%. It is assumed that 35% of the Scheme construction costs are incurred in 2009, 50% in 2010 and 15% in 2011.

Table 5 Capital costs, current day prices

	Do-Minimum				Scheme		
	Greenwich	Woolwich	Both		Greenwich	Woolwich	Both
Year	alone	alone	Tunnels		alone	alone	Tunnels
2009	0	0	0		2310	2310	4037
2010	0	0	0		3301	3299	5768
2011	0	0	0		990	990	1730
2012	0	0	0		0	0	0
2014	800	800	1440		0	0	0
2024	1100	1100	2200		0	0	0
2036	0	0	0		550	550	1000
2061	0	0	0		550	550	1000
Total	1900	1900	3640		7701	7699	13535

Total costs

Table 6 shows these same amounts as adjusted according to the procedures in the TUBA software issued by the DfT and replicated in the business case spreadsheet used in this study. Preparation costs of 6% have been added as it is assumed the scheme is

at the equivalent of Orders Publication stage. Supervision costs of. 5% are also added. Optimism bias has been applied at 44%. These costs are converted to 2002 values using Retail Price Index (RPI) figures of 211.1 for 2008 Q1 and 176.2 for 2002. They are also adjusted to market prices and discounted to 2002.

Validation against TUBA

The business case spreadsheet produces slightly different numbers from TUBA as the spreadsheet is more accurate in its allocation of operation and maintenance costs between years. In the spreadsheet the costs are entered for each year. In TUBA the total operating and maintenance costs over the whole appraisal period are entered as single value. The proportion of these costs that occur each year is also entered, but only as an integer value.

For validation purposes TUBA was run as well as the spreadsheet. The total scheme present value costs in TUBA is £16.4, and in the spreadsheet it is £16.2 million. The Do-Minimum scheme costs £8.875 million in TUBA and £8.845 million in the spreadsheet. The Scheme costs £25.312 in TUBA and £25.016 million in the spreadsheet.

Table 6 Total costs, £'000s

	Scheme		
Costs (present value)	Greenwich	Woolwich	Both
£ '000s	Alone	alone	Tunnels
Investment costs	6219	6217	10639
Operating and maintenance costs	3024	3024	5532
Present Value Total Costs	9243	9241	16171

3. Patronage

Patronage counts

A video survey was carried out on four days from Thursday 25th October 2007 to Sunday 29th October 2007 at each tunnel in order to count the number of pedestrians and cyclists using the tunnels over the full 24 hours for a four day period. The full count data is presented below in Tables 7 and 8 for Greenwich and Tables 9 and 10 for Woolwich overleaf.

Figure 1 shows the total patronage at Greenwich on each day and Figure 2 shows the total patronage at Woolwich each day. Figures 3 and 4 show patronage by time of day for each day at Greenwich and Woolwich.

Figure 5 shows the number of northbound and southbound users of Greenwich tunnel on an average weekday by time of day and Figure 6 shows the same information for the Woolwich tunnel.

Greenwich Tunnel is used by around 1500 pedestrians a day on a weekday and by even more people at the weekend. The highest daily use is on a Saturday. There are a high number of cyclists using the tunnel as well. On an average weekday there are nearly 800 cyclists using the tunnel which is just over a half of the number of pedestrians. This is a high ratio of cyclists to pedestrians.

At Woolwich there are slightly more pedestrians using the tunnel than at Greenwich, with over 1650 pedestrians recorded each day. Here there are slightly lower numbers at the weekend, with Saturday and Sunday flows of around 1250. The number of cyclists is a lot lower at Woolwich, possibly because of the presence of the Ferry as an alternative. The number of cyclists was 160 on a weekday, 74 on Saturday and 41 on the Sunday. The weekday ratio of cyclists to pedestrians at around 1:10 is still quite high, though not of the same order as observed at Greenwich.

Figure 1 Total patronage at Greenwich by day

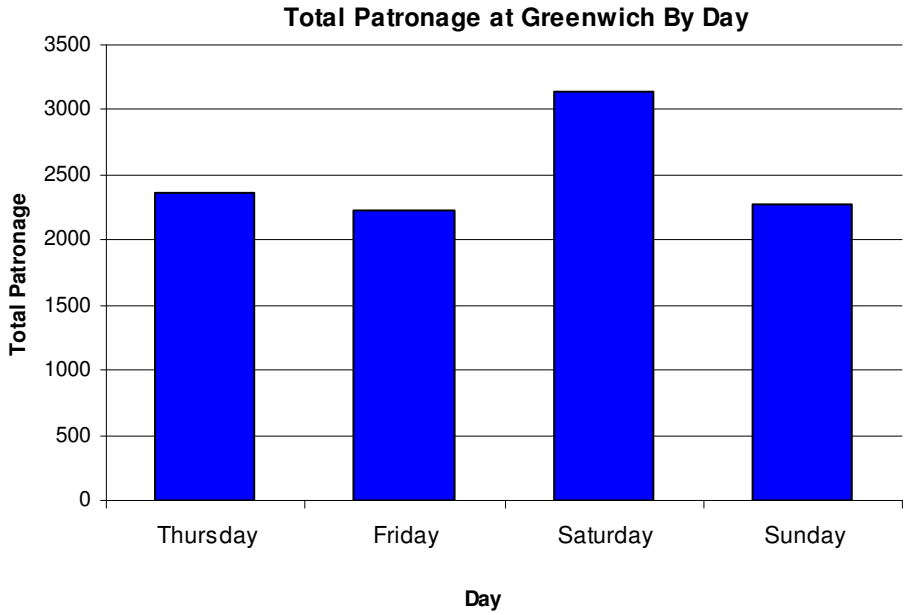

Figure 2 Total patronage at Woolwich by day

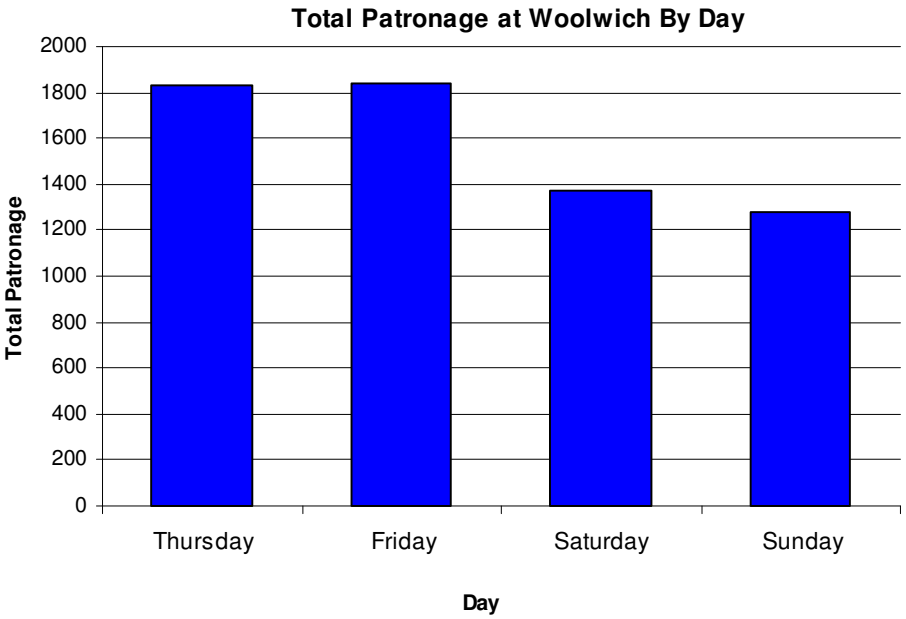

Figure 3 Patronage by time of day for each day at Greenwich

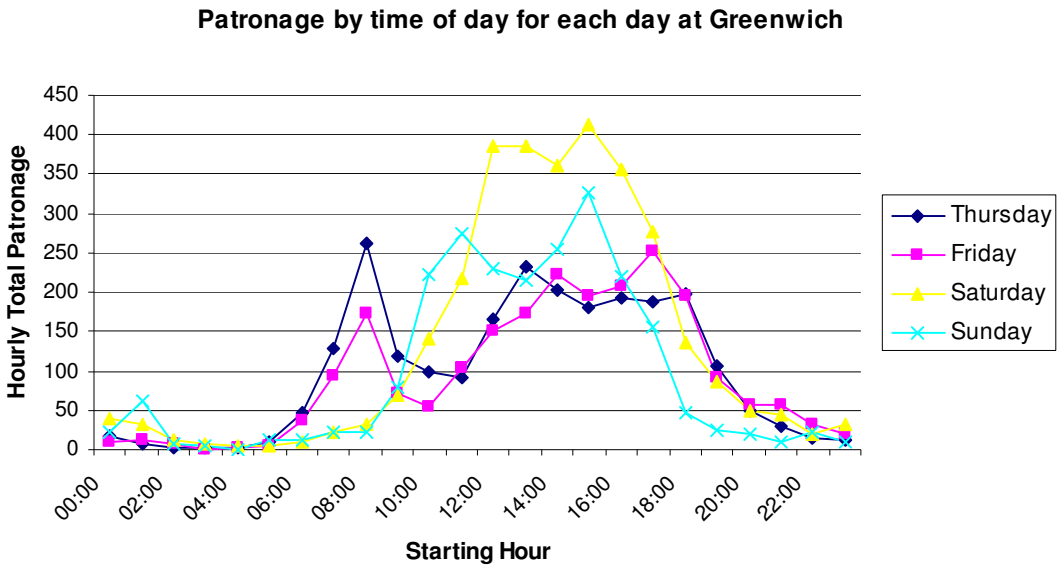

Figure 4 Patronage by time of day for each day at Woolwich

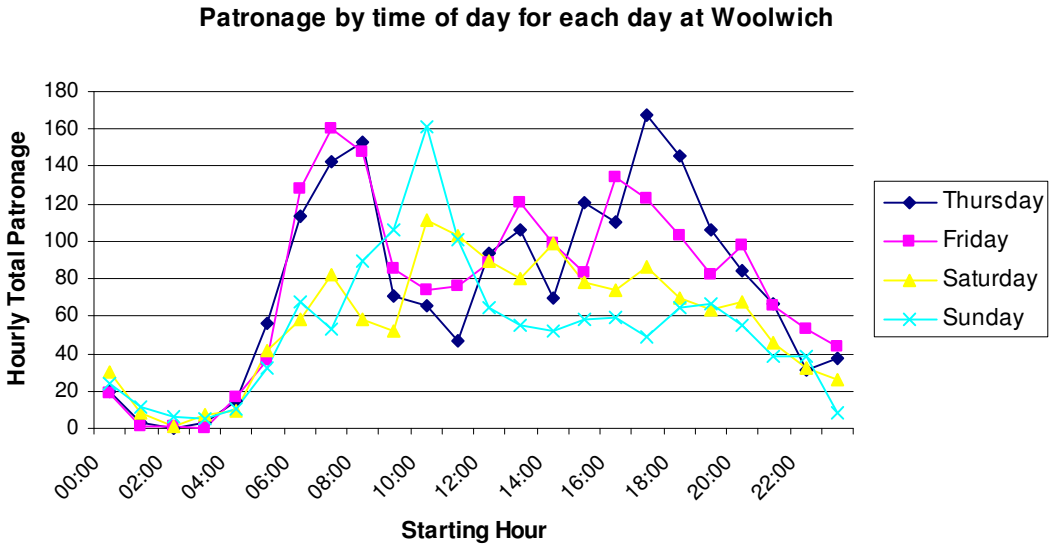

Figure 5 Number of northbound and southbound users of Greenwich tunnel on an average weekday by time of day

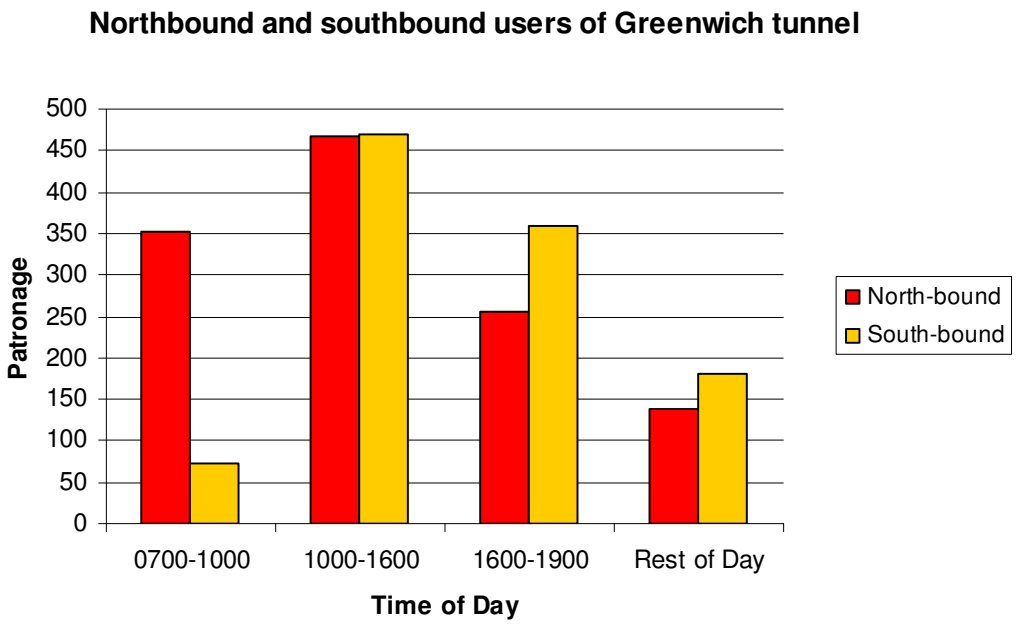

Figure 6 Number of northbound and southbound users of Woolwich tunnel on an average weekday by time of day

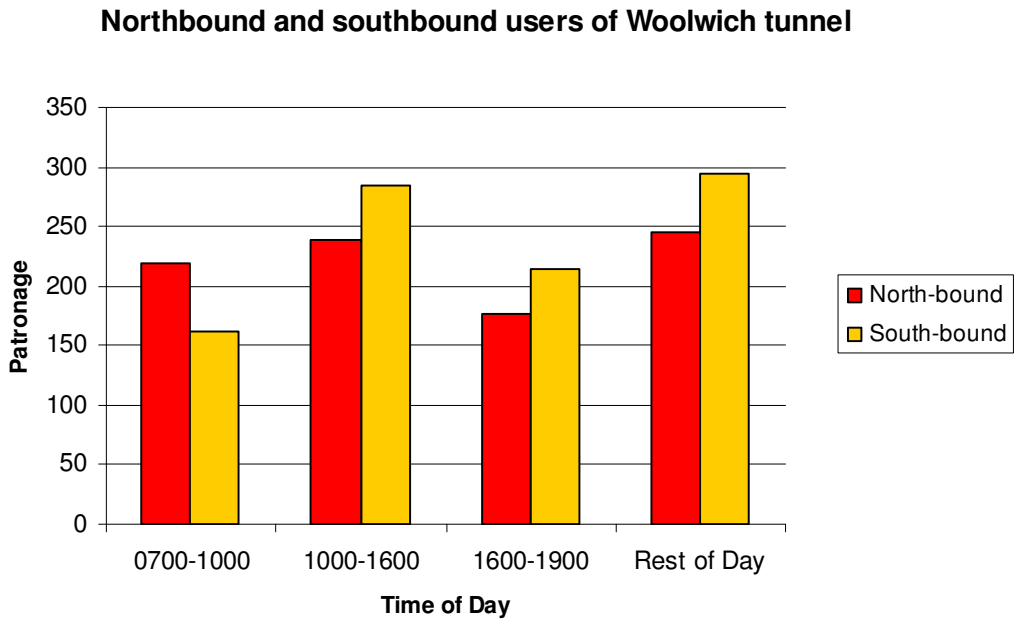

Table 7: Pedestrian Count at Greenwich Foot Tunnel

Time		Thursday 25th Oct. 2007			Friday 26th Oct. 2007			Saturday 27th Oct. 2007			Sunday 28th Oct. 2007		
Start	End	North-bound ped	South-bound ped	Hour Total	North-bound ped	South-bound ped	Hour Total	North-bound ped	South-bound ped	Hour Total	North-bound ped	South-bound ped	Hour Total
00:00	01:00	6	11	17	6	0	6	24	13	37	13	6	19
01:00	02:00	3	2	5	7	3	10	22	7	29	34	23	57
02:00	03:00	2	0	2	2	5	7	11	2	13	2	5	7
03:00	04:00	1	1	2	0	0	0	3	3	6	5	0	5
04:00	05:00	2	0	2	1	1	2	3	1	4	1	0	1
05:00	06:00	1	0	1	1	0	1	0	2	2	7	3	10
06:00	07:00	6	3	9	7	4	11	1	1	2	3	5	8
07:00	08:00	15	7	22	12	8	20	6	7	13	5	11	16
08:00	09:00	82	21	103	28	20	48	4	13	17	6	11	17
09:00	10:00	56	18	74	10	15	25	24	28	52	24	40	64
10:00	11:00	29	53	82	22	21	43	31	94	125	95	108	203
11:00	12:00	30	50	80	28	64	92	81	110	191	64	172	236
12:00	13:00	76	84	160	39	99	138	102	247	349	94	116	210
13:00	14:00	131	77	208	74	78	152	162	192	354	93	113	206
14:00	15:00	100	84	184	121	80	201	173	157	330	120	116	236
15:00	16:00	99	63	162	95	84	179	220	162	382	191	101	292
16:00	17:00	97	54	151	101	60	161	199	136	335	151	50	201
17:00	18:00	46	35	81	93	52	145	190	68	258	102	40	142
18:00	19:00	29	26	55	48	45	93	77	44	121	26	17	43
19:00	20:00	19	33	52	18	32	50	40	37	77	15	8	23
20:00	21:00	15	11	26	17	25	42	17	23	40	13	2	15
21:00	22:00	7	7	14	20	30	50	29	15	44	6	1	7
22:00	23:00	3	1	4	13	13	26	6	12	18	19	3	22
23:00	00:00	7	2	9	15	4	19	19	11	30	7	4	11
Totals		**862**	**643**	**1505**	**778**	**743**	**1521**	**1444**	**1385**	**2829**	**1096**	**955**	**2051**

Table 8: Cyclist Count at Greenwich Foot Tunnel

Time		Thursday 25th Oct. 2007			Friday 26th Oct. 2007			Saturday 27th Oct. 2007			Sunday 28th Oct. 2007		
Start	End	North-bound cyclist	South-bound cyclist	Hour Total	North-bound cyclist	South-bound cyclist	Hour Total	North-bound cyclist	South-bound cyclist	Hour Total	North-bound cyclist	South-bound cyclist	Hour Total
00:00	01:00	0	1	1	0	3	3	0	2	2	2	1	3
01:00	02:00	1	1	2	1	2	3	3	0	3	3	2	5
02:00	03:00	0	0	0	0	1	1	0	0	0	0	0	0
03:00	04:00	0	1	1	0	1	1	1	1	2	0	0	0
04:00	05:00	1	0	1	1	0	1	1	1	2	0	0	0
05:00	06:00	8	1	9	5	0	5	2	0	2	2	0	2
06:00	07:00	31	6	37	19	6	25	6	2	8	3	1	4
07:00	08:00	102	5	107	70	4	74	9	1	10	7	0	7
08:00	09:00	137	22	159	112	14	126	5	10	15	3	3	6
09:00	10:00	40	4	44	41	6	47	10	8	18	5	9	14
10:00	11:00	8	9	17	9	2	11	8	8	16	9	11	20
11:00	12:00	6	5	11	7	4	11	10	16	26	12	26	38
12:00	13:00	5	0	5	9	5	14	14	22	36	8	11	19
13:00	14:00	3	22	25	8	13	21	21	10	31	4	5	9
14:00	15:00	14	5	19	8	13	21	17	14	31	11	7	18
15:00	16:00	5	14	19	7	10	17	13	18	31	25	9	34
16:00	17:00	13	29	42	13	33	46	5	17	22	9	9	18
17:00	18:00	11	95	106	14	94	108	11	7	18	5	9	14
18:00	19:00	33	109	142	16	87	103	1	15	16	2	1	3
19:00	20:00	8	46	54	9	32	41	5	5	10	0	2	2
20:00	21:00	1	23	24	2	13	15	8	2	10	2	3	5
21:00	22:00	5	11	16	1	6	7	0	1	1	1	2	3
22:00	23:00	2	10	12	0	6	6	2	0	2	0	0	0
23:00	00:00	0	4	4	1	1	2	1	2	3	0	0	0
Totals		**434**	**423**	**857**	**353**	**356**	**709**	**153**	**162**	**315**	**113**	**111**	**224**

Table 9: Pedestrian Count at Woolwich Foot Tunnel

Time		Thursday 25th Oct. 2007			Friday 26th Oct. 2007			Saturday 27th Oct. 2007			Sunday 28th Oct. 2007		
Start	End	North-bound ped	South-bound ped	Hour Total	North-bound ped	South-bound ped	Hour Total	North-bound ped	South-bound ped	Hour Total	North-bound ped	South-bound ped	Hour Total
00:00	01:00	2	18	20	8	11	19	9	21	30	8	16	24
01:00	02:00	1	2	3	0	1	1	3	2	5	7	4	11
02:00	03:00	0	0	0	0	0	0	0	1	1	2	4	6
03:00	04:00	1	1	2	0	0	0	6	1	7	2	3	5
04:00	05:00	7	7	14	8	7	15	7	2	9	8	2	10
05:00	06:00	25	23	48	20	6	26	23	16	39	14	18	32
06:00	07:00	55	44	99	51	62	113	27	24	51	33	32	65
07:00	08:00	59	67	126	64	69	133	26	52	78	19	31	50
08:00	09:00	87	45	132	72	62	134	18	38	56	49	39	88
09:00	10:00	33	33	66	46	31	77	21	26	47	70	34	104
10:00	11:00	37	25	62	22	48	70	40	67	107	90	66	156
11:00	12:00	20	26	46	36	36	72	47	48	95	54	43	97
12:00	13:00	56	34	90	33	51	84	34	51	85	26	35	61
13:00	14:00	33	72	105	53	64	117	36	37	73	26	29	55
14:00	15:00	39	30	69	46	45	91	33	62	95	15	35	50
15:00	16:00	42	75	117	37	41	78	40	35	75	28	28	56
16:00	17:00	54	43	97	53	69	122	41	28	69	27	27	54
17:00	18:00	60	89	149	49	55	104	38	40	78	15	30	45
18:00	19:00	52	70	122	60	34	94	48	22	70	27	38	65
19:00	20:00	33	64	97	39	39	78	27	32	59	33	33	66
20:00	21:00	32	46	78	45	49	94	28	40	68	32	22	54
21:00	22:00	23	35	58	32	30	62	23	21	44	21	17	38
22:00	23:00	9	20	29	22	29	51	18	14	32	18	17	35
23:00	00:00	18	18	36	12	30	42	8	17	25	2	6	8
Totals		778	887	1665	808	869	1677	601	697	1298	626	609	1235

Table 10: Cyclist Count at Woolwich Foot Tunnel

Time		Thursday 25th Oct. 2007			Friday 26th Oct. 2007			Saturday 27th Oct. 2007			Sunday 28th Oct. 2007		
Start	End	North-bound cyclist	South-bound cyclist	Hour Total	North-bound cyclist	South-bound cyclist	Hour Total	North-bound cyclist	South-bound cyclist	Hour Total	North-bound cyclist	South-bound cyclist	Hour Total
00:00	01:00	0	0	0	0	0	0	0	0	0	0	0	0
01:00	02:00	0	0	0	0	0	0	0	3	3	0	0	0
02:00	03:00	0	0	0	0	1	1	0	0	0	0	0	0
03:00	04:00	0	1	1	0	0	0	0	0	0	0	0	0
04:00	05:00	1	0	1	2	0	2	0	0	0	0	0	0
05:00	06:00	7	1	8	10	0	10	3	0	3	0	0	0
06:00	07:00	11	3	14	10	5	15	5	2	7	1	2	3
07:00	08:00	13	4	17	23	4	27	2	2	4	3	0	3
08:00	09:00	19	2	21	13	1	14	1	1	2	1	1	2
09:00	10:00	2	3	5	6	2	8	4	1	5	1	1	2
10:00	11:00	3	1	4	2	2	4	1	3	4	5	0	5
11:00	12:00	0	1	1	3	1	4	4	4	8	3	1	4
12:00	13:00	3	1	4	2	2	4	0	4	4	1	2	3
13:00	14:00	1	0	1	1	3	4	5	2	7	0	0	0
14:00	15:00	0	1	1	2	6	8	4	0	4	1	1	2
15:00	16:00	3	1	4	2	3	5	2	1	3	1	1	2
16:00	17:00	0	13	13	3	9	12	1	4	5	4	1	5
17:00	18:00	8	10	18	5	14	19	4	4	8	2	2	4
18:00	19:00	8	16	24	1	8	9	0	0	0	0	0	0
19:00	20:00	0	9	9	0	4	4	1	3	4	0	1	1
20:00	21:00	1	5	6	1	3	4	0	0	0	0	1	1
21:00	22:00	1	8	9	1	3	4	1	1	2	0	0	0
22:00	23:00	1	1	2	1	1	2	0	0	0	0	4	4
23:00	00:00	0	1	1	2	0	2	1	0	1	0	0	0
Totals		82	82	164	90	72	162	39	35	74	23	19	41

Pedestrian and Cyclist Survey

A survey of users of both tunnels was carried out between 7 am and 10 am on Tuesday 14th and Thursday 16th February 2006. The survey results were expanded to the average weekday counts available from the video pedestrian and cyclists count data.

Table 11 shows the journey purpose of respondents. Table 12 shows the frequency of use of the tunnels and table 13 gives the reason provided for using the tunnels.

Table 11 Journey Purpose

	Greenwich		Woolwich	
Journey Purpose	**Pedestrian**	**Cyclists**	**Pedestrian**	**Cyclists**
Employers Business	0	2	1	0
Commuting	42	250	127	12
Other	22	5	39	0
Total	64	257	167	12

Table 12 Frequency of Usage and Tunnels

	Greenwich		Woolwich	
	Pedestrian	Cyclists	Pedestrian	Cyclists
4+ days a week	42	207	122	9
2-3 days a week	11	40	28	3
Once a week	5	3	7	0
Once a fortnight	3	0	1	0
Once a month	2	0	1	0
Less than once a month	0	3	5	0
First time	1	1	0	0
Total	64	254	164	12

Table 13 Reason for Use of Tunnels

Reason for use of Tunnels	Greenwich		Woolwich	
	Pedestrian	Cyclists	Pedestrian	Cyclists
Shortest route to destination	24	135	138	9
Health benefits/exercise	29	102	19	3
Cheaper than DLR or ferry	11	18	10	0
Other	0	2	0	0
Total	64	255	167	12

The survey also asked respondents for the origin and destination of their journey.

Figures 7 and 8 show the origins and destinations of the users of Greenwich tunnel.

Figure 9 shows the desire lines of these users.

Figures 10 to 12 provide the same information for Woolwich.

Comment on distances and use of other modes.

Growth in Patronage numbers

The growth in numbers is separated into two elements:

- A general growth in walking and cycling trips for the area taken from Tempro
- Specific changes in numbers using the tunnels as a result of the scheme and other local factors

Table 14 shows the annual growth rates in numbers of walking and cyclists taken from Tempro 4.3 for selected years. The business case contains the relevant growth rate for all years. It should be noted that Tempro growth is likely to be an underestimate for this area owing to the recent increase in the number of new dwellings planned for the areas near the tunnels and the rapid increase in job numbers at Canary Wharf and elsewhere in London Docklands.

Table 14 Annual increase in walking and cycling trips from Tempro

	Annual growth rates	
Year	Pedestrians	Cyclists
2008	1.28%	1.67%
2009	1.27%	1.64%
2010	1.25%	1.61%
2011	1.24%	1.59%
2012	0.60%	0.71%
2016	0.59%	0.69%
2021	0.57%	0.67%
2026	0.27%	0.34%
2031	0.26%	0.33%
2036	0.32%	0.36%
2041	0.32%	0.36%

It is assumed that the refurbishment of the Greenwich tunnel would result in an 30% increase in patronage numbers in the first year, a 20% increase in the second year and a 10% increase in the third year. This reflects the stage change in the user friendliness of the tunnels, particularly with the increase in security for users of the tunnel which is

likely to attract more female users. No further scheme growth is assumed in the business case.

In Woolwich a 30% increase in patronage is also assumed in the first year 2011. However the opening of the DLR extension is assumed to result in a 50% reduction in numbers in 2012. In Greenwich, the numbers using the tunnel recovered quite rapidly after the opening of the Lewisham extension, a scheme increase of 10% is assumed in 2013 and 20% in 2014. As cycles are not allowed on the DLR the opening of the extension does not affect the number of cyclists. The same scheme growth pattern as Greenwich is assumed ie 30% in the first year, 20% in the second year and 10% in the third year.

It is likely that because of the increased housing and employment numbers in the area, and the likelihood that the Ferry would close when the Thames Gateway bridge is built, that the forecast growth in patronage numbers in conservative.

Table 15 below shows the forecasts number of pedestrians and cyclists using the Greenwich and Woolwich tunnels taking into account growth in Tempro and scheme specific factors.

Table 15 Forecast number of pedestrians and cyclists using the Greenwich and Woolwich tunnels.

	Greenwich		**Woolwich**	
Year	Pedestrians	Cyclists	Pedestrians	Cyclists
2007	1513	783	1671	163
2011	2064	1085	2279	254
2012	2489	1309	1153	307
2016	2884	1480	1556	347
2021	2961	1530	1602	359
2026	2923	1557	1623	365
2031	2961	1583	1645	371
2036	3010	1612	1672	378
2041	3058	1642	1699	385

4. Benefits

The assessment of benefits has been carried out on an annual basis. It is known that the number of users of the tunnels increase in the summer, and that weekend use higher than weekday use at Greenwich so annualisation factor used given in Table 16.

Table 16: Annualisation factor

		Annualisation Factor	Annualisation Factor
Tunnel	**Mode**	**From October count data**	**As used in appraisal**
Greenwich	Pedestrians	430	500
	Cyclists	300	400
Woolwich	Pedestrians	340	400
	Cyclists	300	400

The major benefits considered are:

- Journey ambiance benefits within and around the tunnels
- Benefits of using a lift rather than stairs
- Health benefits to employers
- Absenteeism benefits to employers
- Time savings
- Indirect tax revenues

Journey Ambience

It is acknowledged that pedestrians and cyclists value improvements to the environment in which they make their journey. As cyclists have to walk their cycle through the tunnels the relevant values are those for pedestrians. Recent guidance issued by the DfT in March 2007 in WebTAG unit 3.14.1 provides the following table of values for improvements in journey ambience. In this table the value of different aspects of the pedestrian environment, in the London context, is provided from research by Hueman (2005).

The refurbishment of the tunnels will provide a significantly enhanced experience to the user. An architect's services will be used to ensure that the visual appearance of the scheme is considered. The lighting in and around the tunnels will be considerably enhanced, security provided at all times through the CCTV and help points, signage to

the tunnels will be improved and variable message signs installed in the tunnels. The paving and kerbs will also be renewed.

The research does not provide an exact value to cover these improvements but it is considered that a conservative approach is to use the value accorded to street lighting ie 34 pence a kilometre.

The Greenwich tunnel is 370 metres long so this gives a value to each user of 12.58 pence. The Woolwich tunnel is 490 metres long giving a value to each user of 16.67 pence.

Table 5 Values of different aspects of the pedestrian environment used in the evaluation of the London Strategic Walk Network

Scheme type	Value	Source
Walking schemes		
Street lighting	34p/km	Heuman (2005)
Crowding	17p/km	Heuman (2005)
Kerb level	24p/km	Heuman (2005)
Information panels	8p/km	Heuman (2005)
Pavement evenness	8p/km	Heuman (2005)
Directional signage	5p/km	Heuman (2005)
Benches	5p/km	Heuman (2005)

The journey ambience benefits are applied to all existing users of the tunnel. For new users of the tunnels as a result of the scheme improvements a consumer surplus calculation is used so half the value of the benefit is accrued.

The values contained in Heuman's research are assumed to be at market prices. It is also assumed that the research was undertaken the year before publication of the research, that is in 2004. Applying the RPI index for 2004 (186.7) to the 2002 value of 176.2, converts the 34 pence per kilometre to 32.1 pence in 2002 prices.

Lift availability

At the moment the lifts are not always working so both availability of lifts and reliability is an issue. The lifts can only operate when they are manned, which is between 7am and 9pm. This means that they are not available at night, even though the tunnels are used at night.

A literature review was undertaken to seek any research that is available on the value people place on having a lift available to use rather than stairs. Publicly available work on step-free access at stations cites the desirability of the provision of lifts rather than

offering a valuation of the benefits. The Disability Discrimination Act is cited as a reason for providing this facility.

At the time of preparing this business case Transport for London responded to say that they were making enquiries as to whether they had a value they used.

Two research studies have been discovered which have found a value for the availability of lifts. Suzuki, Kodama, Takahashi, Nitta (2007) reported on an exercise in Japan conducted in 2002 where they asked 62 people using the rebuilt Hankyu Itami station 'How much of 220 yen (around £1.10), which is the fare from Itami to Umeda, is equal to the improvement/development of the barrier-free facilities of the station and station square?

Values were then derived for a range of facilities including the provision of lifts. The average value in 2002 was 31.7 pence for disabled people, 27.6 pence for elderly people and 13.8 pence for able-bodied people.

A survey of 3506 passengers at various railway stations in Suita City in 2001 asked 'A new elevator is going to be constructed in the station. Assume that it will cost a lot to construct a new elevator and users will need to cover some of the cost. If you need to pay some more to 150 yen (around 75 pence), the base fare, how much can you pay more?

The question is likely to lead to an undervaluation of the benefit but even so the average value given was 6 pence which was likely to be based mainly on able-bodied people.

Alice Maynard, a post graduate student at Cranfield University conducted some stated preference work in North London in 2006 with Accent market research company. Accent have many years experience of using stated preference techniques to provide valuations of the value users place on new station facilities and other items. This work is reported in her thesis, Maynard (2007) 'The economic appraisal of transport projects: the incorporation of disabled access. It can be downloaded at http://hdl.handle.net/1826/2046

The survey was completed by 411 respondents of whom 187 experience barriers in the physical environment, ie they have real problems with steps and stairs, lack of seating and long walking distances. 224 people do not experience these problems.

External validation of the values was provided by looking at the value of time for the whole sample from the survey was 9.33 pence per minute which is £5.60 an hour. The disaggregated values were 9.54 pence per minute for commuting trips and 9.04 pence for other trips**.** This compares to the 2006 values of 9.12 pence a minute for commuting trips and 8.07 pence for other trips given in WebTAG guidance Unit 3.5.6. This suggests that the valuations of lifts from t he survey are likely to be reasonable, considering that the survey was conducted in London and the values of time in WebTAG are national values.

The willingness to pay values are shown in table 17 below which is taken from table 29 in Alice Maynard's thesis.

Table 17 Willingness to pay values for a lift

Type of access	Willingness to pay (experience physical barriers to movement)	Willingness to pay (able bodied)
'Ramp only' versus stairs	33 pence	not available
'Stairs with ramp' versus stairs	41 pence	not available
'Stairs with lift' versus stairs	93 pence	17 pence

All these values were statistically significant ($p<0.005$).

The 2002 General Household Survey reports that 21% of the UK population as a whole is disabled. This would give an average value of 37.7 pence in 2006 prices. Table 18 below shows the range of values in 2006 prices and 2002 prices.

Table 18 Willingness to pay values by user disability level

Value of availability of lift and stairs	2006 prices	2002 prices
Willingness to pay (experience physical barriers to movement)	92.8 pence	82.5 pence
Willingness to pay (able bodied)	16.7 pence	14.9 pence
Average value	32.7 pence	29.1 pence

For the appraisal a value of 29.1 pence has been used to cover the availability of lifts at both ends of the tunnel for pedestrians, although it is not clear from this research whether the value should cover each lift or both. The Japanese values are lower but apply only to a single journey in a lift. For cyclists the able bodied value has been used but weighted by two to reflect the burden of carrying a bicycle.

The total value of the journey ambience benefits, in 2002 prices, discounted back to 2002 is £21,412,000 for Greenwich tunnel and £11,085,000 for Woolwich tunnel using a 60 year appraisal period from 2011 to 2070.

Health benefits to employees

There are significant improvements in the health of people who take regular exercise. The method of calculating this impact is taken from WebTAG Unit 3.14.1 and is based on work undertaken by Transport for London. The method involves calculating and valuing the number of preventable deaths per person from exercising for at least thirty minutes per day. The annual benefit of an individual taking moderate exercise is given in paragraph 1.10.5 of WebTAG unit 3.14.1 as 0.0001 times the statistical value of a life. This value for a life is taken from Highway Economics Note No.1 published by the DfT which is reproduced below. The value used in this appraisal is £1,249,890. This is then increased by the annual increase in GDP as advised in the guidance.

Note that because some elements of accident values are not quantified, total accident values may be regarded as minimum estimates

Table 1. Average Value Of Prevention Per Casualty By Severity And Element Of Cost				
2002	Â£ June 2002			
Injury Severity	Lost Output	Medical and ambulance	Human costs	TOTAL
Fatal	429,670	740	819,490	1,249,890
Serious	16,540	10,030	113,870	140,450
Slight	1,750	740	8,340	10,830
Average, all casualties	8,360	1,850	30,080	40,290

The analysis of the origins and destinations of people using the foot tunnels showed that most people had a journey of 30 minutes or longer. It showed that 84% of people using the tunnels between 7am and 10am were commuting to work and therefore likely to be making the trip on a regular basis. There will also be some regular users travelling in other time periods. For this appraisal the assumption was made that health benefits would only be applied to people using the tunnels between 7am and 10am.

The total health benefits, discounted back to 2002 are £3,880,000 for users of Greenwich tunnel and £1,942,000 for users of Woolwich tunnel. According to WebTAG guidance these benefits are not subject to the 'rule of a half' as the benefits do not form a major part of the individual's decision to walk/cycle.

Absenteeism benefits to employers

The improved health of people taking regular exercise is likely to lead to reduce levels of absenteeism from work due to sickness. This is a benefit to the employers of such people. In paragraph 1.11.2 the WebTAG guidance states that ' In the USA, physical activity programmes involving 30 minutes of exercise a day have been shown to reduce short-term sick leave by between 6% and 32%. In the UK the average absence of

employees is 6.8 days, of which 95% is accounted for by short term sick leave'. This gives a value to employers on average of 0.4 times the employee's gross daily salary.

The median gross salary at Canary Wharf is around £45,000 or £180 a day so a conservative value of £120 has been used in the appraisal. This has again only been applied to people using the tunnels between 7am and 10am.

The total value of this benefit to employers, discounted back to 2002 is £1,490,000 for users of Greenwich tunnel and £746,000 for users of Woolwich tunnel. According to WebTAG guidance these benefits are also not subject to the 'rule of a half' as the benefits do not form a major part of the individual's decision to walk/cycle.

Time savings

If the Do-Minimum scenario the tunnels are assumed to close in 2024. At Greenwich, pedestrians have the option of using the DLR service. It is assumed that this will add an extra 8 weighted minutes onto their journey as they may have to walk further (weighted by two and wait for a tram, weighted by 2.5) but the journey across the river will be quicker than the walk time.

Cyclists can not take their bicycles onto the DLR. An exercise was undertaken in OmniTRANS, a transport modelling software package, to calculate their change in journey times given the actual origin and destination of their trip and an assumed average cycle speed of 20 kph. The average increase in journey time was 13 minutes.

In Woolwich, users of the tunnel currently have the option of using the ferry and an extra 4 weighted minutes has been used in the appraisal.

For cyclists there is again the option of using the ferry and an extra 2 weighted minutes has been used. There is a strong possibility though that the ferry will not continue to operate if the Thames Gateway Bridge is opened. In this case the time penalty for cyclists will be much higher as they will have to divert to use the bridge and an increase in journey time of 9 minutes has been used. The time penalty for pedestrians if the ferry is not an option and they have to use the DLR is set at an extra 8 weighted minutes.

These time savings have been subject to 'the rule of the half'.

The total value of these time benefits, discounted back to 2002 is £23,891,000 for users of Greenwich tunnel and £7,845,000 for users of Woolwich tunnel.

Indirect tax revenues

A final consequence of the scheme is that in the Do_Minimum situation pedestrians divert onto the DLR at 2024 when the tunnel closes. This means that they are having to a pay a public transport fare which is VAT free expenditure. Therefore a benefit of the scheme is the amount of VAT that pedestrians pay on the items they are able to purchase because they are not having to spend this money on public transport fares.

It is assumed that the additional payment is £1 per trip but that 50% of users would already hold a travelcard and would not incur this additional payment.

The total value of these indirect tax benefits, discounted back to 2002 is £3,366,000 for users of Greenwich tunnel and £1,514,000 for users of Woolwich tunnel.

Total benefits

The total benefits of the scheme for each tunnel and both together is set out in table 19 below. This shows that the largest benefits come from the journey ambience improvements, the lifts and time savings.

Table 19 Total benefits, present value

Benefit	Greenwich £'000s	Woolwich £'000s	Total £'000s
Journey ambience & lifts	21,412	11,085	32,497
Health	3,880	1,942	5,822
Absenteeism	1,490	746	2,236
Time savings	23,891	7,845	31,736
Indirect tax benefits	3,366	1,514	4,880
Total	50,674	21,617	72,291

5. Benefit Cost Ratio

Table 20 overleaf gives the monetised costs and benefits table for the scheme. The total cost of the Scheme, in present value terms, is £16.17 million, of which £10.64million are investments costs and £5.53 million are operating and maintenance costs (which are paid by the local boroughs). The benefits are worth £72.29 million giving an overall benefit cost ratio of 4.47 to the public sector.

By allocating the costs equally between both tunnels but using the Greenwich benefits of £50.67 m and the Woolwich benefits of £21.62 m this breaks down to a bcr of 6.27 for Greenwich and 2.67 for Woolwich.

The complete scheme, appraised over 60 years, represents high value for money for both tunnels.

When appraised over 30 years the level of benefits fall much more than the costs. The costs are £18.03 million, the benefits are £44.68million and the benefit cost ratio is 2.48.

Table 20: Scheme Modified Monetised Costs and Benefits Table

Analysis of Monetised Costs and Benefits Table		
Noise	n.a.	
Local Air Quality	n.a.	
Greenhouse Gases	n.a.	
Journey Ambience	32,497	
Accidents	n.a.	
Physical Fitness	8,058	
Consumer Users	31,736	
Business Users and Providers		
Reliability		
Option Values		
Indirect tax benefits	4,880	
Present Value of Benefits (see notes) (PVB)	72,291	
Public Accounts		
Present Value of Costs(see notes) (PVC)	16,171	
OVERALL IMPACTS		
Net Present Value(NPV)	56,120	NPV = PVB-PVC
Benefit to Cost Ratio(BCR)	4.47	BCR = PVB/PVC

Note:This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decision.