
TITLE	:	Operational costing of LRT/bus options 4,6,8 and 9
DATE	:	21 November 2014
PREPARED BY	:	Nicolas Reid (MRCagney)
STATUS	:	Draft working paper – Commercial in confidence

1 Purpose

The purpose of this paper is to document fleet and opex cost assumptions for bus and LRT modes and to estimate the cost impacts of each option.

2 Network assumptions

Network service-hours and service-kilometres are calculated from route length, estimated average speed, service frequency and span of service across a nominal year of operation.

Frequencies were based on meeting modelled peak demand at the peak point on each route in 2046 (and 50% of peak demand at off-peak, 25% at night), or a minimum service frequency (8 vph at peak, 6 vph off-peak and 4 vph at night), whichever was higher.

A timetable was developed based on 250 weekdays, and 115 Saturdays, Sundays or public holidays.

- Weekdays: operation at peak frequency for 4 hours per day, off-peak frequency for 8 hours a day and night frequency for 4 hours per day.
- Saturdays, Sundays and Public Holidays: operation at off-peak frequency for 10 hours per day, night frequency for 6 hours per day.

3 Vehicle assumptions

A capacity of 300 passengers per LRV and 50 passengers per standard bus were used as per specification. Options with double decker buses used 77 passengers per bus with the same operating cost, but purchase and refit costs 30% higher than the standard bus.

For heavy rail under Option 9A Auckland AM class EMUs were assumed, operating in single unit (3-car) consists. A capacity of 375 passengers per unit is assumed. However peak fleet requirements were supplied by the AT CRL team rather than calculated from service plans.

In-service peak fleet requirements were increased by 10% to give total fleet requirements, allowing for hot spares and rotations for maintenance.

4 Unit Cost Rates

All figures are in unadjusted 2014 New Zealand dollars. In the options tables all fleet and network purchase and renewals have been annualised.

4.1 LRT vehicles and operations

- Purchase cost per vehicle: \$6,130,000
- Useful lifetime: 30 years
- Midlife renewal at 15 years: \$1,226,000 (equal to 20% of the purchase cost)

- Power supply per service-km: \$2.31 (7kwh per km @ 30c +10% for stations/depots)
- Vehicle maintenance per service-km: \$1.10
- Staffing cost per service-hour: \$36 (driver + overhead @ 120% of bus staffing cost).

4.2 LRT network maintenance and renewals

- Network maintenance per network-km per annum: \$65,815
- Network renewals per network-km per annum: \$24,351 (equal to 37% of 30 years of network maintenance, annualised. Note however this is typically required during middle to end of 30 year period, little network renewals in first 15 years).

4.3 Standard Bus vehicles and operations

- Purchase cost per vehicle: \$500,000
- Useful lifetime: 12 years
- Midlife renewal at 6 years: \$100,000 (equal to 20% of the purchase cost)
- Fuel, road user charges and vehicle maintenance per service-km: \$2.00
- Staffing cost per service-hour: \$30 (driver + overhead)
- Note no separate network maintenance or renewals for buses, road maintenance covered by road user charges.

4.4 Double Decker Bus vehicles and operations

As above, except:

- Purchase cost per vehicle: \$650,000
- Midlife renewal at 6 years: \$130,000

4.5 Heavy rail vehicles and operations

- Purchase cost per unit: \$8,000,000 (as supplied)
- Useful lifetime: 40 years (estimated)
- Midlife renewal at 20 years: \$1,600,000 (estimated: equal to 20% of the purchase cost)
- Operating cost per service-km: \$4 (as supplied)
- Staffing cost per crew per year: \$120,000 (as supplied)

4.6 Heavy rail network maintenance and renewals

- At the time of writing the unit cost rates for heavy rail network maintenance and renewals had not been supplied. For the purposes of this working paper the equivalent figures for the LRT network have been used as indicative placeholders.

5 Option Eight

5.1 General Description

Three LRT lines replacing three core bus corridors, converging via Upper Queen St on Queen St.

5.2 Elements Removed From Base Case

Option Eight involves the removal of the Dominion Road buses from Mt Roskill to the CBD, the Sandringham Road buses from Owairaka to the CBD, the Mt Eden Road buses from Three Kings to the CBD and the Queen Street section of the City Link bus. These bus routes would be replaced by LRT lines along the same existing bus corridors that will be detailed in the subsequent sub-section. The deletion of these bus routes would involve a removal of 151 peak vehicles, 6,459,649 service kilometres per annum and 434,402 service hours per annum.

5.3 Elements Added to Base Case

To replace the removed bus routes detailed in the previous sub-section, it is proposed to add three LRT lines along the following corridors:

- LRT Dominion - Ian McKinnon - Upper Queen – Queen
- LRT Mt Eden - Newton Rd - Ian McKinnon - Upper Queen – Queen
- LRT Sandringham - New North - Ian McKinnon - Upper Queen – Queen

The addition of these three LRT lines would require 26 additional peak trams with a capacity of 300 passengers each. These LRT lines would involve an additional 1,651,825 service kilometres per annum, an additional 104,460 service hours per annum and a new network length of 19.23 kilometres.

5.4 Summary of Cost Impacts

The proposed bus removals from the base case would represent a saving of \$34,251,358.00, which is composed of the total annualised fleet opex, renewals and maintenance removed. On the other hand, the proposed LRT additions would cost a total of \$18,237,987.51 from annualised fleet and network opex, renewals and maintenance.

Overall, there is a net annualised opex saving for Option Eight of \$16,013,370.49.

5.5 Detailed Costings

The table below provides detailed costings for the proposed element removals and additions to the Base Case under Option Eight

BUS **REMOVALS** FROM NETWORK						
Network length removed	N/A	kilometres	Notes: buses removed are regular capacity single deckers (50 pax)			
Service hours per annum removed	434,402	service-hours				
Service kilometres per annum removed	6,459,649	service-kilometres				
Peak vehicles removed	151	vehicles				
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit		Total:
Annualised vehicle purchase cost	151	15	166	\$ 41,667		\$6,916,666.67
Annualised vehicle renewals	151	15	166	\$ 8,333		\$1,383,333.33
Total annualised fleet costs:						\$8,300,000.00
Marginal operating costs	Service-hours	Service-km		Cost per unit		Total:
Staffing costs per service-hour	434,402				\$30	\$13,032,060.00
Fuel, RUC and maintenance costs per service-km		6,459,649			\$2	\$12,919,298.00
Total annual marginal operating costs:						\$25,951,358.00
Total annualised fleet opex, renewals and maintenance removed:						\$34,251,358.00

BUS **ADDITIONS** TO NETWORK						
Network length added	N/A	kilometres	Notes:			
Service hours per annum added	0	service-hours				
Service kilometres per annum added	0	service-kilometres				
Peak vehicle requirement added	0	vehicles				
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit		Total:
Annualised vehicle purchase cost	0	0	0	\$ 0		\$0.00
Annualised vehicle renewals	0	0	0	\$ 0		\$0.00
Total annualised fleet costs:						\$0.00
Marginal operating costs	Service-hours	Service-km		Cost per unit		Total:
Staffing costs per service-hour	0	-			\$30	\$0.00
Fuel, RUC and maintenance costs per service-km	-	0			\$2	\$0.00
Total annual marginal operating costs:						\$0.00
Total annualised fleet opex, renewals and maintenance removed:						\$0.00

LRT **ADDITIONS** TO NETWORK						
Network length added	19.23	kilometres	Notes: LRVs added are 45m length 2.65m width (300pax)			
Service hours per annum added	104,460	service-hours				
Service kilometres per annum added	1,651,825	service-kilometres				
Peak vehicle requirement added	26	vehicles				
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit		Total:
Annualised vehicle purchase cost	26	3	29	\$ 204,333		\$5,925,666.67
Annualised vehicle renewals	26	3	29	\$ 40,867		\$1,185,133.33
Total annualised fleet costs:						\$7,110,800.00
Marginal operating costs	Service-hours	Service-km		Cost per unit		Total:
Staffing costs per service-hour	104,460	-		\$ 36.00		\$3,760,560.00
Power costs per service-km (fleet and stops/depot)	-	1,651,825		\$ 2.31		\$3,815,716.77
Marginal maintenance per service-km	-	1,651,825		\$ 1.10		\$1,817,007.98
Total annual marginal operating costs:						\$9,393,284.75
Network maintenance and renewals	Network length			Cost per unit		Total:
Network maintenance per track-km per year	19.23			\$65,815		\$1,265,622.45
Annualised network renewals per track-km per year	19.23			\$24,352		\$468,280.31
Total annualised network maintenance:						\$1,733,902.76
Total annualised fleet and network opex, renewals and maintenance added:						\$18,237,987.51

NET ANNUALISED OPEX COST FOR OPTION: -116,013,370.49



6 Option Nine A

6.1 General Description

One LRT corridor replacing buses on Manukau Rd, in combination with a heavy rail extension to Mt Roskill and the introduction of double decker buses on two routes.

Note, heavy rail vehicle requirements and service-operating costs were supplied by Auckland Transport CRL team. They indicated the need for nine EMU units and nine crews to operate the branch line pattern through to the CRL. Track/station operating costs of the new railway branch have been estimated in line with LRT figures.

6.2 Elements Removed From Base Case

Option Nine entails the removal of the entire bus routes along Sandringham Road and Dominion Road as well as the Manukau Road buses between Onehunga and the CBD. These bus routes would be replaced by new Medium Double Decker bus routes and one LRT line along the same existing bus corridors that will be detailed in the subsequent sub-section. The deletion of these bus routes would involve a removal of 256 peak vehicles, 11,091,437 service kilometres per annum and 430,230 service hours per annum.

6.3 Elements Added to Base Case

To replace the removed bus routes detailed in the previous sub-section, it is proposed to add two medium double decker bus routes, one LRT line and one heavy rail branch line along the following corridors:

- Sandringham Rd bus (net route) - Double Decker
- Dominion Rd bus (net route) - Double Decker
- LRT Onehunga Mall - Mt Smart Rd - Manukau Rd - Broadway - Khyber Pass - Park - Grafton B - Symonds - Anzac – Wynyard
- Heavy rail operating from new Mt Roskill station to expanded Parnell station, via inner western line and CRL.

The addition of the two double decker bus routes would require 37 additional double decker buses with a capacity of 77 passengers each. These double decker routes would entail an additional 1,665,823 service kilometres per annum and an additional 111,732 service hours per annum.

Furthermore, the proposed LRT line would require 19 additional peak trams with a capacity of 300 passengers each. This LRT line would involve an additional 965,794 service kilometres per annum, an additional 58,230 service hours per annum and a new network length of 25.06 kilometres.

The heavy rail branch pattern requires 9 EMU trains with a capacity of 375 passengers each. This service pattern would require an additional 811,234 service-kilometre per annum, an additional route length of 25.8 kilometres and an additional network length of 3.8km.

6.4 Summary of Cost Impacts

The proposed bus removals from the base case would represent a saving of \$49,189,774.40, which is composed of the total annualised fleet opex, renewals and maintenance removed. On the other hand, the two proposed medium double decker bus routes would cost a total of \$9,348,606.24 from annualised fleet opex, renewals and maintenance. Moreover, the proposed LRT line would cost a total of \$12,798,411.01 from annualised fleet and network opex, renewals and maintenance, while the heavy rail branch pattern would cost an annual total of \$6,827,568.57 for fleet and network opex, renewals and maintenance.

Overall, there is a net annualised opex saving for Option Nine A of \$20,492,281.58.

6.5 Detailed Costings

The table below provides detailed costings for the proposed element removals and additions to the Base Case under Option Nine:

BUS "REMOVALS" FROM NETWORK					
Network length removed	N/A	kilometres	Notes: buses removed are regular capacity single deckers (50 pax)		
Service hours per annum removed	430,230	service-hours			
Service kilometres per annum removed	11,091,437	service-kilometres			
Peak vehicles removed	256	vehicles			
Fleet purchase and renewals					
	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit	Total:
Annualised vehicle purchase cost	256	26	282	\$ 41,667	\$11,750,000.00
Annualised vehicle renewals	256	26	282	\$ 10,833	\$3,054,906.00
Total annualised fleet costs:					\$14,804,906.00
Marginal operating costs					
	Service-hours	Service-km	Cost per unit		Total:
Staffing costs per service-hour	430,230			\$30	\$12,906,900.00
Fuel, RUC and maintenance costs per service-km		11,091,437		\$2	\$22,182,874.40
Total annual marginal operating costs:					\$35,089,774.40
Total annualised fleet opex, renewals and maintenance removed:					\$49,894,680.40

BUS **ADDITIONS** TO NETWORK					
Network length added	N/A	kilometres	Notes: Additions are medium capacity double deckers (77 pax). Added routes cover only inner parts of Sandringham and Dominion Rd north of Mt Roskill Branch line.		
Service hours per annum added	111,732	service-hours			
Service kilometres per annum added	1,665,823	service-kilometres			
Peak vehicle requirement added	37	vehicles			
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit	Total:
Annualised vehicle purchase cost	37	4	41	\$ 54,167	\$2,220,833.33
Annualised vehicle renewals	37	4	41	\$ 10,833	\$444,166.67
Total annualised fleet costs:					\$2,665,000.00
Marginal operating costs	Service-hours	Service-km		Cost per unit	Total:
Staffing costs per service-hour	111,732	-		\$30	\$3,351,960.00
Fuel, RUC and maintenance costs per service-km	-	1,665,823		\$2	\$3,331,646.24
Total annual marginal operating costs:					\$6,683,606.24
Total annualised fleet opex, renewals and maintenance added:					\$9,348,606.24

LRT **ADDITIONS** TO NETWORK					
Network length added	25.06	kilometres	Notes: LRVs added are 45m length 2.65m width (300pax)		
Service hours per annum added	61,740	service-hours			
Service kilometres per annum added	982,290	service-kilometres			
Peak vehicle requirement added	20	vehicles			
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit	Total:
Annualised vehicle purchase cost	20	2	22	\$ 204,333	\$4,495,333.33
Annualised vehicle renewals	20	2	22	\$ 40,867	\$899,066.67
Total annualised fleet costs:					\$5,394,400.00
Marginal operating costs	Service-hours	Service-km		Cost per unit	Total:
Staffing costs per service-hour	61,740	-		\$ 36.00	\$2,222,640.00
Power costs per service-km (fleet and stops/depot)	-	982,290		\$ 2.31	\$2,269,090.82
Marginal maintenance per service-km	-	982,290		\$ 1.10	\$1,080,519.44
Total annual marginal operating costs:					\$5,572,250.26
Network maintenance and renewals	Network length			Cost per unit	Total:
Network maintenance per track-km per year	25.06			\$65,815	\$1,649,323.90
Annualised network renewals per track-km per year	25.06			\$24,352	\$610,249.84
Total annualised network maintenance:					\$2,259,573.74
Total annualised fleet and network opex, renewals and maintenance added:					\$13,226,224.01

HEAVY RAIL **ADDITIONS** TO NETWORK						
Network length added	3.8	kilometres	Notes: Assumes branch line added and service operates Mt Roskill to Parnell via CRL. PVR and crew requirements and costs as advised by CRL team. NOTE: LRT NETWORK MAINTENANCE AND RENEWAL FIGURES USED AS PLACHOLDERS PENDING FURTHER INFORMATION ON HEAVY RAIL COSTS			
Route-length added	25.8	kilometres				
Crews required per annum	9	crews				
Service kilometres per annum added	811,234	service-kilometres				
Peak vehicle requirement added	9	vehicles				
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit		Total:
Annualised vehicle purchase cost	8	1	9	\$ 200,000		\$1,800,000.00
Annualised vehicle renewals	8	1	9	\$ 40,000		\$360,000.00
Total annualised fleet costs:						\$2,160,000.00
Marginal operating costs	Crews	Service-km		Cost per unit		Total:
Crew costs per crew per annum	9	-		\$120,000		\$1,080,000.00
Operating cost per service-km	-		811,234	\$4.00		\$3,244,935.68
Total annual marginal operating costs:						\$4,324,935.68
Network maintenance and renewals	Network length			Cost per unit		Total:
Network maintenance per track-km per year	3.8			\$65,815		\$250,097.00
Annualised network renewals per track-km per year	3.8			\$24,352		\$92,535.89
Total annualised network maintenance:						\$342,632.89
Total annualised fleet and network opex, renewals and maintenance added:						\$6,827,568.57

NET ANNUALISED OPEX COST FOR OPTION:	-\$20,492,281.58
---	-------------------------

7 Option Four

7.1 General Description

Four LRT lines replacing four core bus corridors feeding to two City Centre spines. Two lines converge on Queen St via Upper Queen St, two lines converge on Symonds St via Upper Symonds St and Grafton Bridge.

7.2 Elements Removed From Base Case

Option Four involves the removal of the Dominion Road buses from Mt Roskill to the CBD, the Sandringham Road buses from Owairaka to the CBD, the Mt Eden Road buses from Three Kings to the CBD, the Manukau Road buses from Onehunga to the CBD and the Queen Street section of the City Link bus. These bus routes would be replaced by LRT lines along the same existing bus corridors that will be detailed in the subsequent sub-section. The deletion of these bus routes would involve a removal of 254 peak vehicles, 10,920,721 service kilometres per annum and 723,878 service hours per annum.

7.3 Elements Added to Base Case

To replace the removed bus routes detailed in the previous sub-section, it is proposed to add four LRT lines along the following corridors:

- LRT Dominion - Ian McKinnon - Upper Queen - Queen – Wynyard
- LRT Mt Eden - Alex Evans - Ian McKinnon - Upper Queen - Queen – Wynyard
- LRT Sandringham - New North - Ian McKinnon - Upper Queen – Queen – Wynyard
- LRT Onehunga Mall - Mt Smart Rd - Manukau Rd - Broadway - Khyber Pass - Park - Grafton B - Symonds - Anzac - Wynyard

The addition of these three LRT lines would require 49 additional peak trams with a capacity of 300 passengers each. These LRT lines would involve an additional 2,935,124 service kilometres per annum, an additional 180,990 service hours per annum and a new network length of 32.06 kilometres.

7.4 Summary of Cost Impacts

The proposed bus removals from the base case would represent a saving of \$57,507,782.00, which is composed of the total annualised fleet opex, renewals and maintenance removed. On the other hand, the proposed LRT additions would cost a total of \$32,655,950.80 from annualised fleet and network opex, renewals and maintenance.

Overall, there is a net annualised opex saving for Option Four of \$24,851,831.20.

7.5 Detailed Costings

The table below provides detailed costings for the proposed element removals and additions to the Base Case under Option Four

BUS **REMOVALS** FROM NETWORK						
Network length removed	N/A	kilometres	Notes: buses removed are regular capacity single deckers (50 pax)			
Service hours per annum removed	723,878	service-hours				
Service kilometres per annum removed	10,920,721	service-kilometres				
Peak vehicles removed	254	vehicles				
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit	Total:	
Annualised vehicle purchase cost	254	25	279	\$ 41,667	\$11,625,000.00	
Annualised vehicle renewals	254	25	279	\$ 8,333	\$2,325,000.00	
					Total annualised fleet costs:	
					\$13,950,000.00	
Marginal operating costs	Service-hours	Service-km	Cost per unit		Total:	
Staffing costs per service-hour	723,878				\$30 \$21,716,340.00	
Fuel, RUC and maintenance costs per service-km		10,920,721			\$2 \$21,841,442.00	
					Total annual marginal operating costs:	
					\$43,557,782.00	
Total annualised fleet opex, renewals and maintenance removed:						\$57,507,782.00

BUS **ADDITIONS** TO NETWORK						
Network length added	N/A	kilometres	Notes:			
Service hours per annum added	0	service-hours				
Service kilometres per annum added	0	service-kilometres				
Peak vehicle requirement added	0	vehicles				
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit	Total:	
Annualised vehicle purchase cost	0	0	0	\$ 0	\$0.00	
Annualised vehicle renewals	0	0	0	\$ 0	\$0.00	
					Total annualised fleet costs:	
					\$0.00	
Marginal operating costs	Service-hours	Service-km	Cost per unit		Total:	
Staffing costs per service-hour	0	-			\$30 \$0.00	
Fuel, RUC and maintenance costs per service-km	-	0			\$2 \$0.00	
					Total annual marginal operating costs:	
					\$0.00	
Total annualised fleet opex, renewals and maintenance added:						\$0.00

LRT **ADDITIONS** TO NETWORK						
Network length added	32.06	kilometres	Notes: LRVs added are 45m length 2.65m width (300pax)			
Service hours per annum added	180,990	service-hours				
Service kilometres per annum added	2,935,124	service-kilometres				
Peak vehicle requirement added	49	vehicles				
Fleet purchase and renewals	Fleet for service	Fleet for spares/rotation @10%	Total fleet	Cost per unit	Total:	
Annualised vehicle purchase cost	49	5	54	\$ 204,333	\$11,034,000.00	
Annualised vehicle renewals	49	5	54	\$ 40,867	\$2,206,800.00	
					Total annualised fleet costs:	
					\$13,240,800.00	
Marginal operating costs	Service-hours	Service-km	Cost per unit		Total:	
Staffing costs per service-hour	180,990	-	\$ 36.00		\$6,515,640.00	
Power costs per service-km (fleet and stops/depot)	-	2,935,124	\$ 2.31		\$6,780,135.33	
Marginal maintenance per service-km	-	2,935,124	\$ 1.10		\$3,228,635.87	
					Total annual marginal operating costs:	
					\$16,524,411.20	
Network maintenance and renewals	Network length			Cost per unit	Total:	
Network maintenance per track-km per year	32.06			\$65,815	\$2,110,028.90	
Annualised network renewals per track-km per year	32.06			\$24,352	\$780,710.69	
					Total annualised network maintenance:	
					\$2,890,739.59	
Total annualised fleet and network opex, renewals and maintenance added:						\$32,655,950.80

NET ANNUALISED OPEX COST FOR OPTION: -524,851,831.20



