THE QUADRO 2021 MANUAL

PART 2

THE VALUATION OF COSTS IN QUADRO

Contents

Chapter

Version of Document	WebTAG Version	WebTAG Workbook
July 2021	May 2021	TAG_data_book_July_2021

1. THE VALUATION OF TIME

1.1 QUADRO calculates the delays at maintenance works and translates these into monetary figures using the Department's standard values of time. **The latest values of time recommended by the DfT for use in most routine economic appraisals of transport projects are provided in WebTAG: TAG data book.**

1.2 The values of time per vehicle (in pence/hour) used in QUADRO are given in Table 1/1, together with the underlying assumptions about occupancy and the work, commuting and other non-work split.

Type of Vehicle and Purpose	Weekly Average Occupancy	Occupant Purpose	Value of time (pence/hour)	
			per occupant	per vehicle
Working Car	1.00 driver	Working	1486	
	0.16 passengers	Working	1486	1724
		(Ave working occupant)	(1486)	
Non-Working Car				
- **Commuting**	1.00 driver	Commuting	836	
	0.15 passengers	Commuting	836	962
- **Other**	1.00 driver	Other Non-Work	382	
	0.91 passengers	Other Non-Work	382	729
Average Car	1.00 driver 0.61 passengers	(Derived from above assuming 12.1% of car kilometres are in 'working' mode, 25.5% in 'commuting' mode and 62.5% in 'other' mode)		910
Working Light Goods Vehicle (LGV)	1.00 driver	Working	1052	1262
	0.20 passengers	Working	1052	
Non-Working LGV				
- **Commuting**	1.00 driver	Commuting	836	
	0.59 passengers	Commuting	836	1330
- **Other**	1.00 driver	Other Non-Work	382	
	0.59 passengers	Other Non-Work	382	607
Average LGV	1.00 driver 0.25 passengers	(Derived from above assuming 88% of LGV kilometres are in 'working' mode, 2.6% in 'commuting' mode and 9.4% in 'other' mode)		1203
Other Goods Vehicle (OGV1&2)	1.00 driver	Working	1213	1213
Public Service Vehicle (PSV)	1.00 driver	Working	1194	
	12.2 passengers	Working (1.5%)	842	
		(Ave working occupant)	869	
		Commuting (13.5%)	836	
		Other (85.0%)	382	6684
Average Vehicle	(Based on 2002 national average vehicle proportions and 2010 occupancies)			1004

Table 1/1: Annual Average Values of Time per Person and per Vehicle in COBA based on 2010 car and 2000 other vehicle occupancies (2010 values and resource prices)

1.3 The National Travel Survey (NTS) (Ref 2.1) showed that in an average week 12.1% of car mileage was in working time, 25.5% in commuting mode and 62.5% in other non-work mode, and these figures have been adopted in QUADRO. These average percentages have been further disaggregated for each hour of the day for different days of the week, see Part 5, Table 8/1. Local proportions of cars in work, commuting and other non-work time can be used where there are statistically reliable local data, in consultation with the Overseeing Organisation (see Part 4 of the COBA Manual). When local values are used, the disaggregated hourly and daily values will be factored accordingly by QUADRO. **Also, see Part 5 Chapter 8 for details of car occupancies for weekday and weekend and predicted decline in car occupancy over time.**

1.4 Light Goods Vehicles are also considered to be in working, commuting or other non-working mode. The NTS showed that in an average week 88% of LGV kilometres was in working time, 2.6% was in commuting mode and 9.4% in other non-working mode. These figures are used in QUADRO. These percentages have not been further disaggregated for different hours or days of the week.

1.5 The real value of average employee earnings is assumed to reflect the growth in the real value of both working time and non-working time. Future growth is expected to grow in line with real GDP per head. Forecasts of growth in the real value of time are given in Table 1/2.

1.6 These assumptions relate to long term forecasts only, and undue weight should not be given to short term fluctuations.

Forecast Growth In Values of Time

Year	Work VOT Growth (% pa)	Non-work VOT Growth (% pa)	Year	Work VOT Growth (% pa)	Non-work VOT Growth (% pa)
2003	2.85	2.85	2052	1.50	1.50
2004	1.75	1.75	2053	1.50	1.50
2005	2.17	2.17	2054	1.50	1.50
2006	2.00	2.00	2055	1.50	1.50
2007	1.54	1.54	2056	1.50	1.50
2008	-1.09	-1.09	2057	1.50	1.50
2009	-4.79	-4.79	2058	1.50	1.50
2010	1.26	1.26	2059	1.50	1.50
2011	0.43	0.43	2060	1.50	1.50
2012	0.76	0.76	2061	1.50	1.50
2013	1.55	1.55	2062	1.50	1.50
2014	2.08	2.08	2063	1.50	1.50
2015	1.56	1.56	2064	1.50	1.50
2016	0.89	0.89	2065	1.50	1.50
2017	1.14	1.14	2066	1.50	1.50
2018	0.65	0.65	2067	1.50	1.50
2019	0.89	0.89	2068	1.50	1.50
2020	-0.17	-0.17	2069	1.50	1.50
2021	-0.17	-0.17	2070	1.50	1.50
2022	1.50	1.50	2071	1.50	1.50
2023	1.50	1.50	2072	1.50	1.50
2024	1.50	1.50	2073	1.50	1.50
2025	1.50	1.50	2074	1.50	1.50
2026	1.50	1.50	2075	1.50	1.50
2027	1.50	1.50	2076	1.50	1.50
2028	1.50	1.50	2077	1.50	1.50
2029	1.50	1.50	2078	1.50	1.50
2030	1.50	1.50	2079	1.50	1.50
2031	1.50	1.50	2080	1.50	1.50

2032	1.50	1.50	2081	1.50	1.50
2033	1.50	1.50	2082	1.50	1.50
2034	1.50	1.50	2083	1.50	1.50
2035	1.50	1.50	2084	1.50	1.50
2036	1.50	1.50	2085	1.50	1.50
2037	1.50	1.50	2086	1.50	1.50
2038	1.50	1.50	2087	1.50	1.50
2039	1.50	1.50	2088	1.50	1.50
2040	1.50	1.50	2089	1.50	1.50
2041	1.50	1.50	2090	1.50	1.50
2042	1.50	1.50	2091	1.50	1.50
2043	1.50	1.50	2092	1.50	1.50
2044	1.50	1.50	2093	1.50	1.50
2045	1.50	1.50	2094	1.50	1.50
2046	1.50	1.50	2095	1.50	1.50
2047	1.50	1.50	2096	1.50	1.50
2048	1.50	1.50	2097	1.50	1.50
2049	1.50	1.50	2098	1.50	1.50
2050	1.50	1.50	2099	1.50	1.50
2051	1.50	1.50	2100	1.50	1.50

Table 1/2: Assumed Compound Annual Rates of Growth of the Real Value of Time (% pa)

Conversion from Resource Costs to Market Prices

1.7 QUADRO works in resource costs that have to be converted to market prices to be consistent with the 'Economic Efficiency of the Transport System' (TEE) table. The market price of time is obtained by multiplying the resource value by (1 + t) where t is the average rate of indirect taxation in the economy; in 2010 this was 19%.

2. THE VALUATION OF VEHICLE OPERATING COSTS

2.1 Differences in the vehicle operating costs (VOC) incurred by traffic with and without maintenance works are calculated in QUADRO. Fuel consumption costs can be either petrol, diesel, or electric car costs. VOC will tend to increase during maintenance works if speeds through the maintained section of road are very low or if the diversion route is lengthy. A number of simplifications are applied to the VOC calculations in QUADRO. All categories of vehicle on a given link are assumed to travel at the same speed. The diversion route is modelled as a single link with uniform speed. Also, the effects of temporary blockages caused by breakdowns and accidents (see Part 4 Chapter 3) are assessed solely in terms of the extra journey time experienced because of additional queuing and diversion, and changes in operating costs are not calculated.

The latest vehicle operating cost (VOC) parameter values recommended by the DfT for use in economic appraisals of transport projects are provided in TAG data book.

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Conversion from Resource Costs to Market Prices

2.7 QUADRO works in resource costs that need to be converted to market prices for inclusion in the 'Economic Efficiency of the Transport System' (TEE) table. Market prices are equal to resource cost plus fuel duty for business use and resource cost plus fuel duty and VAT for non-business use. The resource cost, fuel duty, and VAT rates used in the program for past and future years are shown in Table 2/3.

Year	Resource Cost					Duty				VAT rate		
	Petrol	Diesel	Gas Oil	Electricity		Petrol	Diesel	Gas Oil	Electric	Petrol	Diesel	Electric Road
	(p/litre)	(p/litre)	(p/litre)	Road (p/kWh)	Rail (p/kWh)	(p/litre)	(p/litre)	(p/litre)	(p/kWh)	(%)	(%)	(%)
2002*	17.86	18.66	16.47			57.88	59.14	3.79		17.50	17.50	
2003*	20.80	21.21	17.95			56.02	57.26	4.67		17.50	17.50	
2004*	24.52	26.10	19.90			54.51	54.36	4.97		17.50	17.50	
2005*	30.18	33.97	25.08			53.11	52.93	5.98		17.50	17.50	
2006*	33.46	36.97	29.47			51.74	51.60	7.15		17.50	17.50	
2007*	33.44	35.73	27.65			52.19	51.99	8.72		17.50	17.50	
2008*	42.62	51.45	42.22			51.98	51.98	10.04		17.29	17.29	
2009*	33.26	37.06	31.40			54.76	54.76	10.63		15.00	15.00	
2010*	42.57	44.31	39.63	11.73	6.73	57.19	57.19	10.99	0.00	17.50	17.50	5.00
2011*	52.03	56.23	50.86	12.46	7.00	57.02	57.02	10.96	0.00	20.00	20.00	5.00
2012*	53.09	58.06	52.32	12.95	7.64	55.85	55.85	10.74	0.00	20.00	20.00	5.00
2013*	51.26	55.92	50.14	13.56	8.40	54.88	54.88	10.55	0.00	20.00	20.00	5.00
2014*	45.23	49.58	43.77	13.66	8.50	53.94	53.94	10.37	0.00	20.00	20.00	5.00
2015*	32.33	34.95	30.15	13.40	8.61	53.58	53.58	10.30	0.00	20.00	20.00	5.00
2016*	29.96	30.62	26.63	13.18	8.37	52.48	52.48	10.09	0.00	20.00	20.00	5.00
2017*	35.88	37.45	32.64	13.68	8.71	51.47	51.47	9.89	0.00	20.00	20.00	5.00
2018	39.68	43.24	37.63	14.71	10.33	50.18	50.18	9.65	0.00	20.00	20.00	5.00
2019	38.13	41.47	35.86	15.02	10.71	50.13	50.13	9.64	0.00	20.00	20.00	5.00
2020	36.50	39.69	34.31	15.32	10.68	48.17	48.17	9.26	0.00	20.00	20.00	5.00
2021	37.72	41.02	35.45	15.06	10.74	49.68	49.68	9.55	0.00	20.00	20.00	5.00
2022	38.73	42.13	36.48	15.04	10.79	50.34	50.34	9.68	0.00	20.00	20.00	5.00
2023	39.33	42.82	37.14	15.16	10.88	50.74	50.74	9.75	0.00	20.00	20.00	5.00
2024	39.80	43.35	37.67	15.21	10.96	51.18	51.18	9.84	0.00	20.00	20.00	5.00
2025	40.24	43.85	38.17	15.44	11.14	51.59	51.59	9.92	0.00	20.00	20.00	5.00
2026	41.03	44.75	39.09	15.56	11.38	51.94	51.94	9.98	0.00	20.00	20.00	5.00
2027	41.42	45.20	39.55	15.46	10.93	52.29	52.29	10.05	0.00	20.00	20.00	5.00
2028	41.81	45.65	40.01	15.15	10.76	52.64	52.64	10.12	0.00	20.00	20.00	5.00
2029	42.59	46.55	40.92	15.13	11.03	52.98	52.98	10.18	0.00	20.00	20.00	5.00
2030	42.99	47.00	41.38	15.40	10.98	53.33	53.33	10.25	0.00	20.00	20.00	5.00

Table 2/3: Fuel and Electricity Prices and Components 2002-2030 (2010 prices, *= actual prices/rates)

Year	Resource Cost					Duty				VAT rate		
	Petrol	Diesel	Gas Oil	Electricity		Petrol	Diesel	Gas Oil	Electric	Petrol	Diesel	Electric Road
	(p/litre)	(p/litre)	(p/litre)	Road (p/kWh)	Rail (p/kWh)	(p/litre)	(p/litre)	(p/litre)	(p/kWh)	(%)	(%)	(%)
2031	42.99	47.00	41.38	15.40	10.98	53.67	53.67	10.32	0.00	20.00	20.00	5.00
2032	42.99	47.00	41.38	15.40	10.98	54.01	54.01	10.38	0.00	20.00	20.00	5.00
2033	42.99	47.00	41.38	15.40	10.98	54.35	54.35	10.45	0.00	20.00	20.00	5.00
2034	42.99	47.00	41.38	15.40	10.98	54.69	54.69	10.51	0.00	20.00	20.00	5.00
2035	42.99	47.00	41.38	15.40	10.98	55.03	55.03	10.58	0.00	20.00	20.00	5.00
2036	42.99	47.00	41.38	15.40	10.98	55.37	55.37	10.64	0.00	20.00	20.00	5.00
2037	42.99	47.00	41.38	15.40	10.98	55.72	55.72	10.71	0.00	20.00	20.00	5.00
2038	42.99	47.00	41.38	15.40	10.98	56.07	56.07	10.78	0.00	20.00	20.00	5.00
2039	42.99	47.00	41.38	15.40	10.98	56.40	56.40	10.84	0.00	20.00	20.00	5.00
2040	42.99	47.00	41.38	15.40	10.98	56.73	56.73	10.90	0.00	20.00	20.00	5.00
2041	42.99	47.00	41.38	15.40	10.98	57.06	57.06	10.97	0.00	20.00	20.00	5.00
2042	42.99	47.00	41.38	15.40	10.98	57.39	57.39	11.03	0.00	20.00	20.00	5.00
2043	42.99	47.00	41.38	15.40	10.98	57.73	57.73	11.10	0.00	20.00	20.00	5.00
2044	42.99	47.00	41.38	15.40	10.98	58.07	58.07	11.16	0.00	20.00	20.00	5.00
2045	42.99	47.00	41.38	15.40	10.98	58.41	58.41	11.23	0.00	20.00	20.00	5.00
2046	42.99	47.00	41.38	15.40	10.98	58.75	58.75	11.29	0.00	20.00	20.00	5.00
2047	42.99	47.00	41.38	15.40	10.98	59.10	59.10	11.36	0.00	20.00	20.00	5.00
2048	42.99	47.00	41.38	15.40	10.98	59.44	59.44	11.43	0.00	20.00	20.00	5.00
2049	42.99	47.00	41.38	15.40	10.98	59.79	59.79	11.49	0.00	20.00	20.00	5.00
2050	42.99	47.00	41.38	15.40	10.98	60.14	60.14	11.56	0.00	20.00	20.00	5.00
2051	42.99	47.00	41.38	15.40	10.98	60.50	60.50	11.63	0.00	20.00	20.00	5.00
2052	42.99	47.00	41.38	15.40	10.98	60.85	60.85	11.70	0.00	20.00	20.00	5.00
2053	42.99	47.00	41.38	15.40	10.98	61.21	61.21	11.77	0.00	20.00	20.00	5.00
2054	42.99	47.00	41.38	15.40	10.98	61.57	61.57	11.84	0.00	20.00	20.00	5.00
2055	42.99	47.00	41.38	15.40	10.98	61.93	61.93	11.90	0.00	20.00	20.00	5.00
2056	42.99	47.00	41.38	15.40	10.98	62.29	62.29	11.97	0.00	20.00	20.00	5.00
2057	42.99	47.00	41.38	15.40	10.98	62.66	62.66	12.04	0.00	20.00	20.00	5.00
2058	42.99	47.00	41.38	15.40	10.98	63.02	63.02	12.12	0.00	20.00	20.00	5.00
2059	42.99	47.00	41.38	15.40	10.98	63.39	63.39	12.19	0.00	20.00	20.00	5.00
2060	42.99	47.00	41.38	15.40	10.98	63.76	63.76	12.26	0.00	20.00	20.00	5.00

Table 2/3: Fuel and Electricity Prices and Components 2031-2060 (2010 prices)

Year	Resource Cost					Duty				VAT rate		
	Petrol (p/litre)	Diesel (p/litre)	Gas Oil (p/litre)	Electricity Road (p/kWh)	Electricity Rail (p/kWh)	Petrol (p/litre)	Diesel (p/litre)	Gas Oil (p/litre)	Electric (p/kWh)	Petrol (%)	Diesel (%)	Electric Road (%)
2061	42.99	47.00	41.38	15.40	10.98	64.14	64.14	12.33	0.00	20.00	20.00	5.00
2062	42.99	47.00	41.38	15.40	10.98	64.51	64.51	12.40	0.00	20.00	20.00	5.00
2063	42.99	47.00	41.38	15.40	10.98	64.89	64.89	12.47	0.00	20.00	20.00	5.00
2064	42.99	47.00	41.38	15.40	10.98	65.27	65.27	12.55	0.00	20.00	20.00	5.00
2065	42.99	47.00	41.38	15.40	10.98	65.66	65.66	12.62	0.00	20.00	20.00	5.00
2066	42.99	47.00	41.38	15.40	10.98	66.04	66.04	12.70	0.00	20.00	20.00	5.00
2067	42.99	47.00	41.38	15.40	10.98	66.43	66.43	12.77	0.00	20.00	20.00	5.00
2068	42.99	47.00	41.38	15.40	10.98	66.82	66.82	12.84	0.00	20.00	20.00	5.00
2069	42.99	47.00	41.38	15.40	10.98	67.21	67.21	12.92	0.00	20.00	20.00	5.00
2070	42.99	47.00	41.38	15.40	10.98	67.60	67.60	13.00	0.00	20.00	20.00	5.00
2071	42.99	47.00	41.38	15.40	10.98	68.00	68.00	13.07	0.00	20.00	20.00	5.00
2072	42.99	47.00	41.38	15.40	10.98	68.40	68.40	13.15	0.00	20.00	20.00	5.00
2073	42.99	47.00	41.38	15.40	10.98	68.80	68.80	13.23	0.00	20.00	20.00	5.00
2074	42.99	47.00	41.38	15.40	10.98	69.21	69.21	13.30	0.00	20.00	20.00	5.00
2075	42.99	47.00	41.38	15.40	10.98	69.61	69.61	13.38	0.00	20.00	20.00	5.00
2076	42.99	47.00	41.38	15.40	10.98	70.02	70.02	13.46	0.00	20.00	20.00	5.00
2077	42.99	47.00	41.38	15.40	10.98	70.43	70.43	13.54	0.00	20.00	20.00	5.00
2078	42.99	47.00	41.38	15.40	10.98	70.84	70.84	13.62	0.00	20.00	20.00	5.00
2079	42.99	47.00	41.38	15.40	10.98	71.26	71.26	13.70	0.00	20.00	20.00	5.00
2080	42.99	47.00	41.38	15.40	10.98	71.68	71.68	13.78	0.00	20.00	20.00	5.00
2081	42.99	47.00	41.38	15.40	10.98	72.10	72.10	13.86	0.00	20.00	20.00	5.00
2082	42.99	47.00	41.38	15.40	10.98	72.52	72.52	13.94	0.00	20.00	20.00	5.00
2083	42.99	47.00	41.38	15.40	10.98	72.94	72.94	14.02	0.00	20.00	20.00	5.00
2084	42.99	47.00	41.38	15.40	10.98	73.37	73.37	14.10	0.00	20.00	20.00	5.00
2085	42.99	47.00	41.38	15.40	10.98	73.80	73.80	14.19	0.00	20.00	20.00	5.00
2086	42.99	47.00	41.38	15.40	10.98	74.24	74.24	14.27	0.00	20.00	20.00	5.00
2087	42.99	47.00	41.38	15.40	10.98	74.67	74.67	14.35	0.00	20.00	20.00	5.00
2088	42.99	47.00	41.38	15.40	10.98	75.11	75.11	14.44	0.00	20.00	20.00	5.00
2089	42.99	47.00	41.38	15.40	10.98	75.55	75.55	14.52	0.00	20.00	20.00	5.00
2090	42.99	47.00	41.38	15.40	10.98	75.99	75.99	14.61	0.00	20.00	20.00	5.00
2091	42.99	47.00	41.38	15.40	10.98	76.44	76.44	14.69	0.00	20.00	20.00	5.00
2092	42.99	47.00	41.38	15.40	10.98	76.89	76.89	14.78	0.00	20.00	20.00	5.00
2093	42.99	47.00	41.38	15.40	10.98	77.34	77.34	14.87	0.00	20.00	20.00	5.00
2094	42.99	47.00	41.38	15.40	10.98	77.79	77.79	14.95	0.00	20.00	20.00	5.00
2095	42.99	47.00	41.38	15.40	10.98	78.25	78.25	15.04	0.00	20.00	20.00	5.00
2096	42.99	47.00	41.38	15.40	10.98	78.71	78.71	15.13	0.00	20.00	20.00	5.00
2097	42.99	47.00	41.38	15.40	10.98	79.17	79.17	15.22	0.00	20.00	20.00	5.00
2098	42.99	47.00	41.38	15.40	10.98	79.63	79.63	15.31	0.00	20.00	20.00	5.00
2099	42.99	47.00	41.38	15.40	10.98	80.10	80.10	15.40	0.00	20.00	20.00	5.00
2100	42.99	47.00	41.38	15.40	10.98	80.57	80.57	15.49	0.00	20.00	20.00	5.00

Table 2/3: Fuel and Electricity Prices and Components 2061-2100 (2010 prices)

Year	Road (p/kWh)	Rail (p/kWh)	Year	Road (p/kWh)	Rail (p/kWh)
2031	15.40	10.98	2066	15.40	10.98
2032	15.40	10.98	2067	15.40	10.98
2033	15.40	10.98	2068	15.40	10.98
2034	15.40	10.98	2069	15.40	10.98
2035	15.40	10.98	2070	15.40	10.98
2036	15.40	10.98	2071	15.40	10.98
2037	15.40	10.98	2072	15.40	10.98
2038	15.40	10.98	2073	15.40	10.98
2039	15.40	10.98	2074	15.40	10.98
2040	15.40	10.98	2075	15.40	10.98
2041	15.40	10.98	2076	15.40	10.98
2042	15.40	10.98	2077	15.40	10.98
2043	15.40	10.98	2078	15.40	10.98
2044	15.40	10.98	2079	15.40	10.98
2045	15.40	10.98	2080	15.40	10.98
2046	15.40	10.98	2081	15.40	10.98
2047	15.40	10.98	2082	15.40	10.98
2048	15.40	10.98	2083	15.40	10.98
2049	15.40	10.98	2084	15.40	10.98
2050	15.40	10.98	2085	15.40	10.98
2051	15.40	10.98	2086	15.40	10.98
2052	15.40	10.98	2087	15.40	10.98
2053	15.40	10.98	2088	15.40	10.98
2054	15.40	10.98	2089	15.40	10.98
2055	15.40	10.98	2090	15.40	10.98
2056	15.40	10.98	2091	15.40	10.98
2057	15.40	10.98	2092	15.40	10.98
2058	15.40	10.98	2093	15.40	10.98
2059	15.40	10.98	2094	15.40	10.98
2060	15.40	10.98	2095	15.40	10.98
2061	15.40	10.98	2096	15.40	10.98
2062	15.40	10.98	2097	15.40	10.98
2063	15.40	10.98	2098	15.40	10.98
2064	15.40	10.98	2099	15.40	10.98
2065	15.40	10.98	2100	15.40	10.98

Table 2/4: Resource cost of electricity from 2031 (2010 prices)

2.8 The tax rates for non-fuel VOC are assumed to be constant over time as they are only affected by VAT. The VAT rate is assumed to remain constant over time.

Carbon Dioxide Emissions

2.9 Carbon dioxide emissions are considered in terms of the change in the equivalent tonnes of carbon dioxide released as a result of implementing a highway scheme or maintenance job(s); see TAG Unit A3 for further

details. In QUADRO, carbon dioxide emissions are estimated from fuel consumption with and without works and the monetary value for emissions is reported in Table 2c Analysis of Monetised Impacts. The emission rates from TAG data book used in QUADRO are listed in Table 2/5 while the costs per tonne of carbon dioxide are given in Table 2/6. Table 2/6 lists three different cost assumptions (low, central, high); only the central assumption is used to calculate the final Emission Benefits Figure in Table 2c.

Year	Petrol Kg CO2e/l	Diesel Kg CO2e/l	Electric Kg CO2e/kWh
2010	2.230	2.562	0.389
2011	2.211	2.567	0.384
2012	2.211	2.609	0.377
2013	2.201	2.597	0.367
2014	2.189	2.601	0.360
2015	2.189	2.601	0.350
2016	2.189	2.602	0.340
2017	2.160	2.556	0.330
2018	2.130	2.511	0.319
2019	2.100	2.465	0.308
2020	2.071	2.420	0.296
2021	2.071	2.420	0.283
2022	2.071	2.420	0.269
2023	2.071	2.420	0.255
2024	2.071	2.420	0.240
2025	2.071	2.420	0.224
2026	2.071	2.420	0.207
2027	2.071	2.420	0.189
2028	2.071	2.420	0.171
2029	2.071	2.420	0.151
2030	2.071	2.420	0.130
2031	2.071	2.420	0.116
2032	2.071	2.420	0.103
2033	2.071	2.420	0.092
2034	2.071	2.420	0.082
2035	2.071	2.420	0.073
2036	2.071	2.420	0.065
2037	2.071	2.420	0.058
2038	2.071	2.420	0.052
2039	2.071	2.420	0.046
2040	2.071	2.420	0.041
2041	2.071	2.420	0.040
2042	2.071	2.420	0.038
2043	2.071	2.420	0.037
2044	2.071	2.420	0.036
2045	2.071	2.420	0.034
2046	2.071	2.420	0.033
2047	2.071	2.420	0.032
2048	2.071	2.420	0.030
2049	2.071	2.420	0.029
2050 onwards	2.071	2.420	0.028

Table 2/5 Carbon Dioxide equivalent emissions per litre of fuel burnt/kWh electricity used

Year	Low	Central	High	Year	Low	Central	High
2010	26.05	52.11	78.16	**2056**	113.77	241.44	369.97
2011	26.05	52.98	79.03	**2057**	115.51	248.39	381.26
2012	26.92	52.98	79.90	**2058**	117.24	254.46	391.68
2013	26.92	53.85	81.64	**2059**	118.98	260.54	402.97
2014	27.79	54.71	82.51	**2060**	119.85	266.62	413.40
2015	27.79	55.58	83.37	**2061**	120.72	271.83	422.08
2016	28.66	56.45	85.11	**2062**	121.59	276.18	431.63
2017	28.66	57.32	85.98	**2063**	122.46	280.52	439.45
2018	29.53	58.19	87.72	**2064**	122.46	284.86	447.27
2019	29.53	59.06	88.59	**2065**	122.46	288.34	454.22
2020	30.40	59.93	90.32	**2066**	122.46	291.81	461.16
2021	30.40	60.79	92.06	**2067**	122.46	295.28	467.24
2022	31.27	62.53	92.93	**2068**	121.59	297.89	473.32
2023	31.27	63.40	94.66	**2069**	121.59	299.63	478.53
2024	32.13	64.27	96.40	**2070**	120.72	302.23	482.88
2025	33.00	65.14	98.14	**2071**	119.85	303.97	487.22
2026	33.00	66.00	99.01	**2072**	118.98	305.71	491.56
2027	33.87	66.87	100.74	**2073**	118.11	306.57	495.03
2028	33.87	68.61	102.48	**2074**	117.24	307.44	498.51
2029	34.74	69.48	104.22	**2075**	115.51	308.31	501.11
2030	34.74	70.35	105.09	**2076**	113.77	308.31	502.85
2031	38.21	76.43	114.64	**2077**	112.90	308.31	504.59
2032	41.69	83.37	125.06	**2078**	111.17	308.31	505.46
2033	45.16	89.45	134.61	**2079**	109.43	307.44	506.32
2034	47.77	96.40	144.17	**2080**	107.69	306.57	505.46
2035	51.24	102.48	154.59	**2081**	105.95	306.57	507.19
2036	54.71	109.43	164.14	**2082**	104.22	305.71	507.19
2037	58.19	115.51	173.70	**2083**	102.48	304.84	507.19
2038	60.79	122.46	183.25	**2084**	99.88	303.97	507.19
2039	64.27	128.54	193.67	**2085**	98.14	303.10	507.19
2040	67.74	135.48	203.22	**2086**	96.40	301.36	505.46
2041	71.22	141.56	212.78	**2087**	94.66	299.63	504.59
2042	73.82	148.51	222.33	**2088**	92.06	297.89	502.85
2043	77.29	154.59	232.75	**2089**	90.32	295.28	500.24
2044	80.77	161.54	242.31	**2090**	87.72	293.55	498.51
2045	84.24	167.62	251.86	**2091**	85.98	290.94	496.77
2046	86.85	174.56	261.41	**2092**	84.24	289.20	495.03
2047	90.32	180.64	271.83	**2093**	81.64	287.47	492.43
2048	93.80	187.59	281.39	**2094**	79.90	284.86	489.82
2049	97.27	193.67	290.94	**2095**	77.29	282.26	487.22
2050	99.88	200.62	300.49	**2096**	75.56	279.65	483.74
2051	102.48	207.57	312.65	**2097**	73.82	277.05	481.14
2052	105.09	214.51	323.94	**2098**	71.22	274.44	476.80
2053	107.69	221.46	335.23	**2099**	69.48	271.83	474.19
2054	109.43	228.41	347.39	**2100**	66.87	268.36	469.85
2055	112.03	235.36	358.68				

Table 2/6 Cost per Tonne of Carbon Dioxide equivalent (£ per tonne of CO2e)

3 THE VALUATION OF ACCIDENTS

3.1 Accident rates might change in the presence of roadworks because traffic that diverts from the main route may travel on roads of a lower standard, and be subject to a higher accident rate. This coupled with the likelihood of the diversion route being longer than the main route, also points towards an increase in accidents as a result of the works. QUADRO estimates any such increase and converts it into a monetary value. In previous versions of QUADRO it was further assumed that even vehicles remaining on the main route might experience different accident rates if roadworks are present. However, this assumption is no longer made (recent research suggests that the presence of roadworks has little effect on the accident rate).

3.2 There are also two ways in which accidents cause costs to the community. By partially blocking the carriageway for a period, delays are caused to other road users and QUADRO makes an estimate of this effect for accidents which occur within the site itself (see Part 4 Chapter 3). The second cost is the 'direct' accident cost, which in addition to the 'casualty' cost (fatal, serious and slight injuries) includes the costs associated with damage to property, insurance administration, Police time, and an allowance for damage only accidents. QUADRO calculates these for all accidents on the network, using the Department's standard values for average personal injury accidents on various types of road. The treatment is compatible with that presented in Part 2 of the COBA Manual. The values of most elements of accident costs are proportional to national income, and for this reason it is assumed that values change in line with GDP per head.

Year	Change in Value of Accident (% pa)	Year	Change in Value of Accident (% pa)
2003	0.97	2052	1.50
2004	0.99	2053	1.50
2005	1.01	2054	1.50
2006	1.03	2055	1.50
2007	1.05	2056	1.50
2008	1.04	2057	1.50
2009	0.99	2058	1.50
2010	1.00	2059	1.50
2011	1.00	2060	1.50
2012	1.01	2061	1.50
2013	1.03	2062	1.50
2014	1.05	2063	1.50
2015	1.07	2064	1.50
2016	1.07	2065	1.50
2017	1.09	2066	1.50
2018	1.09	2067	1.50
2019	1.10	2068	1.50
2020	1.10	2069	1.50
2021	1.10	2070	1.50
2022	1.50	2071	1.50
2023	1.50	2072	1.50
2024	1.50	2073	1.50
2025	1.50	2074	1.50
2026	1.50	2075	1.50
2027	1.50	2076	1.50
2028	1.50	2077	1.50
2029	1.50	2078	1.50
2030	1.50	2079	1.50
2031	1.50	2080	1.50
2032	1.50	2081	1.50
2033	1.50	2082	1.50
2034	1.50	2083	1.50
2035	1.50	2084	1.50
2036	1.50	2085	1.50
2037	1.50	2086	1.50
2038	1.50	2087	1.50
2039	1.50	2088	1.50
2040	1.50	2089	1.50
2041	1.50	2090	1.50
2042	1.50	2091	1.50
2043	1.50	2092	1.50
2044	1.50	2093	1.50
2045	1.50	2094	1.50
2046	1.50	2095	1.50
2047	1.50	2096	1.50
2048	1.50	2097	1.50
2049	1.50	2098	1.50
2050	1.50	2099	1.50
2051	1.50	2100	1.50

Table 3/1: Assumed Compound Annual Rates of Growth of Accident Values (%)

Accident Rates

3.3 The QUADRO user has to consider accident rates for the main route and the diversion route. COBA differentiates between 'link only' accident rates, and 'combined' rates which attribute junction accidents to the links. **In QUADRO junctions are not modelled explicitly and so the COBA combined rates are used**. Table 3/2 shows the default rates used in QUADRO expressed in personal injury accidents per million vehicle kilometres based on 2008 to 2010 data. As discussed earlier, the QUADRO by default assumes that roadworks result in no increase in accident rate

3.4 There are fifteen accident types relating to the types of roads that are further subdivided by speed limit. The description of "Modern" relates to roads designed and built to geometric standards relevant post 1980. "Older" relates to the majority of the major road network that was not built to recent standards (for single carriageways this description refers to 'A' roads only), and "Other" relates to 'B', 'C' and 'unclassified' single carriageway links. Accident rates and severity splits have been reducing over recent years and this trend is expected to continue into the future, see Part 2, Chapter 4 in the COBA manual for a fuller explanation. The values for the accident rate change coefficients (and severity split change coefficients) β, incorporated in QUADRO for the different accident types are given in Table 3/2. Local accident information can be used where available. The default information given in Table 3/2, contained in the program.

ACCIDENTS WITH OR WITHOUT WORKS (2009 Base)					
Accident Type	**Road Type**	**Accident Rate (PIA/mvkm)**		**β**	
1	D2 Motorway	0.080		0.956	
2	D3 Motorway	0.067		0.956	
3	D4 Motorway	0.079		0.956	
		30/40 mph speed limit		**50/60/70 mph speed limit**	
		PIA/mvkm	**β**	**PIA/mvkm**	**β**
4	Modern S2 Roads	0.532	0.959	0.244	0.955
5	Modern S2 Roads with HS	0.532	0.959	0.244	0.955
6	Modern WS2 Roads	0.863	0.959	0.163	0.955
7	Modern WS2 Roads with HS	0.863	0.959	0.163	0.955
8	Older S2 A Roads	0.863	0.959	0.244	0.955
9	Other S2 Roads	0.559	0.951	0.233	0.933
10	Modern D2 Roads	0.553	0.967	0.107	0.956
11	Modern D2 Roads with HS	0.599	0.967	0.072	0.956
12	Older D2 Roads	0.599	0.967	0.107	0.956
13	Modern D3+ Roads	0.620	0.951	0.123	0.946
14	Modern D3+ Roads with HS	0.620	0.951	0.123	0.946
15	Older D3+ Roads	0.620	0.951	0.123	0.946

Note: HS refers to the one metre wide hard strip provided both sides of the carriageway

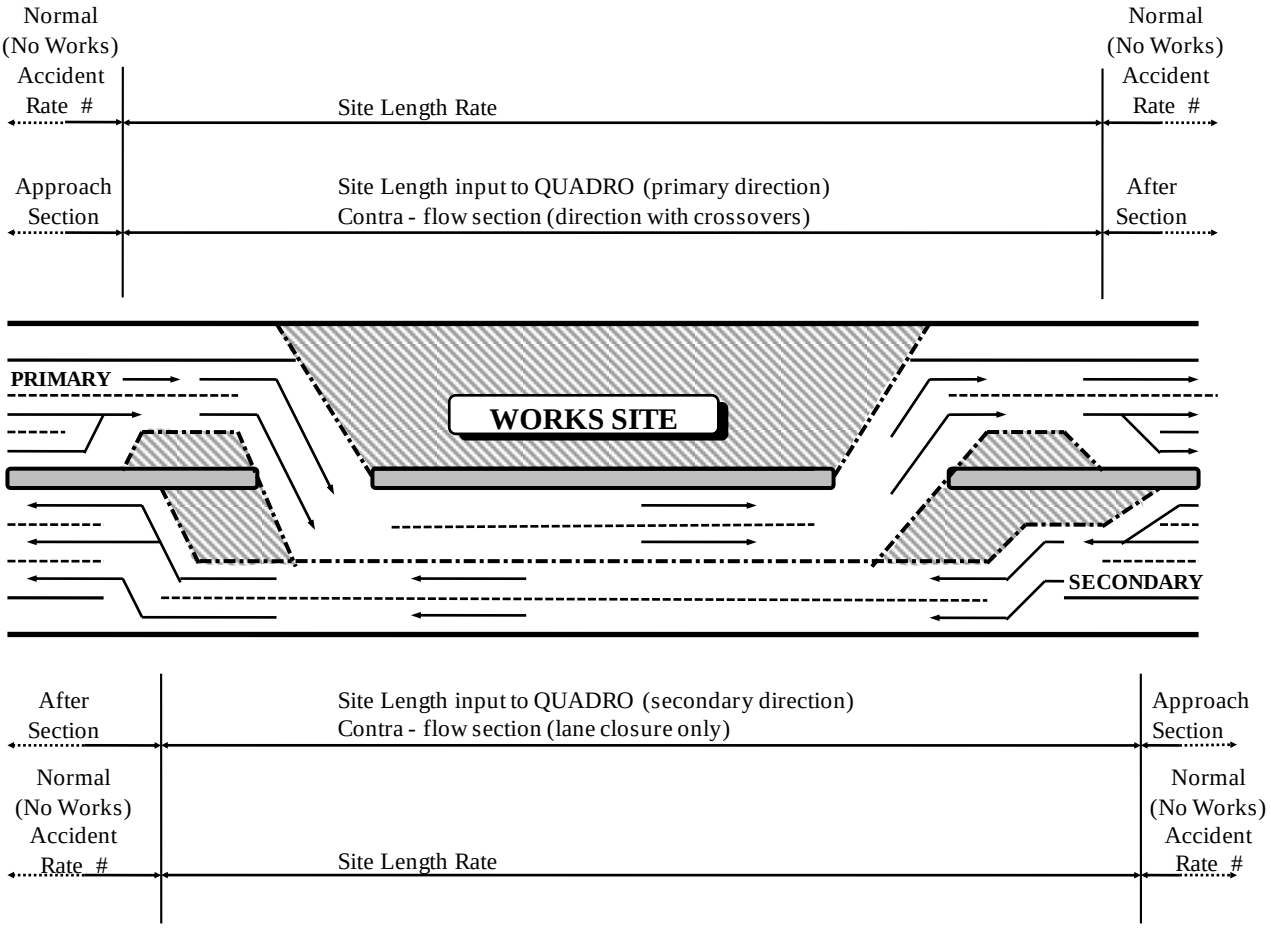
Table 3/2: Default Accident Rates and Accident Rate Reduction Factor (β) – With or Without Works (personal injury accidents per million vehicle kilometres - 2009 Base)

Local Data

3.5 The site length rate corresponds to accidents along the site itself, reflecting a change in the geometric standards of the carriageway and whether the direction of travel is affected by the crossover. The site

length rate should be calculated for the site length being input to QUADRO, that is, first cone to last cone, see Figure 3/1. The second component is made up largely of accidents in the approaches to and departures from the site. These are independent of the site length, and are a measure of the extra accidents associated with the presence of these site features (i.e. the very presence of roadworks is assumed to change the accident rate beyond the roadworks site). The site presence rate is expressed as an additive adjustment to the corresponding without works accident rate The site presence rate should be calculated to represent the extra accidents occurring within the approaches to and departures from the site. Previous TRL research (Ref 2.2) found that this 'area of influence' could extend to almost 6km either side of the site itself. However, the latest TRL research into accidents at motorway roadworks sites suggested that the area of influence could be defined as first roadworks sign to last roadworks sign.

3.6 QUADRO calculates accident costs for the two directions of travel separately, and so different local rates should be calculated for each direction if possible, particularly if the traffic management arrangements differ.



Extra accidents in the approach and after sections (caused by the presence of works) are calculated using **site presence rates.**

Figure 3/1: Definitions used to Calculate Accident Numbers with Works Present (Example: D3 Motorway, full contra-flow with 2-lane crossovers)

Accidents on Diversion Route

3.7 There is no default for the accident rate on the diversion route and so a value must be specified, which need not be the same in both directions since the routes themselves may be different. However, a default

Accident Type (AT) taken from Table 3/2 can be specified where the diversion route is considered to be of fairly constant road standard. If a default AT is used then the 'free-speed' specified for the diversion route speed-flow relationship on input record KEY 054, see Part 6 Chapter 3, will determine the accident values used by the program.

3.8 If possible, local data can be used for the calculation of diversion route accidents. If the route consists of links of varying standards in series or parallel with one another, the user must estimate a composite rate. The compositing formulae presented below are consistent with those suggested for preparing a combined speed/flow relationship, see Part 7. If the user adopts a different method for speed/flow, it should be applied to accident rates as well. The recommended method is to disaggregate the diversion route into its component links and ascribe an accident rate to each link. This should be the local observed rate where available, or failing that a rate selected from Table 3/2. The composite rate is the sum of the expected number of accidents on each link, divided by the veh-km of travel per year on the combined route.

For **series** links this gives:

$$\text{accident rate, } R = \frac{\sum Q_i L_i R_i}{QL} = \frac{\sum Q_i L_i R_i}{\sum Q_i L_i}$$

where: Ri is the rate on link i
Li is the link length
Qi is the link flow in the year of the works

the combined length, $L = \Sigma Li$

$$\text{and the average flow, } Q = \frac{\sum Q_i L_i}{\sum L_i}$$

For **parallel** links or routes, if the method of representation outlined in Part 7 is adopted, the composite rate is given by:

$$R = \frac{\sum 1/L_i \sum Q_i L_i R_i}{N \sum Q_i}$$

where N is the number of parallel links or routes being combined.

These formulae calculate the correct total accident rates on the composite diversion route without works. When there is diverting traffic simplifying assumptions are involved, as in the speed/flow calculations in Part 7.

Example

3.9 Consider two links A & B, for which suitable data are available

	Traffic Flow in Job Year (AADT)	Length	Observed Accident Rate

A	10,000	3km	0.3
B	5,000	2km	0.6

For combination in **series**, the composite rate is,

$$R = \frac{(10000 \times 3 \times 0.3) + (5000 \times 2 \times 0.6)}{(10000 \times 3) + (5000 \times 2)} = 0.375$$

For combination in **parallel**, the composite rate is,

$$R = \frac{(1/3 + 1/2) \times [10000 \times 3 \times 0.3) + (5000 \times 2 \times 0.6)]}{2 \times (10000 + 5000)} = 0.415$$

3.10 If QDIV (QUADRO DIVersion) is used to derive the single representative speed/flow relationship needed for the QUADRO diversion route (see Part 7), then the above compositing formulae have been incorporated in this program to avoid the possible errors that can be made in using these manual calculations.

Accident Costs

3.11 For the main route, the accident cost defaults given in Table 3/3 should normally be used, which are in average 2010 prices, and include an allowance for damage only accidents. The figures are the same as those used in COBA for combined link and junction accident costs. For the diversion route a composite cost should be estimated using the same relationships as for rates, in paragraph 3.8 above. In exceptional cases, local accident costs may be used where reliable local data are available. However, if QUADRO is being run as part of an economic appraisal, this must be done in consultation with the Overseeing Organisation.

ACCIDENT COSTS (2009 Base)			
Accident Type	**Road Type**	**Accident Costs (£)**	
1 - 3	Motorways	104,426	
		30/40 mph speed limit	**50/60/70 mph speed limit**
4 - 8 9	S2 A Roads Other S2 Roads	90,962 87,395	151,650 127,445
10 - 15	Dual Carriageways	88,121	113,568

Table 3/3: Default Accident Costs per Injury Accident –2009 Base)
(2010 values and prices)

Accident Casualties

3.12 QUADRO output includes estimates of the number of casualties for each of the three injury severities. Table 3/4 contains the program defaults, which should normally be used. For the diversion route a composite split should be estimated using the same relationships as for rates, in paragraph 3.8 above. If local accident costs are being used; this will imply local severity splits as well.

ACCIDENT CASUALTIES (2009 BASE)							
Accident Type	**Casualty Severity**	**Fatal (f)**		**Serious (se)**		**Slight (sl)**	
1 – 3	Motorways	0.020		0.123		1.455	
		30/40 mph speed limit			**50/60/70 mph speed limit**		
		f	**se**	**sl**	**f**	**se**	**sl**
4 - 8	S2 A Roads	0.009	0.132	1.176	0.038	0.238	1.300
9	Other S2 Roads	0.007	0.134	1.132	0.026	0.222	1.218
10 - 15	Dual Carriageways	0.009	0.112	1.238	0.025	0.151	1.297
Casualties Per Accident Change Factors β.							
Accident Type	**Casualty Severity**	**Fatal (f)**		**Serious (se)**		**Slight (sl)**	
1 – 3	Motorways	0.978		0.979		1.002	
		30/40 mph speed limit			**50/60/70 mph speed limit**		
		f	**se**	**sl**	**f**	**se**	**sl**
4 - 8	S2 A Roads	0.971	0.995	1.001	0.979	0.983	1.002
9	Other S2 Roads	0.985	0.997	1.001	0.987	0.989	0.998
10 - 15	Dual Carriageways	0.998	0.990	1.002	0.984	0.985	0.998

Table 3/4: Default Casualties per Accident and Change Factors β.

4. SPECIFYING MAINTENANCE WORKS

4.1 An essential element in QUADRO is the specification of the costs of individual maintenance jobs or profiles. This raises a number of issues, discussed below.

4.2 In the simplest case, the assessment is of an individual maintenance job to be carried out in the near future. In such a case, the range of different works costs may be quite limited. There may be for example:

i) a single works cost but variations in site management;

ii) variations in works cost, for example, due to working constraints resulting from variations in site management, night time working or different lengths of contracts involving different costs;

iii) an alternative job of a different type to be carried out later, for example, a preventative maintenance job next year compared with a major repair or reconstruction job in five years' time.

4.3 The specification of the jobs to be assessed and their cost has to be made in the context of local conditions. The generation of Trunk Road maintenance scheme options to be costed and evaluated are mainly based on data from routine machine surveys (e.g., TRACS, SCRIM) supplemented by data from localised machine (e.g., Deflectograph, FWD) and visual surveys. These, augmented by knowledge of the structure of the road, its traffic loadings and additional data from core samples, can be used to identify the appropriate strengthening and/or surface treatment options as well as the likely future maintenance requirements.

4.4 Even when considering an individual maintenance job, it will often be necessary to consider alternatives in a life-cycle context. There is therefore no sharp distinction between the assessment of an individual maintenance job and the assessment of a 60-year profile of jobs for a new or existing road. Such profiles have to be considered when QUADRO results are to be included in the economic evaluation, see Part 3 Chapter 2, or when alternative maintenance strategies are being assessed by maintenance engineers planning their expenditure programmes. The specification of alternative profiles should be jointly agreed between maintenance engineers and designers, and in the case of trunk road works Highways England. Advice should be sought from the Overseeing Organisation when in doubt.

4.5 Research by the Highways Agency has shown that the structural deterioration of certain thick, strong flexible pavements does not follow conventional theories on pavement deterioration mechanisms. These pavements, characterised by substantial cover of bituminous materials and low deflections, and termed as "long-life" pavements (LLPs) are expected to last for an indefinite period without requiring structural maintenance provided timely surface maintenance is carried out so that surface deterioration is not allowed to compromise the pavement structure.

4.6 The life of road pavements that do not satisfy the defined criteria for "long life" pavements is defined in terms of the expected number of standard axles which it can carry before serious structural distress is exhibited. These pavements, termed as "Determinate-life" pavements (DLPs) will require both structural maintenance (e.g. overlay, combinations of overlays and partial reconstruction, or reconstruction) and surface maintenance.

4.7 The future maintenance requirements for any given stretch of road, are likely to be influenced by the cumulative number of standard axles carried by the road, the pavement life (for DLPs) in terms of the expected number of standard axles which it can carry before serious structural distress is exhibited, the level of past cyclic and other maintenance work and the quality of the original construction, materials and weather conditions. Local analysis, described in paragraph 4.3, is therefore necessary if a more realistic assessment of future maintenance needs is required.

4.8 Working practices at road works are increasingly driven by the need to minimise delays to road users in spite of the growth in traffic. This has resulted in increasing amounts of maintenance works, particularly on roads with high traffic flows, being carried out at night. This influences both the costs and the duration of works.

4.9 For new roads, typical maintenance profiles, costs, durations and timings for various carriageway standards are given in Table 4/1. This Table covers the standard 60 year appraisal period.

Single 2 Lane	Year	0	11	22	32	42	52		
Initial Flow 12,000 AADT	Works	New	TS	Ov	TS	Ov	TS		
(DLP)	Cost		66	240	66	252	66		
	Duration (days)		4	12	4	12	4		
Single (2+1) Lane	Year	0	11	22	32	42	52		
Initial Flow 19,000 AADT	Works	New	TS	Ov	TS	Ov	In		
(DLP)	Cost		96	360	96	378	156		
	Duration (days)		6	15	6	15	12		
Dual 2 Lane (D2AP)	Year	0	11	22	32	42	52		
Initial Flow 30,000 AADT	Works	New	TS	Ov	In	Ov	In		
(DLP)	Cost		168	576	354	684	576		
	Duration (days)		5	12	7	12	12		
Dual 2 Lane (D2AP)	Year	0	11	22	32	42	52		
Initial Flow 30,000 AADT	Works	New	TS	In	In	In	In		
(LLP)	Cost		168	354	576	354	354		
	Duration (days)		6	7	12	7	7		
Dual 3 Lane (D3AP)	Year	0	11	22	32	41	50	59	
Initial Flow 65,000 AADT	Works	New	In	Ov	In	Ov	In	Ov	
(DLP)	Cost		480	768	480	912	480	912	
	Duration (nights)		9	16	9	16	9	16	
Dual 3 Lane (D3AP)	Year	0	11	21	31	40	49	58	
Initial Flow 65,000 AADT	Works	New	In	In	In	In	In	In	
(LLP)	Cost		480	708	480	708	480	708	
	Duration (nights)		9	15	9	15	9	15	
3 Lane Motorway (D3M)	Year	0	10	19	27	34	41	48	55
Initial Flow 80,000 AADT	Works	New	In	In	In	In	In	In	In
(DLP)	Cost		552	816	552	816	552	816	552
	Duration (nights)		14	24	14	24	14	24	14
4 Lane Motorway (D4M)	Year	0	10	19	27	34	41	48	55
Initial Flow 80,000 AADT	Works	New	In	In	In	In	In	In	In
(DLP)	Cost		738	1092	738	1092	738	1092	738
	Duration (nights)		19	32	19	32	19	32	19

Costs in £'000 per km of road (i.e. both directions), in average 2010 prices, includes treatment and traffic management costs.

Durations and costs are per km of road using day working rates for S2AP and D2AP roads and night working rates for D3AP, D3M and D4M.

TS = Thin Surfacing (typically 30mm) In = Inlay (depths = 50mm, 100mm)

Ov = Overlay (height = 50mm, 100mm)

National average percentages of heavy vehicles assumed for each road type.

LLP = Long Life Flexible Pavement DLP = Determinate Life Flexible Pavement

Table 4/1: Typical Maintenance Profiles, Costs and Durations for New Roads.

5. INPUT OF MAINTENANCE WORKS COSTS

5.1 When preparing works costs data for input to QUADRO the user has to define the works cost of maintenance jobs in average 2010 prices, for comparison with user costs in the same price base.

5.2 The procedure is as follows. If works cost estimates are in up-to-date prices, they should be deflated to average 2010 prices using the treasury GDP Deflator Series. For example, suppose works costs are £1m in Q1 2012 prices, conversion to average 2010 price is:

$$£1\text{m} \times \frac{\text{Average 2010 GDP deflator}}{\text{2012 Q1 GDP deflator}}$$

5.3 For maintenance jobs that are programmed to start in later years within the profile, costs should be estimated using the same price base as for current jobs. The potential for maintenance cost increases in excess of general cost inflation for future jobs must also be taken into account as recommended in the latest TAG Unit A1.2.

5.4 The user has to specify the year in which maintenance works will take place; this is important in view of the discounting procedure. QUADRO assumes that any individual job will not take longer than 52 weeks to complete, so that it is unnecessary for the user to allocate costs of a single job to a number of years. If in exceptional circumstances a maintenance job is expected to last for more than one year, the recommended procedure is to split the job into two notional jobs in consecutive years. This procedure also applies when one job starts in one year and finishes in the next year.

5.5 The estimated cost of maintenance works should include an allowance for preparation costs as set out in the Overseeing Organisation Agreement plus site supervision costs which are generally 5% of the total costs. As a simplification, preparation and supervision costs should be included in main works costs for discounting purposes rather than assigning them to different years.

5.6 The accounting approach in the appraisal of transport schemes has changed to the market price unit of account, though QUADRO continues to operate in the factor cost unit of account. (See COBA manual, Part 1, Chapter 6 for a fuller explanation). QUADRO requires any elements of indirect taxation (including VAT) to be removed from cost inputs. Under some circumstances Highways England pays VAT on construction and maintenance costs (in others it does not), and any elements of indirect taxation should be removed before being input into QUADRO.

5.7 Where a maintenance job involves advance works which are likely to cause significant traffic delays, these works should be modelled in QUADRO as notionally separate jobs, in view of the likelihood that the traffic arrangements will be different for the advance works compared with the main works.

Risk Assessment and Adjustment Factors for Optimism Bias

5.8 There is a great deal of uncertainty surrounding the final capital cost of major maintenance schemes. A number of techniques have been suggested to improve scheme cost estimates and one method is through the use of detailed risk assessment. Risk assessment attempts to analyse the extent and probability of different outcomes arising during a project and the Department encourages the use of Quantified Risk Assessment techniques.

5.9 Optimism bias is the tendency of appraisers to underestimate costs and to overestimate benefits. Maintenance cost optimism bias should be assessed according to the guidance given in TAG Unit A1.2.

6. A SUMMARY OF THE ITEMS OF WORKS COSTS AND USER DELAY COSTS

Introduction

6.1 This Chapter describes how the QUADRO program brings together the various elements of the maintenance appraisal and presents the results in summary tables. Historically, the program has accepted input and worked in resource costs and with the move to the 'willingness-to-pay' calculus necessary for the appraisal of multi-modal schemes this has not changed. The 'Profile Cost Analysis By Job' (Phase 9 of the output) is basically unchanged and reports the results in a resource cost basis. A new Phase 10 Table 1 – 'Conversion of Travel Costs to Market Prices by Vehicle Category', shows how the tax elements are added to the resource costs of the user delays. Table 2 – 'Impacts of Construction and/or Maintenance in Market Prices', summarises the results in willingness-to-pay terms in a form compatible with the Transport Economic Efficiency (TEE) Table.

Phase 9 – 'Profile Cost Analysis By Job'

6.2 This was the final economic summary table in QUADRO3 and had not been changed in QUADRO2021. It does not conform to economic appraisal practices (because WebTAG requests that money values associated with accidents should not be included in a TEE table), but remains in the output for clarity and comparison purposes only.

Phase 10 – 'Table 1: Conversion of Travel Costs to Market Prices by Vehicle Category'

6.3 This Table shows the calculations necessary to convert the time and vehicle operating cost changes calculated in resource costs to market prices. The individual components given in Phase 7 (in the table headed 'User Cost Differences by Vehicle Category') are presented under the TEE categories and converted to market prices by the appropriate tax correction factors.

Phase 10 – 'Table 2A: Impacts of Construction and/or Maintenance in Market Prices'

6.4 This is an adaptation of the TEE Table (see TAG Unit A1.3 – User and Provider Impacts). Table 2 shows how the elements calculated in Table 1 are amalgamated with the works costs to produce the economic appraisal of the maintenance scheme. An explanation of the calculation of the Indirect Tax Revenues to Government Impact is given in the COBA manual (Part 2, Chapter 11). Because of the change to 'willingness-to-pay', the Total Impact of the maintenance scheme will be different to that printed in Phase 9 which is in resource costs.

Phase 10 – 'Table 2B: Public Accounts'

6.5 This Table shows the summary of Public Accounts. The advice in TAG Unit A1.2, Scheme Costs, is that Central and Local Government Funding is reported separately. QUADRO cannot make this distinction and it is the responsibility of the user to ensure that the results are reported correctly. The calculation of Indirect Tax Revenues is given in the COBA manual, Part 2, Chapter 11 paragraph 11.7.

Phase 10 – 'Table 2C: Analysis of Monetised Impacts'

6.6 This Table summarises the monetised impacts as calculated by QUADRO. There may also be other

significant costs and benefits, some of which cannot be presented in monetised form (see TAG Unit A1.2 – Scheme Costs). Where this is the case, the analysis presented in Table 2C does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.