

Appendix A The Sandringham/Balmoral intersection

A1 Location plan



Figure A1 Map showing the Sandringham/Balmoral and Mt Eden/Balmoral intersections.

A2 Construction plan (existing layout)

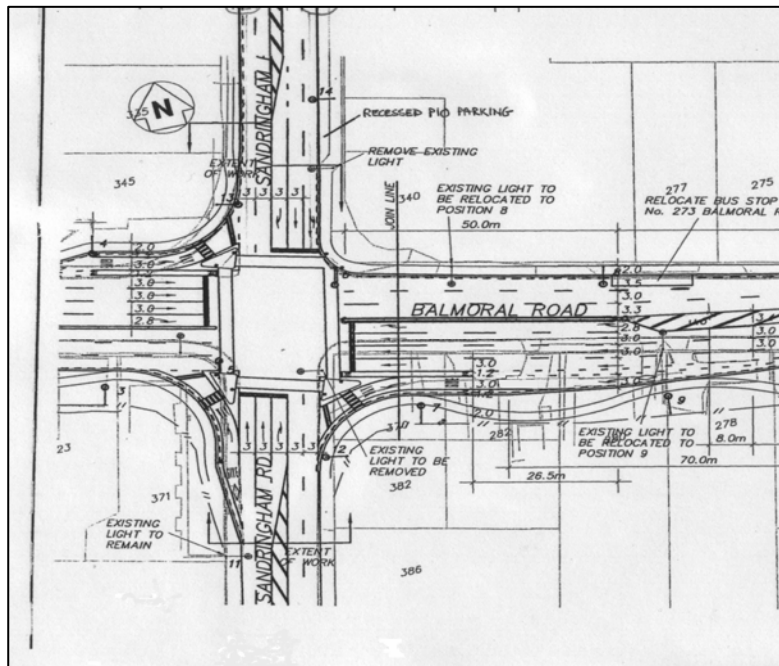


Figure A2 Existing layout of the Sandringham/Balmoral intersection.

A3 Traffic survey data

A3.1 Traffic count summaries

Table A1 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, morning peak period (Balmoral Road).

Vehicle type	Time										Four hour summations				
	630-645	645-700	700-715	715-730	730-745	745-800	800-815	815-830	830-845	845-900	700-800	715-815	730-830	745-845	800-900
Balmoral westbound left-turn only lane															
Cars:	-	-	14	5	12	12	10	13	18	15	43	39	47	53	56
HCVs:	-	-	0	1	1	0	0	2	1	2	2	2	3	3	5
Balmoral westbound left-hand through-lane															
Cars:	-	-	6	12	12	16	25	38	18	34	46	65	91	97	115
HCVs:	-	-	0	2	1	2	3	1	3	0	5	8	7	9	7
Balmoral westbound central through-lane															
Cars:	-	-	32	36	59	63	60	78	60	70	190	218	260	261	268
HCVs:	-	-	0	0	1	1	2	1	2	3	2	4	5	6	8
Balmoral westbound right-hand through-lane															
Cars:	-	-	21	37	48	59	68	75	70	85	168	210	24	272	298
HCVs:	-	-	1	1	2	2	3	4	1	3	8	8	11	10	11
Balmoral westbound right-turn only lane															
Cars:	-	-	28	38	49	54	42	53	41	64	169	183	198	190	200
HCVs:	-	-	4	2	0	1	3	3	4	0	7	6	7	11	10
Balmoral eastbound left-turn only lane															
Cars:	-	-	10	12	25	29	15	20	15	32	89	79	82	67	47
HCVs:	-	-	1	0	2	0	1	0	0	2	3	3	3	1	3
Balmoral eastbound left-hand through-lane															
Cars:	-	-	19	22	31	26	27	16	14	28	98	106	100	83	85
HCVs:	-	-	0	2	5	2	1	1	1	1	9	10	9	5	4
Balmoral eastbound central through-lane															
Cars:	-	-	34	58	54	53	69	53	55	51	199	234	229	230	228
HCVs:	-	-	2	2	3	1	1	2	4	0	8	7	7	8	7
Balmoral eastbound right-hand through-lane															
Cars:	-	-	64	70	75	74	72	61	76	65	283	291	282	283	274
HCVs:	-	-	0	2	1	1	3	1	2	1	4	7	6	7	7
Balmoral eastbound right-turn only lane															
Cars:	-	-	7	9	15	13	15	16	20	22	44	52	59	64	73
HCVs:	-	-	2	3	0	4	1	0	3	4	9	6	5	8	8

Table A2 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, morning peak period (Sandringham Road).

Vehicle type	Time										Four hour summations				
	630-645	645-700	700-715	715-730	730-745	745-800	800-815	815-830	830-845	845-900	700-800	715-815	730-830	745-845	800-900
Sandringham northbound left turn-only lane															
Cars:	-	-	19	20	20	16	14	24	13	36	75	70	74	67	87
HCVs:	-	-	2	1	1	0	2	5	1	3	4	4	8	8	11
Sandringham northbound left-hand through-lane															
Cars:	-	-	30	41	49	69	81	65	52	68	189	240	264	267	266
HCVs:	-	-	1	4	6	5	13	6	5	4	16	28	30	29	28
Sandringham northbound central through-lane															
Cars:	-	-	107	109	152	173	150	117	106	129	541	584	592	546	502
HCVs:	-	-	2	6	4	2	1	1	6	1	14	13	8	10	9
Sandringham northbound right-turn only lane															
Cars:	-	-	26	36	34	50	63	67	29	47	146	183	214	209	206
HCVs:	-	-	3	2	1	0	0	0	1	0	6	3	1	1	1
Sandringham southbound left-turn only lane															
Cars:	-	-	29	33	31	26	43	23	18	36	119	133	123	110	120
HCVs:	-	-	3	1	0	0	2	0	1	1	4	3	3	3	4
Sandringham southbound left-hand through-lane:															
Cars:	-	-	6	1	4	2	5	4	14	7	13	12	15	25	30
HCVs:	-	-	2	0	1	1	1	1	2	3	4	3	4	5	7
Sandringham southbound central through-lane															
Cars:	-	-	39	35	41	34	44	53	62	45	149	154	172	193	204
HCVs:	-	-	1	0	1	3	6	7	6	5	5	10	17	22	24
Sandringham southbound right-turn only lane															
Cars:	-	-	7	13	7	16	17	31	27	31	43	53	71	91	106
HCVs:	-	-	0	1	0	1	2	0	3	2	2	4	3	6	7

Table A3 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, morning peak period (totals).

Vehicle type	Time										Four hour summations				
	630-645	645-700	700-715	715-730	730-745	745-800	800-815	815-830	830-845	845-900	700-800	715-815	730-830	745-845	800-900
Grand total:	-	-	527	617	746	811	865	842	754	900	2714	3037	3257	3260	3326
Total cars:	-	-	503	587	716	785	820	807	708	865	2604	2906	3121	3108	3165
Total HCVs:	-	-	24	30	30	26	45	35	46	35	110	131	136	152	161

The one hour summation used for analysing this intersection during the morning peak period was 800-900.

Table A4 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, off-peak period (Balmoral Road).

Vehicle type	Time								Four hour summations				
	1100-1115	1115-1130	1130-1145	1145-1200	1200-1215	1215-1230	1230-1245	1245-1300	1100-1200	1115-1215	1130-1230	1145-1245	1200-1300
Balmoral westbound left turn-only lane													
Cars:	13	19	27	27	22	23	17	20	86	95	99	89	82
HCVs:	2	2	0	1	1	0	1	0	5	4	2	3	2
Balmoral westbound left-hand through-lane													
Cars:	16	16	29	27	20	16	23	20	88	92	92	86	79
HCVs:	0	2	2	2	2	4	0	1	4	6	8	10	8
Balmoral westbound central through-lane													
Cars:	51	50	64	46	47	51	71	45	211	207	208	215	214
HCVs:	3	4	3	4	1	3	3	2	14	12	11	11	9
Balmoral westbound right-hand through-lane													
Cars:	83	81	93	73	75	77	74	61	330	322	318	299	287
HCVs:	4	2	1	0	0	0	1	2	7	3	1	1	3
Balmoral westbound right-turn only lane													
Cars:	23	27	31	30	21	17	29	27	111	109	99	97	94
HCVs:	2	1	0	3	1	3	1	2	6	5	7	8	7
Balmoral eastbound left turn only-lane													
Cars:	26	23	32	28	18	27	24	26	109	101	105	97	95
HCVs:	4	1	1	2	1	0	1	0	8	5	4	4	2
Balmoral eastbound left-hand through-lane													
Cars:	20	24	10	23	13	29	14	19	77	70	75	79	75
HCVs:	1	3	1	1	5	3	0	2	6	10	10	9	10
Balmoral eastbound central through-lane													
Cars:	68	67	53	61	55	72	48	58	249	236	241	236	233
HCVs:	1	1	0	1	3	4	2	3	3	5	8	10	12
Balmoral eastbound right-hand through-lane													
Cars:	76	86	57	81	78	95	60	82	300	302	311	314	315
HCVs:	5	1	3	4	1	3	1	5	13	9	11	9	10
Balmoral eastbound right-turn only lane													
Cars:	23	38	43	28	32	42	35	36	132	141	145	137	145
HCVs:	3	5	1	4	1	4	0	3	13	11	10	9	8

Table A5 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, off-peak period (Sandringham Road).

Vehicle type	Time								Four hour summations				
	1100-1115	1115-1130	1130-1145	1145-1200	1200-1215	1215-1230	1230-1245	1245-1300	1100-1200	1115-1215	1130-1230	1145-1245	1200-1300
Sandringham northbound left- turn only lane													
Cars:	23	40	31	36	42	40	46	44	130	149	149	164	172
HCVs:	5	2	2	2	2	3	3	3	11	8	9	10	11
Sandringham northbound left-hand through-lane													
Cars:	16	14	14	21	15	18	18	20	65	64	68	72	71
HCVs:	1	1	4	1	2	3	1	3	7	8	10	7	9
Sandringham northbound central through-lane													
Cars:	54	59	60	72	58	35	58	64	245	249	225	223	215
HCVs:	3	0	2	4	4	2	4	2	9	10	12	14	12
Sandringham northbound right-turn only lane													
Cars:	25	18	19	20	20	19	16	25	82	77	78	75	80
HCVs:	1	1	0	1	0	0	3	2	3	2	1	4	5
Sandringham southbound left-turn only lane													
Cars:	20	22	29	31	24	25	24	33	102	106	109	104	106
HCVs:	3	2	3	1	0	1	1	1	9	6	5	3	3
Sandringham southbound left-hand through-lane													
Cars:	6	13	9	14	11	15	15	15	42	47	49	55	56
HCVs:	0	2	0	3	2	2	2	2	5	7	7	9	8
Sandringham southbound central through-lane													
Cars:	63	46	56	63	57	63	50	49	228	222	239	233	219
HCVs:	5	4	2	6	4	2	1	6	17	16	14	13	13
Sandringham southbound right-turn only lane													
Cars:	24	21	27	29	31	28	33	17	101	108	115	121	109
HCVs:	1	3	2	1	1	2	0	2	7	7	6	4	5

Table A6 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, off-peak period (totals).

Vehicle type	Time								Four hour summations				
	1100-1115	1115-1130	1130-1145	1145-1200	1200-1215	1215-1230	1230-1245	1245-1300	1100-1200	1115-1215	1130-1230	1145-1245	1200-1300
Grand total:	674	701	711	751	670	731	680	702	2835	2831	2861	2834	2784
Total cars:	630	664	684	710	639	692	655	661	2688	2697	2725	2696	2647
Total HCVs:	44	37	27	41	31	39	25	41	147	134	136	138	137

The one hour summation used for analysing the off-peak period was 1130-1230.

Table A7 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, evening peak period (Balmoral Road).

Vehicle type	Time								Four hour summations				
	1600-1615	1615-1630	1630-1645	1645-1700	1700-1715	1715-1730	1730-1745	1745-1800	1600-1700	1615-1715	1630-1730	1645-1745	1700-1800
Balmoral westbound left-turn only lane													
Cars:	41	34	36	48	50	57	46	37	159	168	191	201	190
HCVs:	1	1	0	2	1	2	0	0	4	4	5	5	3
Balmoral westbound left-hand through-lane													
Cars:	39	38	41	39	49	49	38	32	157	167	178	175	168
HCVs:	0	3	0	2	1	0	1	0	3	5	6	3	4
Balmoral westbound central through-lane													
Cars:	77	79	74	77	71	89	77	64	307	301	311	314	301
HCVs:	1	1	3	3	3	1	2	0	8	10	10	9	6
Balmoral westbound right-hand through-lane													
Cars:	88	109	100	105	90	110	91	70	402	404	405	396	361
HCVs:	3	3	0	3	0	1	2	1	9	6	4	6	4
Balmoral westbound right-turn only lane													
Cars:	36	60	50	52	65	57	69	46	198	227	224	243	237
HCVs:	4	2	0	0	1	0	1	1	6	3	1	2	3
Balmoral eastbound left-turn lane													
Cars:	19	24	22	22	27	39	19	22	87	95	110	107	107
HCVs:	0	0	1	1	0	1	0	2	2	2	3	2	3
Balmoral eastbound left-hand through-lane													
Cars:	23	25	33	34	41	35	43	18	115	133	143	153	137
HCVs:	1	1	1	2	1	1	1	2	5	5	5	5	5
Balmoral eastbound central through-lane													
Cars:	66	89	78	97	86	87	111	72	330	350	348	381	356
HCVs:	3	3	4	4	0	0	1	0	14	11	8	5	1
Balmoral eastbound right-hand through-lane													
Cars:	71	112	89	116	102	103	115	94	388	419	410	436	414
HCVs:	1	5	8	0	1	0	0	1	14	14	9	1	2
Balmoral eastbound right-turn only lane													
Cars:	36	52	55	58	58	67	57	50	201	223	238	240	232
HCVs:	0	2	2	3	3	2	1	0	7	10	10	9	6

Table A8 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, evening peak period (Sandringham Road).

Vehicle type	Time								Four hour summations				
	1600-1615	1615-1630	1630-1645	1645-1700	1700-1715	1715-1730	1730-1745	1745-1800	1600-1700	1615-1715	1630-1730	1645-1745	1700-1800
Sandringham northbound left-turn only lane													
Cars:	34	31	42	28	37	27	39	34	135	138	134	131	137
HCVs:	2	3	1	2	0	1	2	1	8	6	4	5	4
Sandringham northbound left-hand through-lane													
Cars:	27	19	18	18	27	22	18	17	82	82	85	85	84
HCVs:	6	7	11	2	1	2	0	0	26	21	16	5	3
Sandringham northbound central through-lane													
Cars:	70	60	75	74	87	61	68	77	279	296	297	290	293
HCVs:	6	6	2	7	6	7	5	2	21	21	22	25	20
Sandringham northbound right-turn only lane													
Cars:	25	21	24	21	19	36	17	29	91	85	100	93	101
HCVs:	0	0	0	2	0	0	0	0	2	2	2	2	0
Sandringham southbound left-turn only lane													
Cars:	34	29	33	31	35	35	28	33	127	128	134	129	131
HCVs:	4	0	0	3	3	0	0	2	7	6	6	6	5
Sandringham southbound left-hand through-lane													
Cars:	11	21	43	37	49	54	50	48	112	150	183	190	201
HCVs:	3	3	5	5	0	6	1	7	16	13	16	12	14
Sandringham southbound central through-lane													
Cars:	85	47	120	132	140	152	141	150	416	471	544	565	583
HCVs:	3	5	7	3	4	3	1	3	18	19	17	11	11
Sandringham southbound right-turn only lane													
Cars:	42	37	36	31	39	43	25	34	146	143	149	138	141
HCVs:	4	0	1	1	2	3	1	2	6	4	7	7	8

Table A9 Traffic count summary at the Sandringham/Balmoral intersection on Tuesday 1st February 2005, evening peak period (totals).

Vehicle type	Time							Four hour summations					
	1600-1615	1615-1630	1630-1645	1645-1700	1700-1715	1715-1730	1730-1745	1745-1800	1600-1700	1615-1715	1630-1730	1645-1745	1700-1800
Grand total:	866	964	1015	1065	1099	1153	1071	951	3908	4142	4335	4387	4276
Total cars:	824	919	969	1020	1072	1123	1052	927	3732	3980	4184	4267	4174
Total HCVs:	42	45	46	45	27	30	19	24	176	162	151	120	102

The one hour summation used for analysing the evening peak period was 1645-1745.

A3.2 Usage summaries

For this section, the following points should be noted:

- Rate of use (%) in short lanes is higher during periods of increased congestion (use would be enhanced by any clearways).
- One HCV has been assumed to equal two passenger car units.
- The Mt Eden 2001 and 2005 traffic counts differ by up to 5%.
- The kerbside through-lane on the northbound side of Sandringham Road is used more during the morning peak period, mainly because of morning clearways.

Table A10 Usage summary at the Sandringham/Balmoral intersection on Tuesday 1st February, morning peak period.

Location	Peak hour cars	Peak hour HCVs	Cars + HCVs	Total for movement	% of total	Mt Eden 2001 count	Mt Eden 2005 count
Balmoral westbound left-turn only lane	56	5	66	66	100%	-	-
Balmoral westbound left-hand through-lane	115	7	129	733	18%	12%	11%
Balmoral westbound central through-lane	268	8	284	733	39%	35%	38%
Balmoral westbound right-hand through-lane	298	11	320	733	44%	53%	51%
Balmoral westbound right-turn only lane	200	10	220	220	100%	-	-
Balmoral eastbound left-turn only lane	47	3	53	53	100%	-	-
Balmoral eastbound left-hand through-lane	85	4	93	623	15%	8%	12%
Balmoral eastbound central through-lane	228	7	242	623	39%	42%	40%
Balmoral eastbound right-hand through-lane	274	7	288	623	46%	50%	48%
Balmoral eastbound right-turn only lane	73	8	89	89	100%	-	-
Sandringham northbound left-turn only lane	87	11	109	109	100%	-	-
Sandringham northbound left-hand through-lane	266	28	322	842	38%	45%	40%
Sandringham northbound central through-lane	502	9	520	842	62%	55%	60%
Sandringham northbound right-turn only lane	206	1	208	208	100%	-	-
Sandringham southbound left-turn only lane	120	4	128	128	100%	-	-
Sandringham southbound left-hand through-lane	30	7	44	296	15%	21%	20%
Sandringham southbound central through-lane	204	24	252	296	85%	79%	80%
Sandringham southbound right-turn only lane	106	7	120	120	100%	-	-

Table A11 Usage summary at the Sandringham/Balmoral intersection on Tuesday 1st February, off-peak period.

Location	Peak hour cars	Peak hour HCVs	Cars + HCVs	Total for movement	% of total	Mt Eden 2001 count	Mt Eden 2005 count
Balmoral westbound left-turn only lane	99	2	103	103	100%	-	-
Balmoral westbound left-hand through-lane	92	8	108	658	16%	7%	8%
Balmoral westbound central through-lane	208	11	230	658	35%	40%	43%
Balmoral westbound right-hand through-lane	318	1	320	658	49%	53%	50%
Balmoral westbound right-turn only lane	99	7	113	113	100%	-	-
Balmoral eastbound left-turn only lane	105	4	113	113	100%	-	-
Balmoral eastbound left-hand through-lane	75	10	95	685	14%	14%	9%
Balmoral eastbound central through-lane	241	8	257	685	38%	39%	42%
Balmoral eastbound right-hand through-lane	311	11	333	685	49%	47%	49%
Balmoral eastbound right-turn only lane	145	10	165	165	100%	-	-
Sandringham northbound left-turn only lane	149	9	167	167	100%	-	-
Sandringham northbound left-hand through-lane	68	10	88	337	26%	33%	29%
Sandringham northbound central through-lane	225	12	249	337	74%	67%	71%
Sandringham northbound right-turn only lane	78	1	80	80	100%	-	-
Sandringham southbound left-turn only lane	109	5	119	119	100%	-	-
Sandringham southbound left-hand through-lane	49	7	63	330	19%	15%	17%
Sandringham southbound central through-lane	239	14	267	330	81%	85%	83%
Sandringham southbound right-turn only lane	115	6	127	127	100%	-	-

Table A12 Usage summary at the Sandringham/Balmoral intersection on Tuesday 1st February, evening peak period.

Location	Peak hour cars	Peak hour HCVs	Cars + HCVs	Total for movement	% of total	Mt Eden 2001 count	Mt Eden 2005 count
Balmoral westbound left-turn only lane	201	5	211	211	100%	-	-
Balmoral westbound left-hand through-lane	175	3	181	921	20%	13%	13%
Balmoral westbound central through-lane	314	9	332	921	36%	42%	42%
Balmoral westbound right-hand through-lane	396	6	408	921	44%	45%	45%
Balmoral westbound right-turn only lane	243	2	247	247	100%	-	-
Balmoral eastbound left-turn only lane:	107	2	111	111	100%	-	-
Balmoral eastbound left-hand through-lane	153	5	163	992	16%	11%	
Balmoral eastbound central through-lane	381	5	391	992	39%	39%	37%
Balmoral eastbound right-hand through-lane	436	1	438	992	44%	50%	48%
Balmoral eastbound right-turn only lane	240	9	258	258	100%	-	-
Sandringham northbound left-turn only lane	131	5	141	141	100%	-	-
Sandringham northbound left-hand through-lane	85	5	95	435	22%	33%	32%
Sandringham northbound central through-lane	290	25	340	435	78%	68%	68%
Sandringham northbound right-turn only lane	93	2	97	97	100%	-	-
Sandringham southbound left-turn only lane	129	6	141	141	100%	-	-
Sandringham southbound left-hand through-lane	190	12	214	801	27%	28%	30%
Sandringham southbound central through-lane	565	11	587	801	73%	72%	70%
Sandringham southbound right-turn only lane	138	7	152	152	100%	-	-

Table A13 Usage summary at the Sandringham/Balmoral intersection on Tuesday 1st February for all commuter periods.

Location	Peak hour cars	Peak hour HCVs	Cars + HCVs	Total for movement	% of total	Mt Eden 2001 count	Mt Eden 2005 count	% Balmoral/Mt Eden
Balmoral westbound left-turn only lane	3556	12	380	380	100%	-	-	-
Balmoral westbound left-hand through-lane	382	18	418	2312	18%	11%	11%	169%
Balmoral westbound central through-lane	790	28	846	2312	37%	39%	415	89%
Balmoral westbound right-hand through-lane	1012	18	1048	2312	45%	50%	49%	93%
Balmoral westbound right-turn only lane	542	19	580	580	100%	-	-	-
Balmoral eastbound left-turn only lane	259	9	277	277	100%	-	-	-
Balmoral eastbound left-hand through-lane	313	19	351	2300	15%	11%	12%	131%
Balmoral eastbound central through-lane	850	20	890	2300	39%	40%	40%	98%
Balmoral eastbound right-hand through-lane	1021	19	1059	2300	46%	49%	48%	95%
Balmoral eastbound right-turn only lane	458	27	512	512	100%	-	-	-
Sandringham northbound left-turn only lane	367	25	417	417	100%	-	-	-
Sandringham northbound left-hand through-lane	419	43	505	1614	31%	37%	34%	93%
Sandringham northbound central through-lane	1017	46	1109	1614	69%	63%	66%	104%
Sandringham northbound right-turn only lane	377	4	385	385	100%	-	-	-
Sandringham southbound left-turn only lane	358	15	388	388	100%	-	-	-
Sandringham southbound left-hand through-lane	269	26	321	1427	22%	21%	22%	101%
Sandringham southbound central through-lane	1008	49	1106	1427	78%	79%	78%	100%
Sandringham southbound right-turn only lane	359	20	399	399	100%	-	-	-

A3.3 Vehicle queue summaries

For the summaries in Chapter A3.3, the abbreviations NBD, SBD, EBD and WBD stand for 'northbound', 'southbound', 'eastbound' and 'westbound' respectively.

Table A14 Vehicle queue summary at the Sandringham/Balmoral intersection on Tuesday 1st February, morning peak period.

Time	Location Tallies																
	Balmoral WBD left-turn only lane	Balmoral WBD left-hand through-lane	Balmoral WBD central through-lane	Balmoral WBD right-hand through-lane	Balmoral WBD right-turn only lane	Balmoral EBD left-turn only lane	Balmoral EBD left-hand through-lane	Balmoral EBD central through-lane	Balmoral EBD right-hand through-lane	Balmoral EBD right-turn only lane	Sandringham NBD left-turn only lane	Sandringham NBD left-hand through-lane	Sandringham NBD central through-lane	Sandringham NBD right-turn lane	Sandringham SBD left-turn and through-lane	Sandringham SBD central through-lane	Sandringham SBD right-turn only lane
0800-0900	0	2	3	4	8	2	3	8	9	0	10	15	9	4	6	2	2
	0	1	7	7	7	0	4	8	11	0	10	21	10	3	4	2	2
	0	1	6	4	12	0	1	5	5	6	9	16	6	6	13	0	0
	0	2	5	5	5	0	3	5	7	2	15	11	6	2	1	3	3
	0	5	6	6	11	0	5	11	13	3	10	20	3	5	18	2	2
	0	3	10	10	7	0	3	2	6	3	10	16	5	7	4	4	4
	0	3	6	8	3	0	1	4	8	3	15	16	5	3	4	5	5
	0	2	5	12	5	0	4	3	4	0	23	16	7	1	4	4	4
	0	3	3	4	6	0	4	8	10	0	9	19	2	3	4	6	6
	0	1	2	2	8	0	2	5	7	0	6	25	10	2	2	4	4
	0	1	2	5	13	0	1	5	5	0	7	19	8	5	7	3	3
	0	1	5	3	7	0	1	4	5	0	14	16	8	6	3	0	0
	0	2	3	6	4	0	4	6	11	1	8	23	6	5	4	2	2
	0	3	3	5	4	0	3	8	9	2	10	12	2	1	6	3	3
	0	2	7	8	7	0	3	5	8	2	7	18	6	0	0	4	4
	0	0	4	8	8	0	4	7	10	0	8	15	6	3	8	4	4
	0	3	0	0	7	0	3	7	11	0	7	12	5	2	2	0	0
	0	3	5	5	9	0	3	6	9	1	10	15	9	6	8	6	6
	0	4	8	7	9	0	4	6	7	6	15	20	4	1	5	5	6
	0	3	7	5	5	0	5	11	9	4	11	21	10	5	9	8	8
	0	3	8	5	11	0	3	2	6	0	25	25	9	5	7	1	1
	0	6	10	11	10	0	2	3	5	2	25	25	4	6	15	5	5
	0	2	9	9	8	0	4	4	8	5	10	15	11	6	13	6	6
	0	2	5	6	7	0	1	4	10	0	10	12	3	2	5	2	2
	0	4	6	8	6	0	1	2	3	1	10	19	5	7	2	3	3
	0	2	7	12	2	0	4	4	4	2	11	17	5	3	3	5	5
	0	1	6	9	5	0	4	8	11	3	10	15	6	8	9	5	5
	0	1	3	7	6	0	2	9	10	0	7	9	5	4	7	4	4
	0	2	3	2	5	0	4	4	5	0	8	11	7	1	4	5	7
	0	3	3	4	4	0	9	9	5	0	7	14	5	7	5	7	7
	0	5	8	8	8	0	8	8	8	0	6	15	5	1	2	0	1
Total	-	70	160	195	261	2	90	177	237	52	-	324	542	205	123	191	116
# count	24	30	31	31	35	26	30	30	30	29	19	31	32	33	32	32	33
average	-	2	5	6	7	0	3	6	8	2	-	10	17	6	4	6	4
mean queue length	0 m	26 m			42 m	0 m	34 m			12 m	0 m	81 m		36 m	24 m	36 m	24 m

Table A15 Vehicle queue summary at the Sandringham/Balmoral intersection on Tuesday 1st February, off-peak period.

Time	Location Tallies																
	Balmoral WBD left-turn only lane	Balmoral WBD left-hand through-lane	Balmoral WBD central through-lane	Balmoral WBD right-hand through-lane	Balmoral WBD right-turn only lane	Balmoral EBD left-turn only lane	Balmoral EBD left-hand through-lane	Balmoral EBD central through-lane	Balmoral EBD right-hand through-lane	Balmoral EBD right-turn lane	Sandringham NBD left-turn lane	Sandringham NBD left-hand through-lane	Sandringham NBD central through-lane	Sandringham NBD right-turn only lane	Sandringham SBD left-turn and through-lane	Sandringham SBD central through-lane	Sandringham SBD right-turn lane
1130-1230	0	1	4	7	6	0	2	6	4	6	0	2	5	0	2	4	4
	0	3	7	6	6	0	1	5	7	6	0	0	7	0	2	3	2
	0	4	7	7	5	0	9	8	7	0	0	2	9	0	6	10	7
	0	3	7	9	5	0	1	6	4	5	0	2	6	4	1	3	3
	0	2	10	6	0	0	1	3	4	0	0	2	6	2	1	1	4
	0	2	1	2	6	0	3	4	7	0	0	1	6	6	3	1	4
	0	1	1	6	6	0	2	5	8	4	0	1	3	2	7	4	2
	0	1	3	6	5	0	2	2	4	4	0	1	4	1	0	1	2
	0	1	2	2	5	0	2	5	7	3	0	2	7	2	5	2	2
	0	1	7	5	2	0	1	5	7	0	0	0	9	1	7	2	2
	0	1	3	5	4	0	0	2	1	5	0	4	10	2	3	6	5
	0	1	5	9	4	0	3	2	5	5	0	2	8	3	3	5	4
	0	1	3	3	6	0	3	5	8	3	0	2	5	1	7	8	3
	0	2	5	7	3	0	4	6	11	3	0	4	8	2	0	4	5
	0	2	8	7	6	0	0	5	9	6	0	1	2	0	5	4	3
	0	1	7	7	4	0	0	3	8	8	0	1	4	2	3	5	2
	0	2	4	8	2	0	2	5	9	0	0	0	4	3	4	5	1
	0	1	2	13	3	0	3	4	4	2	0	3	6	2	4	3	6
	0	3	7	2	6	0	5	4	7	4	0	3	10	4	6	7	5
	0	4	6	8	2	0	4	7	11	2	0	0	5	4	5	9	4
	0	1	4	10	7	0	0	9	12	4	0	1	5	2	2	6	2
	0	3	6	2	2							2	8	3	5	7	6
				7								2	9	0	6	6	2
												2	7	7	5	7	3
												1	4	4	5	9	4
												4	13	2	6	7	3
														2	4	6	6
Total	-	41	109	144	90	-	48	101	144	70	-	46	177	63	105	149	95
# count	22	22	22	23	22	21	20	21	21	21	22	27	27	27	27	27	27
average	-	2	5	6	4	-	2	5	7	3	-	2	7	2	4	6	4
mean queue length	0 m	26 m		24 m	0 m	28 m			18 m	0 m	27 m		12 m	24 m	36 m	24 m	

Appendix B The Mt Eden/Balmoral intersection

B1 Intersection layout

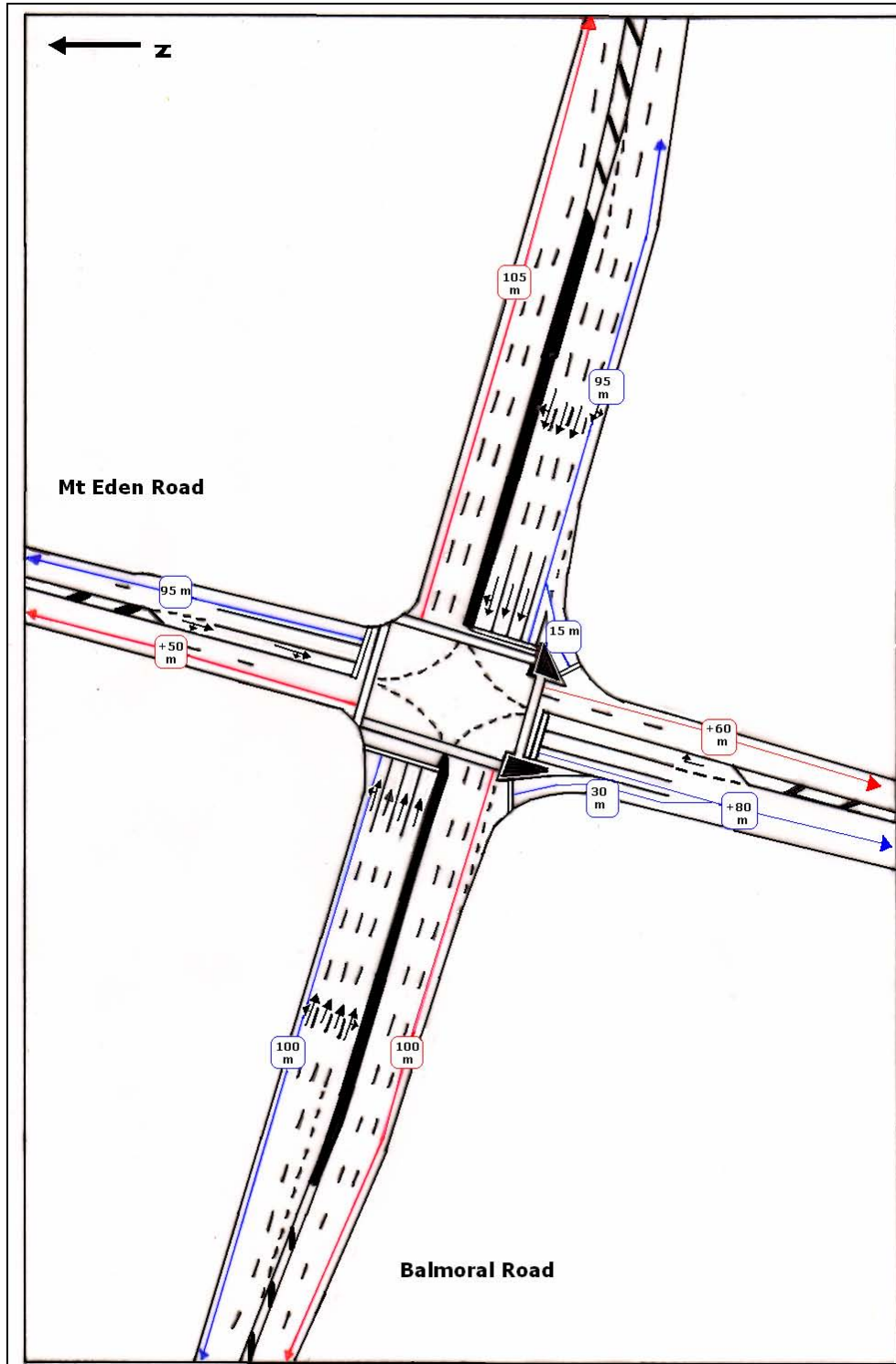


Figure B1 Bird's eye sketch of the Mt Eden/Balmoral intersection, taken from an aerial photo by Auckland City's GIS network (not to scale).

B2 Traffic survey data

B2.1 Traffic count summaries

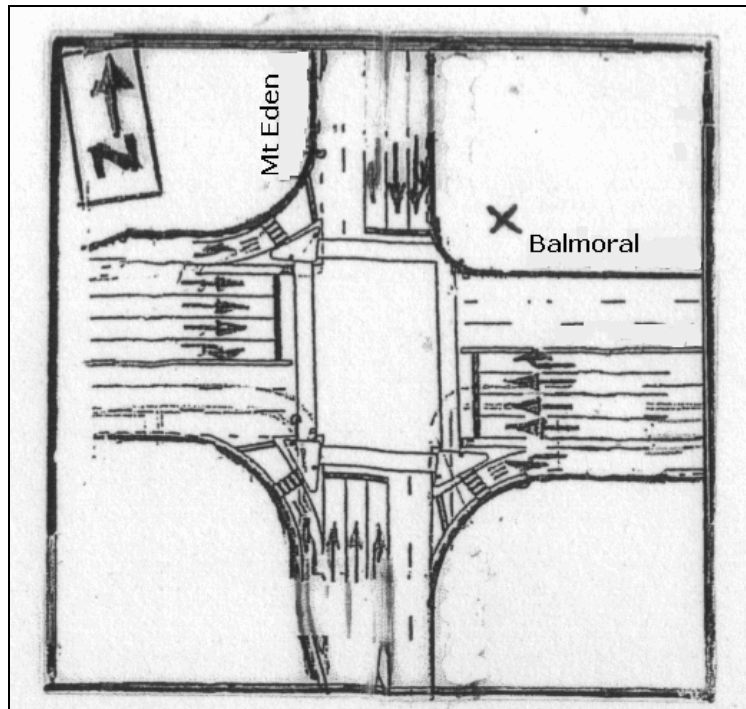


Figure B2 Intersection diagram of the Mt Eden/Balmoral intersection.

The one-hour summaries used for analysing this intersection were:

- morning peak period: 730–830
- off-peak period: 1130–1230
- evening peak period: 1700–1800

Table B1 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, morning peak period (Balmoral Road).

Vehicle type	Time								Four hour summations				
	700-715	715-730	730-745	745-800	800-815	815-830	830-845	845-900	700-800	715-815	730-830	745-845	800-900
Balmoral westbound left-turn only lane													
Cars:	14	20	10	7	28	20	24	29	51	65	65	79	101
HCVs:	1	2	0	1	0	0	3	1	4	3	1	4	4
Balmoral westbound left-hand through-lane													
Cars:	4	9	13	13	18	22	13	16	39	53	66	66	69
HCVs:	0	2	2	1	2	2	2	2	5	7	7	7	8
Balmoral westbound central through-lane													
Cars:	24	47	51	59	66	90	61	68	181	223	266	276	285
HCVs:	4	2	5	2	0	2	2	4	13	9	9	6	8
Balmoral westbound right-hand through-lane													
Cars:	39	48	75	76	108	103	92	80	238	307	362	379	383
HCVs:	2	1	3	1	0	5	3	1	7	5	9	9	9
Balmoral westbound right-turn only lane													
Cars:	20	39	30	57	53	25	35	63	146	179	165	170	176
HCVs:	0	2	1	1	0	3	3	1	4	4	5	7	7
Balmoral eastbound left-turn only lane													
Cars:	28	34	37	42	39	19	27	28	141	127	113	74	113
HCVs:	0	3	0	1	0	0	1	0	4	4	1	2	1
Balmoral eastbound left-hand through-lane													
Cars:	17	22	35	27	30	14	18	26	101	114	106	89	88
HCVs:	1	3	3	3	2	1	3	2	10	11	9	9	8
Balmoral eastbound central through-lane													
Cars:	78	79	103	113	91	85	86	86	373	386	392	375	348
HCVs:	5	2	3	5	3	2	1	3	15	13	13	11	9
Balmoral eastbound right-hand through-lane													
Cars:	115	102	133	128	113	97	93	93	478	476	471	431	396
HCVs:	1	4	1	5	2	2	1	2	11	12	10	10	7
Balmoral eastbound right-turn only lane													
Cars:	53	53	50	71	52	72	58	62	227	226	245	253	244
HCVs:	0	2	3	1	3	1	2	3	6	9	8	7	9

Table B2 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, morning peak period (Mt Eden Road).

Vehicle type	Time								Four hour summations				
	700-715	715-730	730-745	745-800	800-815	815-830	830-845	845-900	700-800	715-815	730-830	745-845	800-900
Mt Eden northbound left-turn only lane													
Cars:	31	30	60	44	38	45	66	46	165	172	187	193	195
HCVs:	1	3	7	3	1	3	2	1	14	14	14	9	7
Mt Eden northbound left-hand through-lane													
Cars:	49	54	69	89	75	53	67	55	261	287	286	284	250
HCVs:	5	9	4	3	9	4	6	3	21	25	20	22	22
Mt Eden northbound central through-lane													
Cars:	107	133	152	146	104	56	89	95	538	535	458	395	344
HCVs:	6	1	6	4	4	1	0	4	17	15	15	9	9
Mt Eden northbound right-turn only lane													
Cars:	29	56	45	73	58	39	53	47	203	232	215	223	197
HCVs:	1	2	2	1	0	2	0	0	6	5	5	3	2
Mt Eden southbound left-turn only lane													
Cars:	16	13	19	10	22	16	22	28	58	64	67	70	88
HCVs:	0	1	2	1	0	0	1	0	4	4	3	2	1
Mt Eden southbound left-hand through-lane													
Cars:	13	11	10	13	25	17	4	12	47	59	65	59	58
HCVs:	3	1	0	0	1	1	1	1	4	2	2	3	4
Mt Eden southbound central through-lane													
Cars:	45	41	55	50	73	64	62	77	191	219	242	249	276
HCVs:	2	1	5	6	5	5	4	4	14	17	21	20	18
Mt Eden southbound right-turn only lane													
Cars:	9	11	8	19	19	38	27	32	47	57	84	103	116
HCVs:	1	0	0	2	0	2	0	0	3	2	4	4	2

Table B3 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, morning peak period (totals).

Vehicle type	Time								Four hour summations				
	700-715	715-730	730-745	745-800	800-815	815-830	830-845	845-900	700-800	715-815	730-830	745-845	800-900
Grand total:	724	843	1002	1078	1044	911	932	975	3647	3942	4011	3912	3862
Total cars:	691	802	955	1037	1012	875	897	943	3485	3781	3855	3768	3727
Total HCVs:	33	41	47	41	32	36	35	32	162	161	156	144	165

Table B4 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, off-peak period (Balmoral Road).

Vehicle type	Time								Four hour summations				
	1100-1115	1115-1130	1130-1145	1145-1200	1200-1215	1215-1230	1230-1245	1245-1300	1100-1200	1115-1215	1130-1230	1145-1245	1200-1300
Balmoral westbound left-turn only lane													
Cars:	23	38	25	41	40	35	35	28	127	144	141	151	138
HCVs:	1	4	5	2	2	2	1	2	12	13	11	7	7
Balmoral westbound left-hand through-lane													
Cars:	9	13	6	10	15	10	12	18	38	44	41	47	55
HCVs:	4	0	1	0	2	1	2	1	5	3	4	4	5
Balmoral westbound central through-lane													
Cars:	59	58	67	57	68	57	66	59	241	250	249	248	250
HCVs:	2	0	5	3	2	2	2	3	10	10	12	9	9
Balmoral westbound right-hand through-lane													
Cars:	59	75	74	62	88	74	76	73	270	299	298	300	311
HCVs:	2	2	5	1	2	1	5	1	10	10	9	9	9
Balmoral westbound right-turn only lane													
Cars:	28	25	36	31	40	33	36	37	120	132	140	140	146
HCVs:	0	2	1	2	3	2	0	1	5	8	8	7	6
Balmoral eastbound left-turn only lane													
Cars:	20	23	23	22	31	22	19	23	88	99	98	94	95
HCVs:	0	1	1	1	0	0	1	1	3	3	2	2	2
Balmoral eastbound left-hand through-lane													
Cars:	14	10	13	9	6	15	13	5	46	38	43	43	39
HCVs:	3	1	1	3	1	2	2	2	8	6	7	8	7
Balmoral eastbound central through-lane													
Cars:	56	50	54	65	60	64	62	55	225	229	243	251	241
HCVs:	2	1	2	1	3	5	1	4	6	7	11	10	13
Balmoral eastbound right-hand through-lane													
Cars:	53	55	73	85	64	64	73	64	266	277	286	286	265
HCVs:	5	2	2	2	4	2	3	5	11	10	10	11	14
Balmoral eastbound right-turn only lane													
Cars:	22	44	50	53	49	37	41	40	169	196	189	180	167
HCVs:	5	2	1	5	2	8	1	5	13	10	16	16	16

Table B5 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, off-peak period (Mt Eden Road).

Vehicle type	Time								Four hour summations				
	1100-1115	1115-1130	1130-1145	1145-1200	1200-1215	1215-1230	1230-1245	1245-1300	1100-1200	1115-1215	1130-1230	1145-1245	1200-1300
Mt Eden northbound left-turn only lane													
Cars:	41	40	45	33	33	46	41	39	159	151	157	153	159
HCVs:	5	1	2	2	1	1	4	5	10	8	8	8	11
Mt Eden northbound left-hand through-lane													
Cars:	26	21	26	32	29	25	25	31	105	108	112	111	110
HCVs:	4	4	1	4	1	3	4	4	13	10	9	12	12
Mt Eden northbound central through-lane													
Cars:	64	72	84	71	68	69	70	69	291	295	292	278	276
HCVs:	4	5	2	2	7	2	3	5	13	16	13	14	17
Mt Eden northbound right-turn only lane													
Cars:	28	28	42	34	36	31	25	29	132	140	143	126	121
HCVs:	1	2	1	2	0	1	2	2	6	5	4	5	5
Mt Eden southbound left-turn only lane													
Cars:	31	30	37	25	29	37	34	28	123	121	128	125	128
HCVs:	3	0	0	2	1	1	2	1	5	3	4	6	5
Mt Eden southbound left-hand through-lane													
Cars:	17	11	11	11	15	16	10	26	50	48	53	52	67
HCVs:	2	1	3	0	4	0	0	2	6	8	7	4	6
Mt Eden southbound central through-lane													
Cars:	78	65	82	75	75	74	70	83	300	297	306	294	302
HCVs:	4	6	2	4	6	3	7	6	16	18	15	20	22
Mt Eden southbound right-turn only lane													
Cars:	32	19	26	47	31	34	22	27	124	123	138	134	114
HCVs:	1	0	0	0	2	0	0	0	1	2	2	2	2

Table B6 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, off-peak period (totals).

Vehicle type	Time								Four hour summations				
	1100-1115	1115-1130	1130-1145	1145-1200	1200-1215	1215-1230	1230-1245	1245-1300	1100-1200	1115-1215	1130-1230	1145-1245	1200-1300
Grand total:	708	711	809	799	820	779	770	784	3027	3139	3207	3167	3152
Total cars:	660	677	774	763	777	743	730	734	2874	2991	3057	3013	2984
Total HCVs:	48	34	35	36	43	36	40	50	153	148	150	154	168

Table B7 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, evening peak period (Balmoral Road).

Vehicle type	Time								Four hour summations				
	1600-1615	1615-1630	1630-1645	1645-1700	1700-1715	1715-1730	1730-1745	1745-1800	1600-1700	1615-1715	1630-1730	1645-1745	1700-1800
Balmoral westbound left-turn only lane													
Cars:	48	57	48	73	74	82	69	82	226	252	277	298	307
HCVs:	2	0	3	0	0	1	0	0	5	3	4	1	1
Balmoral westbound left-hand through-lane													
Cars:	30	31	28	41	35	48	34	29	130	135	152	158	146
HCVs:	1	5	3	1	1	1	1	0	10	13	10	4	4
Balmoral westbound central through-lane													
Cars:	91	105	105	119	116	142	110	115	420	445	482	487	483
HCVs:	5	2	5	3	2	1	2	2	15	12	11	8	7
Balmoral westbound right-hand through-lane													
Cars:	102	113	122	130	133	150	109	124	467	498	535	522	516
HCVs:	2	4	0	1	0	4	3	1	7	5	5	8	8
Balmoral westbound right-turn only lane													
Cars:	52	43	33	60	49	48	65	59	188	185	190	222	221
HCVs:	0	2	1	1	0	1	0	1	4	4	3	2	2
Balmoral eastbound left-turn only lane													
Cars:	29	11	13	23	16	25	26	24	79	66	80	90	91
HCVs:	0	1	0	1	1	0	0	0	2	3	2	2	1
Balmoral eastbound left-hand through-lane													
Cars:	17	15	26	31	23	36	37	30	89	95	116	127	126
HCVs:	2	2	0	1	3	1	1	1	5	6	5	6	6
Balmoral eastbound central through-lane													
Cars:	72	66	69	84	76	98	77	98	291	295	327	335	349
HCVs:	2	1	3	1	1	0	0	2	7	6	5	2	3
Balmoral eastbound right-hand through-lane													
Cars:	89	85	93	116	93	147	94	121	383	387	449	450	458
HCVs:	1	4	2	2	2	0	0	1	9	10	6	4	3
Balmoral eastbound right-turn only lane													
Cars:	71	71	67	93	77	96	99	102	302	308	333	365	374
HCVs:	7	2	3	3	4	1	2	2	15	12	11	10	9

Table B8 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, evening peak period (Mt Eden Road).

Vehicle type	Time								Four hour summations				
	1600-1615	1615-1630	1630-1645	1645-1700	1700-1715	1715-1730	1730-1745	1745-1800	1600-1700	1615-1715	1630-1730	1645-1745	1700-1800
Mt Eden northbound left-turn only lane													
Cars:	56	58	50	62	67	64	58	53	226	237	243	251	242
HCVs:	1	2	2	2	1	2	0	0	7	7	7	5	3
Mt Eden northbound left-hand through-lane													
Cars:	30	34	34	28	48	35	33	21	126	144	145	144	137
HCVs:	1	1	1	0	5	0	3	0	3	7	6	8	8
Mt Eden northbound central through-lane													
Cars:	71	72	87	74	96	77	76	66	304	329	334	323	315
HCVs:	2	4	5	3	0	2	3	3	14	12	10	8	8
Mt Eden northbound right-turn only lane													
Cars:	33	41	46	44	55	36	43	40	164	186	181	178	174
HCVs:	0	0	0	0	1	0	1	0	0	1	1	2	2
Mt Eden southbound left-turn only lane													
Cars:	20	31	28	37	38	40	49	34	116	134	143	164	161
HCVs:	2	1	1	0	1	0	1	0	4	3	2	2	2
Mt Eden southbound left-hand through-lane													
Cars:	44	31	30	42	57	51	28	56	147	160	180	178	192
HCVs:	2	3	6	5	4	5	7	2	16	18	20	21	18
Mt Eden southbound central through-lane													
Cars:	119	116	129	99	135	133	112	135	463	479	496	479	515
HCVs:	3	1	4	6	4	1	1	0	14	15	15	12	6
Mt Eden southbound right-turn only lane													
Cars:	46	40	48	41	63	50	41	50	175	192	202	195	204
HCVs:	0	1	1	1	1	0	0	1	3	4	3	2	2

Table B9 Traffic count summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, evening peak period (totals).

Vehicle type	Time								Four hour summations				
	1600-1615	1615-1630	1630-1645	1645-1700	1700-1715	1715-1730	1730-1745	1745-1800	1600-1700	1615-1715	1630-1730	1645-1745	1700-1800
Grand total:	1053	1056	1099	1228	1282	1378	1185	1258	4436	4668	4991	5073	5104
Total cars:	1020	1020	1059	1197	1251	1358	1160	1242	4296	4527	4865	4966	5011
Total HCVs:	33	36	40	31	31	20	25	16	140	141	126	107	93

B2.2 Usage summaries

For all tables in this section, rate of use (%) is higher during periods of increased congestion. One HCV has been assumed to be equivalent to two passenger car units.

Table B10 Usage summary of the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, morning peak period.

Location	Totals					
	Peak hour car	Peak hour HCV	Car + HCV	Total for movement	% of total	Mt Eden 2001 count
Balmoral westbound left-turn only lane	65	1	67	67	100%	-
Balmoral westbound left-hand through-lane	66	7	80	744	11%	12%
Balmoral westbound central through-lane	266	9	284	744	38%	35%
Balmoral westbound right-hand through-lane	362	9	380	744	515	535
Balmoral westbound right-turn only lane	165	5	175	175	100%	-
Balmoral eastbound left-turn only lane	113	1	115	115	100%	-
Balmoral eastbound left-hand through-lane	106	9	124	1033	12%	8%
Balmoral eastbound central through-lane	392	13	418	1033	40%	42%
Balmoral eastbound right-hand through-lane	471	10	491	1033	485	50%
Balmoral eastbound right-turn only lane	245	8	261	261	100%	-
Mt Eden northbound left-turn only lane	187	14	215	215	100%	-
Mt Eden northbound left-hand through-lane	286	20	326	814	40%	45%
Mt Eden northbound central through-lane	458	15	488	814	605	55%
Mt Eden northbound right-turn only lane	215	5	225	225	100%	-
Mt Eden southbound left-turn only lane	67	3	73	73	100%	-
Mt Eden southbound left-hand through-lane	65	2	69	353	20%	21%
Mt Eden southbound central through-lane	242	21	284	353	80%	79%
Mt Eden southbound right-turn only lane	84	4	92	92	100	-

Table B11 Usage summary of the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, off-peak period.

Location	Totals					
	Peak hour car	Peak hour HCV	Car + HCV	Total for movement	% of total	Mt Eden 2001 count
Balmoral westbound left-turn only lane	141	11	163	163	100%	-
Balmoral westbound left-hand through-lane	41	4	49	638	8%	7%
Balmoral westbound central through-lane	249	12	273	638	43%	40%
Balmoral westbound right-hand through-lane	298	9	316	638	50%	53%
Balmoral westbound right-turn only lane	140	8	156	156	100%	-
Balmoral eastbound left-turn only lane	98	2	102	102	100%	-
Balmoral eastbound left-hand through-lane	43	7	57	628	9%	14%
Balmoral eastbound central through-lane	243	11	265	628	42%	39%
Balmoral eastbound right-hand through-lane	286	10	306	628	49%	47%
Balmoral eastbound right-turn only lane	189	16	221	221	100%	-
Mt Eden northbound left-turn only lane	157	6	169	169	100%	-
Mt Eden northbound left-hand through-lane	112	9	130	448	29%	33%
Mt Eden northbound central through-lane	292	13	318	448	71%	67%
Mt Eden northbound right-turn only lane	143	4	151	151	100%	-
Mt Eden southbound left-turn only lane	128	4	136	136	100%	-
Mt Eden southbound left-hand through-lane	53	7	67	403	17%	15%
Mt Eden southbound central through-lane	306	15	336	403	83%	85%
Mt Eden southbound right-turn only lane	138	2	142	142	100%	-

Table B12 Usage summary of the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, evening peak period.

Location	Totals					
	Peak hour car	Peak hour HCV	Car + HCV	Total for movement	% of total	Mt Eden 2001 count
Balmoral westbound left-turn only lane	307	1	309	309	100%	-
Balmoral westbound left-hand through-lane	146	4	154	1183	13%	13%
Balmoral westbound central through-lane	483	7	497	1183	42%	42%
Balmoral westbound right-hand through-lane	516	8	532	1183	45%	45%
Balmoral westbound right-turn only lane	221	2	225	225	100%	-
Balmoral eastbound left-turn only lane	91	1	93	93	100%	-
Balmoral eastbound left-hand through-lane	126	6	138	957	14%	11%
Balmoral eastbound central through-lane	349	3	355	957	37%	39%
Balmoral eastbound right-hand through-lane	458	3	464	957	48%	50%
Balmoral eastbound right-turn only lane	374	9	392	392	100%	-
Mt Eden northbound left-turn only lane	242	3	248	248	100%	-
Mt Eden northbound left-hand through-lane	137	8	153	484	32%	33%
Mt Eden northbound central through-lane	315	8	331	484	68%	67%
Mt Eden northbound right-turn only lane	174	2	178	178	100%	-
Mt Eden southbound left-turn only lane	161	2	165	165	100%	-
Mt Eden southbound left-hand through-lane	192	18	228	755	30%	28%
Mt Eden southbound central through-lane	515	6	527	755	70%	72%
Mt Eden southbound right-turn only lane	204	2	208	208	100%	-

Table B13 Usage summary of the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, all commuter periods.

Location	Totals					
	Peak hour car	Peak hour HCV	Car + HCV	Total for movement	% of total	Mt Eden 2001 count
Balmoral westbound left-turn only lane	513	13	539	539	100%	-
Balmoral westbound left-hand through-lane	253	15	283	2565	11%	11%
Balmoral westbound central through-lane	998	28	1054	2565	48%	50%
Balmoral westbound right-hand through-lane	1176	26	1228	2565	48%	50%
Balmoral westbound right-turn only lane	526	15	556	556	100%	-
Balmoral eastbound left-turn only lane	302	4	310	310	100%	-
Balmoral eastbound left-hand through-lane	275	22	319	2618	12%	11%
Balmoral eastbound central through-lane	984	27	1038	2618	40%	40%
Balmoral eastbound right-hand through-lane	1215	23	1261	2618	48%	49%
Balmoral eastbound right-turn only lane	808	33	874	874	100%	-
Mt Eden northbound left-turn only lane	586	23	632	632	100%	-
Mt Eden northbound left-hand through-lane	535	37	609	1746	35%	37%
Mt Eden northbound central through-lane	1065	36	1137	1746	65%	63%
Mt Eden northbound right-turn only lane	532	11	554	554	100%	-
Mt Eden southbound left-turn only lane	356	9	374	374	100%	-
Mt Eden southbound left-hand through-lane	310	27	364	1511	24%	21%
Mt Eden southbound central through-lane	1063	42	1147	1511	76%	79%
Mt Eden southbound right-turn only lane	426	8	442	442	100%	-

B2.3 Vehicle queue summaries

In Chapter B2.3, the abbreviations NBD, SBD, EBD and WBD are used for 'northbound', 'southbound', 'eastbound' and 'westbound' respectively.

Table B14 Vehicle queue summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, morning peak period.

Time	Location Tallies															
	Balmoral WBD left-turn only lane*	Balmoral WBD left-hand through-lane*	Balmoral WBD central through-lane	Balmoral WBD right-hand through-lane	Balmoral WBD right-turn only lane	Balmoral EBD left-turn and through-lane*	Balmoral EBD central through-lane	Balmoral EBD right-hand through-lane	Balmoral EBD right-turn only lane	Mt Eden NBD left-turn only lane*	Mt Eden NBD left-hand through-lane*	Mt Eden NBD central-through-lane	Mt Eden NBD right-turn only lane	Mt Eden SBD left-turn and through-lane*	Mt Eden SBD central through-lane	Mt Eden SBD right-turn only lane
0730-0830	0 0 0 0 0 0	9 4 0 5 4 2	15 9 4 12 25 15	20 5 5 16 25 13	11 8 3 15 20 17	23 18 7 3 10 15 25 23	23 20 10 5 13 25 13	23 25 9 11 18 2 25 23	10 7 5 4 4 22 17 15	0 0	7 20 7 8 4 7 11 14 11 17 19 16 2 13 16 7 9 26 30 23 17 12 20	15 30 17 15 14 7 30 28 25 30 22 17 8 18 31 30 30 35 35 30	3 7 4 10 4 7 2 10 5 7 13 12 11 14 8 6 8 8 8 10 13 6 14	2 3 3 2 3 4 3 1 0 1 3 3 4 6 4 4 1 6	3 6 6 4 5 7 1 1 3 4 12 11 6 5 0 7	0 1 2 0 0 0 3 2 3 1 3 6 3 3 1 3 4 6 1 6
Total	-	24	80	84	74	124	144	156	84	-	316	536	186	55	89	48
# count	7	6	6	6	6	8	8	8	8	22	23	23	23	18	18	1
average	-	4	13	14	12	16	16	20	11	-	14	23	8	3	5	3

Note:

* indicates a short lane, which is likely to be obstructed at times by the adjacent lane.

Table B16 Vehicle queue summary for the Mt Eden/Balmoral intersection on Wednesday 9th February 2005, evening peak period.

Time	Location Tallies															
	Balmoral WBD left-turn only*	Balmoral WBD left-hand through-lane*	Balmoral WBD central through-lane	Balmoral WBD right-hand through-lane	Balmoral WBD right-turn lane	Balmoral EBD left-turn and through-lane*	Balmoral EBD central through-lane	Balmoral EBD right-hand through-lane	Balmoral EBD right-turn only lane	Mt Eden NBD left-turn only lane*	Mt Eden NBD left-hand through-lane*	Mt Eden NBD central through-lane	Mt Eden NBD right-turn lane	Mt Eden SBD left-turn and through-lane*	Mt Eden SBD central through-lane	Mt Eden SBD right-turn
1645-1745	0	11	13	13	8	8	12	19	16	0	6	8	8	8	14	8
	2	7	20	20	5	5	15	18	19	0	5	6	6	14	20	8
	0	5	20	20	7	7	11	13	11	5	8	13	8	8	25	11
	0	6	25	25	7	8	11	13		3	3	10	6	14	18	5
	2	6	30	30	0	9	9	9		4	2	4	4	17	20	7
	3	5	20	20	7	8	9	14		0	5	10	7	11	24	5
	0	1	6	6	8	3	12	15					6	18	31	9
	0	8	12	12	11	7	11	11		0	3	9	10	14	19	10
	0	14	17	17	11	6	12	17		0	6	12	5	16	16	7
	0	7	17	19	5	5	10	15	9	0	2	6	8	12	12	1
	2	2	20	23	11	2	5	7	19	0	8	13	5	12	15	11
	4	5	13	13	9	6	8	14	9	0	3	7	4	13	27	4
	0	8	14	21	8	5	9	15	11	0	5	7	5	14	25	2
	1	4	13	14	9	3	18	16	9	0	4	8	4	16	29	4
	3	3	19	20		6	11	17	3	0	4	7	2	19	30	5
						5	9	16	10	0	4	10	7	17	29	9
	0	4	9	17	5	4	16	17	15	0	5	6	8	10	27	12
	0	10	27	25	10	4	7	13	18	0	4	9	7			
						7	12	11	13	0	5	8	5	7	16	7
						8	9	10	14	0	2	6	5	4	21	12
						5	13	19	14	0	3	6	7	10	21	14
						8	8	9	12	0	3	10				
						6	9	11	14	0	4	7	5			
						8	8	9	17	0	6	10	1			
						8	9	10	11	0	3	7	11			
						6	10	14	13	0	8	6	4			
						5	8	15	17	0	4	7	8			
						6	10	14	14		2	4	6			
						3	7	15	10		2	6	9			
						6	13	16	18		1	7	3			
						5	15	18	15		4	9	7			
						7	9	10	9		8	8	1			
						6	10	15	6		2	9	6			
						5	9	13	15				9			
						7	11	12	16				9			
Total	17	106	295	315	121	207	365	480	377	12	134	255	197	254	439	151
# count	17	17	17	17	16	35	35	35	29	26	32	32	33	20	20	20
average	1	6	17	19	8	6	10	14	13	0	4	8	6	13	22	8

* indicates a short lane which is likely to be blocked by adjacent lanes

Appendix C Lengthening short lanes—economic analysis

C1 Proposed changes

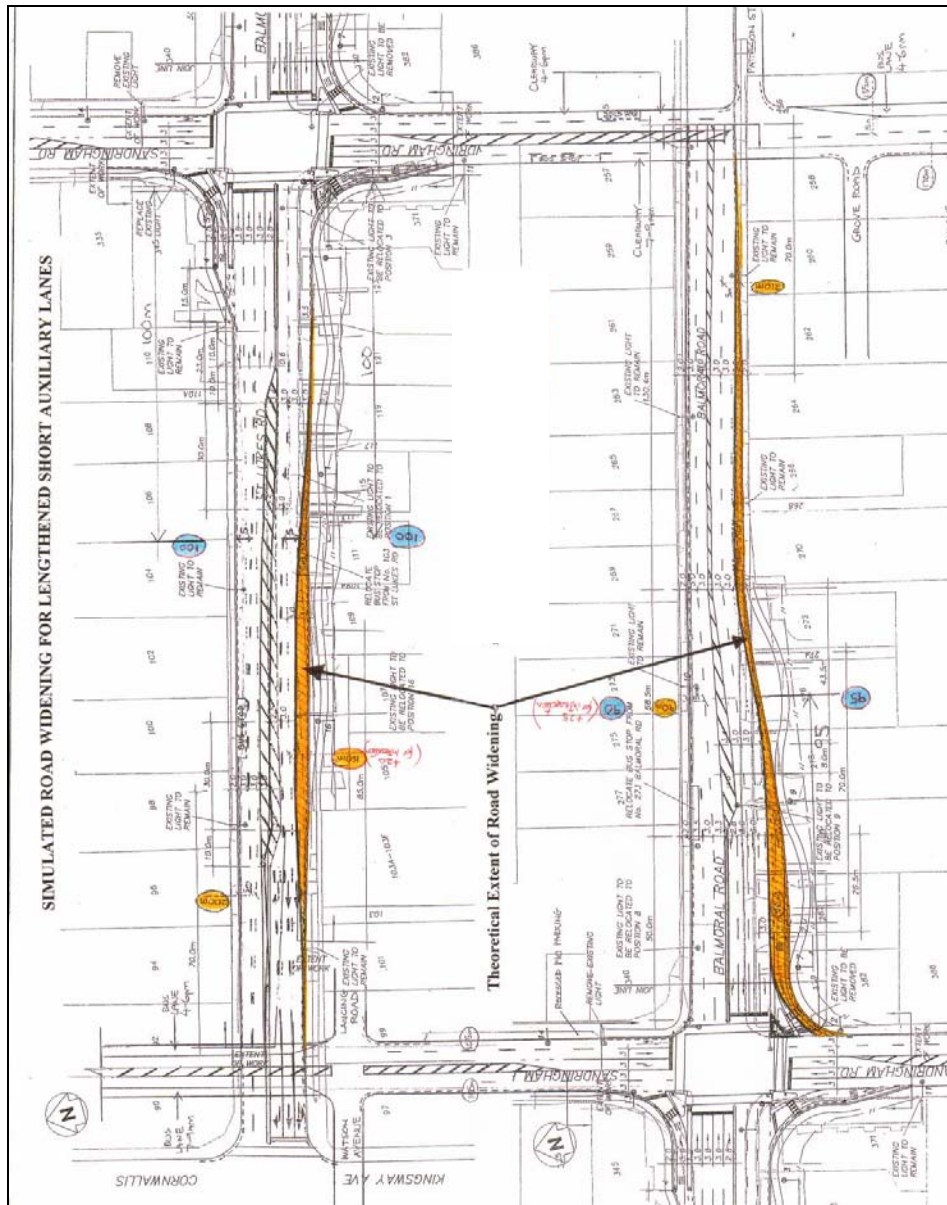


Figure C1 Simulated road widening/lengthening for short through-lanes on Balmoral Road at the Sandringham/Balmoral intersection (Option 1).

Notes to Figure C1:

- (a) Before the theoretical widening, the Balmoral Road eastbound approach measured 100 m; afterwards, it measured 200 m.
- (b) Before the theoretical widening, the Balmoral Road eastbound departure measured 90 m; afterwards, it measured 90 m.
- (c) Before the theoretical widening, the Balmoral Road westbound approach measured 95 m; afterwards, it measured 210 m.
- (d) Before the theoretical widening, the Balmoral Road westbound departure measured 100 m; afterwards, it measured 160 m.

C2 B/C analysis overview

The B/C analysis was calculated by Bruno Royce and checked by Ivan Jurisich. The 'base date' was 1st July 2004 and 'time zero' was a year after this (1st July 2005). The figures yielded a FYRR of 7% and a B/C of 4.9.

Table C1 Inflation update and discount factors.

Inflation update and discount factors	Update factors	Discount factors
Vehicle operation	1.04	1.0000
Travel time	1.05	1.0000
Accidents	1.05	1.0000
Construction and maintenance	1.00	0.9091

Table C2 First year benefits of upgrading the Sandringham/Balmoral intersection.

First year benefits	Do minimum	Option 1	Net benefit
Vehicle operation costs	\$163,000	\$159,000	\$4,000
Travel time costs	\$1,459,000	\$1,422,000	\$37,000
Accident costs	\$0	\$0	\$0
Total benefits	\$1,622,000	\$1,581,000	\$41,000

Table C3 Design life benefits of upgrading the Sandringham/Balmoral intersection.

Design life benefits	Do minimum	Option 1	Net benefit
Vehicle operation costs	\$3,210,000	\$3,025,000	\$185,000
Travel time costs	\$41,048,000	\$38,170,000	\$2,878,000
Accident costs	\$0	\$0	\$0
Total benefits	\$44,258,000	\$41,195,000	\$3,063,000

Table C4 Costs of upgrading the Sandringham/Balmoral intersection.

Costs	Do minimum	Option 1	Net benefit
Capital cost estimate	690,000	0	
Maintenance cost estimate	-	-	
Total cost x factors	\$627,000	\$0	\$627,000

C3 'Do minimum' v. long lanes (Option 1): travel time and vehicle operating costs

The rate of traffic growth was taken to be 3%. The speed limit used for these calculations was 50 kph.

Table C5 Flow scale at the Sandringham/Balmoral intersection over the design life of Option 1 (22 years).

Design year	0	4	10	16	22
Flow scale	1.00	1.12	1.30	1.48	1.66

Table C6 Predicted average delays, stop rates and traffic flow at the Sandringham/Balmoral intersection if the 'do minimum' option is taken.

Design year	Time period	Total flow	Average delay (s)	Stop rate
Year Zero (existing)	a.m. peak	3326	32.6	0.87
	p.m. peak	4387	47.9	0.91
	off-peak	2861	24.9	0.80
Year 4	a.m. peak	3725	39.2	0.87
	p.m. peak	4913	94.1	1.21
	off-peak	3204	26.8	0.79
Year 10	a.m. peak	4324	59.7	0.99
	p.m. peak	5703	219.9	1.79
	off-peak	3719	33.3	0.81
Year 16	a.m. peak	4922	127.2	1.38
	p.m. peak	6493	340.2	2.33
	off-peak	4234	43.9	0.84
Year 22	a.m. peak	5521	232.7	1.87
	p.m. peak	7282	500.8	2.94
	off-peak	4749	76.0	1.07

Table C7 Predicted average delays, stop rates and traffic flow at the Sandringham/Balmoral intersection if Option 1 is taken.

Design year	Time period	Total flow	Average delay (s)	Stop rate
Year zero (existing)	a.m. peak	3326	31.1	0.84
	p.m. peak	4387	46.7	0.90
	off-peak	2861	24.4	0.78
Year 4	a.m. peak	3725	37.7	0.86
	p.m. peak	4913	77.0	1.11
	off-peak	3204	27.0	0.79
Year 10	a.m. peak	4324	55.3	0.95
	p.m. peak	5703	202.5	1.71
	off-peak	3719	33.9	0.79
Year 16	a.m. peak	4922	105.6	1.27
	p.m. peak	6493	335.2	2.27
	off-peak	4234	43.8	0.83
Year 22	a.m. peak	5521	191.3	1.70
	p.m. peak	7282	424.1	2.65
	off-peak	4749	77.3	1.04

Table C8 Duration of commuter periods.

Time period	hours/day	days/year	hours/year
a.m. peak	2	245	490
p.m. peak	2	245	490
off-peak	7	297	2079

Table C9 Matrix for calculation cost of travel time and vehicle operation.

Cost	Base	A.m. peak	P.m. peak	Off-peak	Update	Cost
Travel time (\$/hr)	-	15.13	14.96	17.95	-	-
Vehicle operation delay: cost while stopped (c/min)	1.158	-	-	-	-	1.158
Vehicle operation stops (c/stop)*	1.2	-	-	-	1	1.2

* 60 kph to 0 kph

Table C10 Cost comparison (travel time and vehicle operation) of 'do minimum' and Option 1.

First year	Travel time cost	Vehicle operation cost		Total
		Delays	Stops	
Cost of 'do minimum'	\$1,389,649	\$58,711	\$97,589	\$1,545,950
Cost of Option 1	\$1,353,827	\$57,167	\$95,317	\$1,506,311
Saving	\$35,822	\$1,544	\$2,272	\$39,638

Table C11 Cost of 'do minimum' over the 25-year design life.

Design year	Travel time costs	Vehicle operation (VO)		Discount factor	Cost over design life			
		Delay	Stops		Travel time	VO delay	VO stops	Total
4	\$2,132	\$92	\$117	0.6830	\$8,738	\$377	\$4,480	\$9,596
10	\$4,369	\$193	\$160	0.3855	\$10,106	\$446	\$371	\$10,922
16	\$7,714	\$343	\$218	0.2176	\$10,071	\$447	\$284	\$10,803
22	\$13,814	\$611	\$313	0.1228	\$10,178	\$450	\$231	\$10,859
Total					\$39,094	\$1,720	\$1,366	\$42,180

Table C12 Cost of Option 1 over the 25-year design life.

Design year	Travel time costs	Vehicle operation (VO)		Discount factor	Cost over design life			
		Delay	Stops		Travel time	VO delay	VO stops	Total
4	\$1,965	\$84	\$114	0.6830	\$8,017	\$343	\$467	\$8,828
10	\$4,151	\$182	\$155	0.3855	\$9,601	\$422	\$358	\$10,381
16	\$7,425	\$329	\$211	0.2176	\$9,694	\$430	\$276	\$10,399
22	\$12,270	\$539	\$292	0.1228	\$9,040	\$397	\$215	\$9,653
Total					\$36,352	\$1,593	\$1,316	\$39,261
<u>Design life savings (in thousands, discounted to beginning of benefit flow)</u>					\$2,741	\$128	\$50	\$2,919

C4 Engineers' estimates of costs

Table C13 Bill number 100: preliminary and general costs.

Item	Description	Quantity	Unit	Rate \$	Price \$
101	Bond and insurance		LS	3,000.00	3,000.00
102	Letter of notification	1	LS	200.00	200.00
103	Notice of works sign boards	2	ea	350.00	700.00
104	Traffic control and pedestrian safety	1	LS	25,000.00	25,000.00
105	As built plans	1	LS	1,500.00	1,500.00
106	Submit RAMM information	1	LS	500.00	500.00
107	Service utility liaison and co-ordination	1	LS	1,000.00	1,000.00
108	Quality assurance	1	LS	1,000.00	1,000.00
109	Site establishment	1	LS	7,000.00	7,000.00
Total for bill 100					39,900.00

Table C14 Bill number 200: site preparation.

Item	Description	Quantity	Unit	Rate \$	Price \$
201	Site clearance	1	LS	2,000.00	2,000.00
202	Location of services (pilot trenches)	10	Lm	280.00	2,800.00
Total for bill 200					4,800.00

Table C15 Bill number 300: earthworks.

Item	Description	Quantity	Unit	Rate \$	Price \$
301	Erosion and sediment control	1	LS	1,000.00	1,000.00
320	Road excavation				
321	Cut to waste	1000	m ³	33.00	33,000.00
330	Berm works				
331	Strip topsoil and stockpile (on site)	1400	m ²	15.00	21,000.00
Total for bill 300					55,000.00

Table C16 Bill number 500: street drainage.

Item	Description	Quantity	Unit	Rate \$	Price \$
501	Removal of existing catchpits (provisional): single	2	ea	250.00	500.00
502	New catchpits in existing kerb and channel: single (660 x 440)	4	ea	1,800.00	7,200.00
516	Extend existing catchpit lead	10	Lm	100.00	1,000.00
530	Underchannel drain (within new pavement)	460	Lm	40.00	18,400.00
565	Catchpit surround	4	ea	250.00	1,000.00
	Total for bill 500				28,100.00

Table C17 Bill number 800: pavement construction.

Item	Description	Quantity	Unit	Rate \$	Price \$
802	New flexible pavement in existing carriageway	1400	m ²	20.00	28,000.00
	Total for bill 800				28,000.00

Table C18 Bill number 900: services.

Item	Description	Quantity	Unit	Rate \$	Price \$
910	Service cover adjustments				
	Fire hydrants, valves, tobies, survey boxes and water meters (provisional item)	2	ea	250.00	500.00
930	Service ducting (provisional item): 50 mm diameter PVC	500	Lm	30.00	15,000.00
940	Service trenching (provisional item): not exceeding 1.5 m in depth for all materials	500	Lm	190.00	95,000.00
	Total for bill 900				110,500.00

Table C19 Bill number 1000: kerb and channel and concrete work.

Item	Description	Quantity	Unit	Rate \$	Price \$
1001	Remove existing kerb and/or channel: kerb and channel	500	Lm	15.00	7,500.00
1010	New kerb and/or channel				
1011	New kerb and/or channel in existing: Type 1 kerb and channel – precast (ACC)	500	Lm	80.00	40,000.00
	Total for bill 1000				47,500.00

Table C20 Bill number 1100: road pavement.

Item	Description	Quantity	Unit	Rate \$	Price \$
1102	Milling of existing carriageway: not exceeding 50 mm depth	150	m ²	7.00	1,050.00
1110	Asphaltic concrete surfacing (by hand)	1400	m ²	35.00	49,000.00
Total for bill 1100					50,050.00

Table C21 Bill number 1200: road-marking.

Item	Description	Quantity	Unit	Rate \$	Price \$
1235	All road-marking required	1	LS	1,000.00	1,000.00
1240	Sand/waterblasting off existing road-marking	1	LS	1,000.00	1,000.00
Total for bill 1200					2,000.00

Table C22 Bill number 1400: carriageway and amenity lighting.

Item	Description	Quantity	Unit	Rate \$	Price \$
1401	Ducting (underground): 20 mm diameter (in the road/footpath)	50	Lm	86.00	4,300.00
1406	Cabling: 2 x 16 mm ² PVC/NS	100	Lm	14.00	1,400.00
1411	Relocate existing street light (provisional item)	6	ea	3,000.00	18,000.00
Total for bill 1400					23,700.00

Table C23 Bill number 1500: footpaths and vehicle crossings.

Item	Description	Quantity	Unit	Rate \$	Price \$
1413	Concrete footpath/cycleway (provisional): 100 mm thick as per detail	600	m ²	50.00	30,000.00
Total for bill 1500					30,000.00

Table C24 Bill number 1600: grass berm and planted area.

Item	Description	Quantity	Unit	Rate \$	Price \$
1601	Reshape berm	200	m ²	12.00	2,400.00
1602	Topsoiling from stockpile and grassing	200	m ²	10.00	2,000.00
Total for bill 1600					4,400.00




ROUGH ORDER ESTIMATE OF COSTS	
SANDRINGHAM/BALMORAL/ST.LUKES ROAD - SIMULATED LAYOUT	
SUMMARY	
Bill Number and Description	Sub Total
BILL NO 100 - PRELIMINARY & GENERAL	39900.00
BILL NO 200 - SITE PREPARATION	4800.00
BILL NO 300 - EARTHWORKS	55000.00
BILL NO 500 - STREET DRAINAGE	28100.00
BILL NO 800 - PAVEMENT CONSTRUCTION	28000.00
BILL NO 900 - SERVICES	110500.00
BILL NO 1000 - KERB AND CHANNEL AND CONCRETE WORK	47500.00
BILL NO 1100 - ROAD PAVEMENT SURFACING	50050.00
BILL NO 1200 - ROADMARKING	2000.00
BILL NO 1400 - CARRIAGEWAY AND AMENITY LIGHTING	23700.00
BILL NO 1500 - FOOTPATHS AND VEHICLE CROSSINGS	30000.00
BILL NO 1600 - GRASS BERM AND PLANTED AREAS	4400.00
<hr/>	
BASE TOTAL (BT)	423,950.00
CONTINGENCY AMOUNT @ 20%	<u>85,000.00</u>
SUB TOTAL (Excl GST)	510,000.00
ALLOWANCE FOR RELOCATION OF UTILITIES @ 20%	102,000.00
ALLOWANCE FOR PROFESSIONAL SERVICES @ 15%	77,000.00
ALLOWANCE FOR CONSENT APPROVALS = 0.25%	<u>1,000.00</u>
TOTAL PROJECT COST (Excl GST)	690,000.00
Notes: 1. Totals have been rounded to the nearest \$10,000.	
2. Utility relocations are a guesstimate at this stage.	
3. The estimate is based on a desktop analysis.	
4. The allowance for lighting is also a guesstimate.	
5. No allowance for any land-take has been made.	
Prepared by:  24-11-05	Approved by: 
Reviewed by: 	

Figure C2 Facsimile of engineers' estimate for upgrading the Sandringham/Balmoral intersection.

C5 Intersection summaries for variable flow scales

Table C25 Flow scale summary for the Sandringham/Balmoral intersection (existing layout) during the morning peak period.

Flow scale (%)	Cycle time (s)	Effective intersection capacity	Intersection degree of saturation	Practical spare capacity	Average delay (s)	Stop rate	Longest queue (vehicles)	Performance index	Cost total (\$/h)
100	85	3733	0.891	-1	31.1	0.84	16.0	187.6	2967.1
112	105	4096	0.909	-1	37.7	0.86	22.6	237.3	3502.2
130	140	4489	0.963	-7	55.3	0.95	39.6	350.5	4627.1
148	140	4532	1.0286	-17	105.6	1.27	80.6	547.5	7117.7
166	140	4536	1.217	-26	191.3	1.70	143.7	867.4	11494.2

Table C26 Flow scale summary for the Sandringham/Balmoral intersection (shorter lanes) during the morning peak period.

Flow scale (%)	Cycle time (s)	Effective intersection capacity	Intersection degree of saturation	Practical spare capacity	Average delay (s)	Stop rate	Longest queue (vehicles)	Performance index.	Cost total (\$/h)
100	85	3585	0.928	-3	32.6	0.87	17.7	191.8	3005.2
112	110	4137	0.900	0	39.2	0.87	22.9	244.5	3543.4
130	140	4404	0.981	-8	59.7	0.99	43.2	364.2	4769.8
148	140	4431	1.111	-19	127.2	1.38	86.5	605.7	7909.1
166	140	4468	1.235	-27	232.7	1.87	149.1	980.1	13182.2

Table C27 Flow scale summary for the Sandringham/Balmoral intersection (existing layout) during the off-peak period.

Flow scale (%)	Cycle time (s)	Effective intersection capacity.	Intersection degree of saturation	Practical spare capacity	Average delay (s)	Stop rate	Longest queue (vehicles)	Performance index	Cost total (\$/h)
100	70	3149	0.909	-1	24.4	0.78	7.9	138.8	2408.1
112	80	3517	0.911	-1	27.0	0.79	9.9	164.9	2757.4
130	110	4081	0.912	-1	33.9	0.79	15.8	221.5	3390.2
148	140	4485	0.944	-5	43.8	0.83	23.3	297.9	4166.1
166	140	4481	1.060	-15	77.3	1.04	41.6	432.9	5868.2

Table C28 Flow scale summary for the Sandringham/Balmoral intersection (shorter lanes) during the off-peak period.

Flow scale (%)	Cycle time (s)	Effective intersection capacity	Intersection degree of saturation	Practical spare capacity	Average delay (s)	Stop rate	Longest queue (vehicles)	Performance index	Cost total (\$/h)
100	70	3134	0.913	-1	24.9	0.80	7.9	140.2	2418.5
112	80	3548	0.903	0	26.8	0.79	9.4	164.6	2752.8
130	105	4097	0.909	-1	33.3	0.81	15.0	219.4	3373.8
148	140	4535	0.934	-4	43.9	0.84	23.3	300.4	4170.5
166	140	4528	1.049	-14	76.0	1.07	41.7	435.5	5829.1

Table C29 Flow scale summary for the Sandringham/Balmoral intersection (existing layout) during the evening peak period.

Flow scale (%)	Cycle time (s)	Effective intersection capacity	Intersection degree of saturation	Practical spare capacity	Average delay (s)	Stop rate	Longest queue (vehicles)	Performance index	Cost total (\$/h)
100	140	4765	0.921	-2	46.7	0.90	35.7	321.5	4379.1
112	140	4708	1.044	-14	77.0	1.11	60.2	460.8	6016.6
130	140	4751	1.201	-25	202.5	1.71	127.1	923.1	12 284.7
148	140	4891	1.327	-32	335.2	2.27	180.9	1479.4	20 342.6
166	140	5055	1.440	-38	424.1	2.65	248.7	1966.2	27 616.7

Table C30 Flow scale summary for the Sandringham/Balmoral intersection (shorter lanes) during the evening peak period.

Flow scale (%)	Cycle time (s)	Effective. intersection capacity	Intersection degree of saturation	Practical spare capacity	Average delay (s)	Stop rate	Longest queue (vehicles)	Performance index	Cost total (\$/h)	Unsettled
100	140	4692	0.935	-4	47.9	0.91	37.5	326.1	4418.5	
112	140	4668	1.053	-15	94.1	1.21	69.5	509.4	6641.7	
130	140	4656	1.226	-27	219.9	1.79	138.9	969.1	13 020.6	
148	140	4845	1.340	-33	340.2	2.33	199.6	1495.5	20 593.9	
166	140	4605	1.581	-43	500.8	2.94	292.0	2206.5	31 738.5	*

12. Appendix D The SEART/Carbine intersection

D1 Location plan

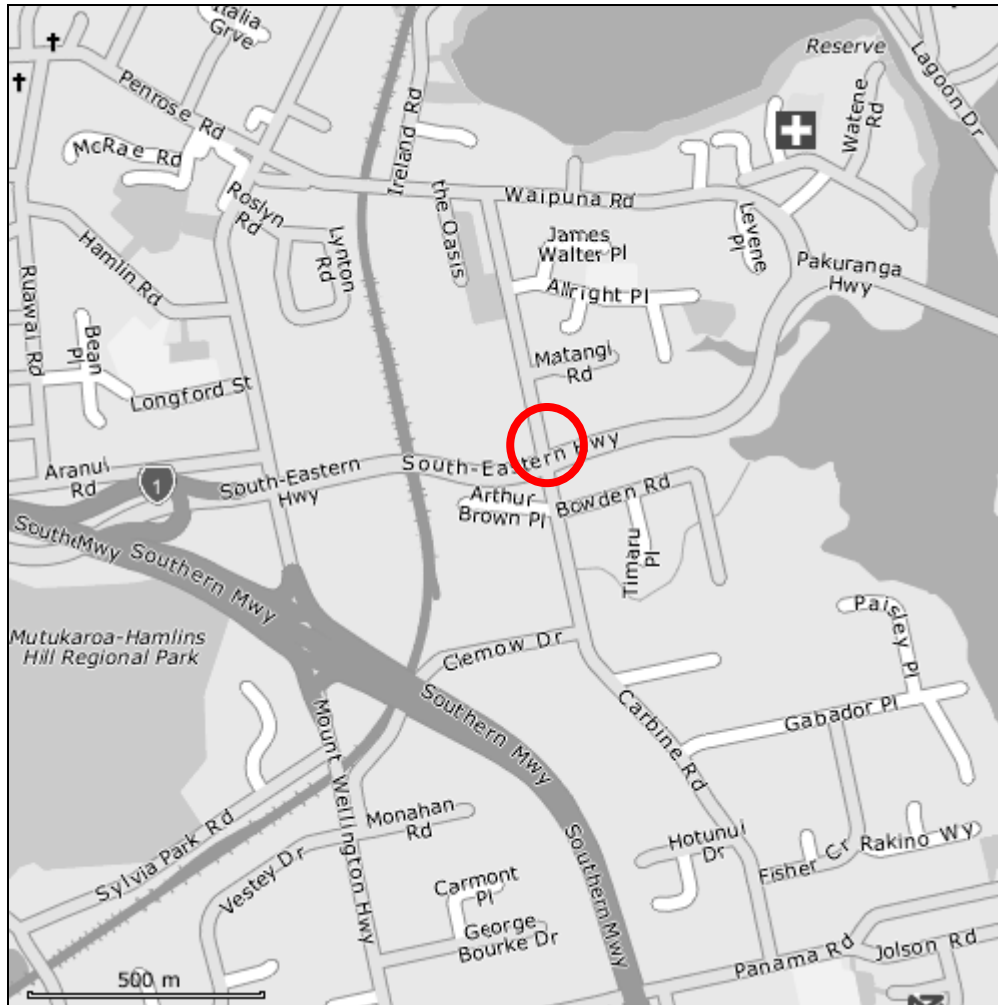


Figure D1 Location plan of the SEART/Carbine intersection.

D2 Aerial view



Figure D2 Aerial photo of the SEART/Carbine intersection, courtesy of Auckland City's GIS network (not to scale).

D3 Traffic survey data.

In all these tables, one HCV has been considered as the equivalent of two passenger car units.

Table D1 Traffic count summary for the SEART/Carbine intersection in February 2005, morning peak period (SEART westbound).

Vehicle Type	Time				One hour summation
	745-800	800-815	815-830	830-845	745-845
SEART westbound left-hand through-lane					
Cars:	130	138	136	127	531
HCVs:	7	17	15	20	59
Car + HCV:					649
Total for movement:					1874
% of total*:					35%
SEART westbound central through-lane					
Cars:	117	168	135	150	570
HCVs:	5	6	6	9	26
Car + HCV:					622
Total for movement:					1874
% of total*:					33%
SEART westbound right-hand through-lane					
Cars:	135	164	121	153	570
HCVs:	0	4	8	3	15
Car + HCV:					603
Total for movement:					1874
% of total*:					32%

*These figures are the ones given in the main body of the report.

Table D2 Traffic count summary for the SEART/Carbine intersection in February 2005, morning peak period (SEART eastbound)

Vehicle type	Time				One hour summation
	745-800	800-815	815-830	830-845	
SEART eastbound left-hand through-lane					
Cars:	148	125	109	125	234
HCVs:	13	8	17	10	48
Car + HCV:					330
Total for movement:					929
% of total:					36%
SEART eastbound central through-lane					
Cars:	135	114	121	122	492
HCVs:	10	12	7	9	38
Car + HCV:					568
Total for movement:					929
% of total:					61%
SEART eastbound right-hand through-lane					
Cars:	5		46	10	25
HCVs:	0	1	0	2	3
Car + HCV:					31
Total for movement:					929
% of total:					3%
SEART eastbound central right-turn lane					
Cars:	45	32	52	63	192
HCVs:	7	8	9	6	30
Car + HCV:					252
Total for movement:					536
% of total:					47%
SEART eastbound right-hand right-turn lane					
Cars:	74	52	65	71	262
HCVs:	1	2	2	6	11
Car + HCV:					284
Total for movement:					536
% of total:					53%

Table D3 Traffic count summary for the SEART/Carbine intersection in February 2005, evening peak period (SEART westbound).

Vehicle Type	Time				One hour summation
	1645–1700	1700–1715	1715–1730	1730–1745	1645–1745
SEART westbound left-hand through-lane					
Cars:	115	65	92	91	363
HCVs:	9	6	6	6	27
Car + HCV:					417
Total for movement:					1147
% of total:					36%
SEART westbound central through-lane					
Cars:	123	87	94	105	409
HCVs:	2	2	2	2	8
Car + HCV:					425
Total for movement:					1147
% of total:					37%
SEART westbound right-hand through-lane					
Cars:	94	62	72	71	299
HCVs:	2	0	0	1	3
Car + HCV:					305
Total for movement:					1147
% of total:					27%

Table D4 Traffic count summary for the SEART/Carbine intersection in February 2005, evening peak period (SEART westbound).

Vehicle type	Time				One hour summation
	1645–1700	1700–1715	1715–1730	1730–1745	1645–1745
SEART eastbound left-hand through-lane					
Cars:	218	166	227	213	440
HCVs:	7	3	4	8	22
Car + HCV:					484
Total for movement:					1817
% of total:					27%
SEART eastbound central through-lane					
Cars:	182	131	168	190	671
HCVs:	6	3	6	5	20
Car + HCV:					671
Total for movement:					1817
% of total:					39%
SEART eastbound right-hand through-lane					
Cars:	120	138	166	174	598
HCVs:	9	0	1	2	12
Car + HCV:					622
Total for movement:					1817
% of total:					34%
SEART eastbound central right-turn lane					
Cars:	7	0	0	0	7
HCVs:	6	2	0	2	10
Car + HCV:					27
Total for movement:					131
% of total:					21%
SEART eastbound right-hand right-turn lane					
Cars:	28	12	19	13	72
HCVs:	3	4	5	4	16
Car + HCV:					104
Total for movement:					131
% of total:					79%

Table D5 Traffic count summary for the SEART/Carbine intersection in February 2005, morning peak totals.

Vehicle type	Time				One hour summation
	745-800	800-815	815-830	830-845	745-845
Grand total:	832	855	809	886	3109
Total cars:	789	797	745	821	2879
Total HCVs:	43	58	64	65	230

Table D7 Traffic count summary for the SEART/Carbine intersection in February 2005, evening peak totals.

Vehicle type	Time				One hour summation
	1645-1700	1700-1715	1715-1730	1730-1745	1645-1745
Grand total:	931	681	862	887	2977
Total cars:	887	661	838	857	2859
Total HCVs:	44	20	24	30	118

Appendix E SEART and Balmoral CAS plots

For all CAS diagrams, please refer to the key in Figure E1. All material in this appendix is taken from LTNZ 2004.

Land Transport NZ k i k Whenua Aotearoa		VEHICLE MOVEMENT CODING SHEET							
		For use with crash data from CAS (Version 2.4 February 2005)							
	TYPE	A	B	C	D	E	F	G	O
A	OVERTAKING AND LANE CHANGE	PULLING OUT OR CHANGING LANE TO RIGHT	HEAD ON	CUTTING IN OR CHANGING LANE TO LEFT	LOST CONTROL (OVERTAKING VEHICLE)	SIDE ROAD	LOST CONTROL (OVERTAKEN VEHICLE)	WEAVING IN HEAVY TRAFFIC	OTHER
B	HEAD ON	ON STRAIGHT	CUTTING CORNER	SWINGING WIDE	BOTH OR UNKNOWN	LOST CONTROL ON STRAIGHT	LOST CONTROL ON CURVE		OTHER
C	LOST CONTROL OR OFF ROAD (STRAIGHT ROADS)	OUT OF CONTROL ON ROADWAY	OFF ROADWAY TO LEFT	OFF ROADWAY TO RIGHT					OTHER
D	CORNERING	LOST CONTROL TURNING RIGHT	LOST CONTROL TURNING LEFT	MISSED INTERSECTION OR END OF ROAD					OTHER
E	COLLISION WITH OBSTRUCTION	PARKED VEHICLE	CRASH OR BROKEN DOWN	NON VEHICULAR OBSTRUCTIONS (INCLUDING ANIMALS)	WORKMANS VEHICLE	OPENING DOOR			OTHER
F	REAR END	SLOW VEHICLE	CROSS TRAFFIC	PEDESTRIAN	QUEUE	SIGNALS T	OTHER		OTHER
G	TURNING VERSUS SAME DIRECTION	REAR OF LEFT TURNING VEHICLE	LEFT TURN SIDE SWIPE	STOPPED OR TURNING FROM LEFT SIDE	NEAR CENTRE LINE	OVERTAKING VEHICLE	TWO TURNING		OTHER
H	CROSSING (NO TURNS)	RIGHT ANGLE (70° TO 110°)							OTHER
J	CROSSING (VEHICLE TURNING)	RIGHT TURN RIGHT SIDE	OBSOLETE	TWO TURNING					OTHER
K	MERGING	LEFT TURN IN	RIGHT TURN IN	TWO TURNING					OTHER
L	RIGHT TURN AGAINST	STOPPED WAITING TO TURN	MAKING TURN						OTHER
M	MANOEUVRING	PARKING OR LEAVING	"U" TURN	"U" TURN	DRIVEWAY MANOEUVRE	PARKING OPPOSITE	ENTERING OR LEAVING	REVERSING ALONG ROAD	OTHER
N	PEDESTRIANS CROSSING ROAD	LEFT SIDE	RIGHT SIDE	LEFT TURN LEFT SIDE	RIGHT TURN RIGHT SIDE	LEFT TURN RIGHT SIDE	RIGHT TURN LEFT SIDE	MANOEUVRING VEHICLE	OTHER
P	PEDESTRIANS OTHER	WALKING WITH TRAFFIC	WALKING FACING TRAFFIC	WALKING ON FOOTPATH	CHILD PLAYING (TRICYCLE)	ATTENDING TO VEHICLE	ENTERING OR LEAVING VEHICLE		OTHER
Q	MISCELLANEOUS	FELL WHILE BOARDING OR ALIGHTING	FELL FROM MOVING VEHICLE	TRAIN	PARKED VEHICLE RAN AWAY	EQUESTRIAN	FELL INSIDE VEHICLE	TRAILER OR LOAD	OTHER

* = Movement applies for left and right hand bends, curves or turns

Figure E1. Key to understanding the symbols and abbreviations in the CAS diagrams.

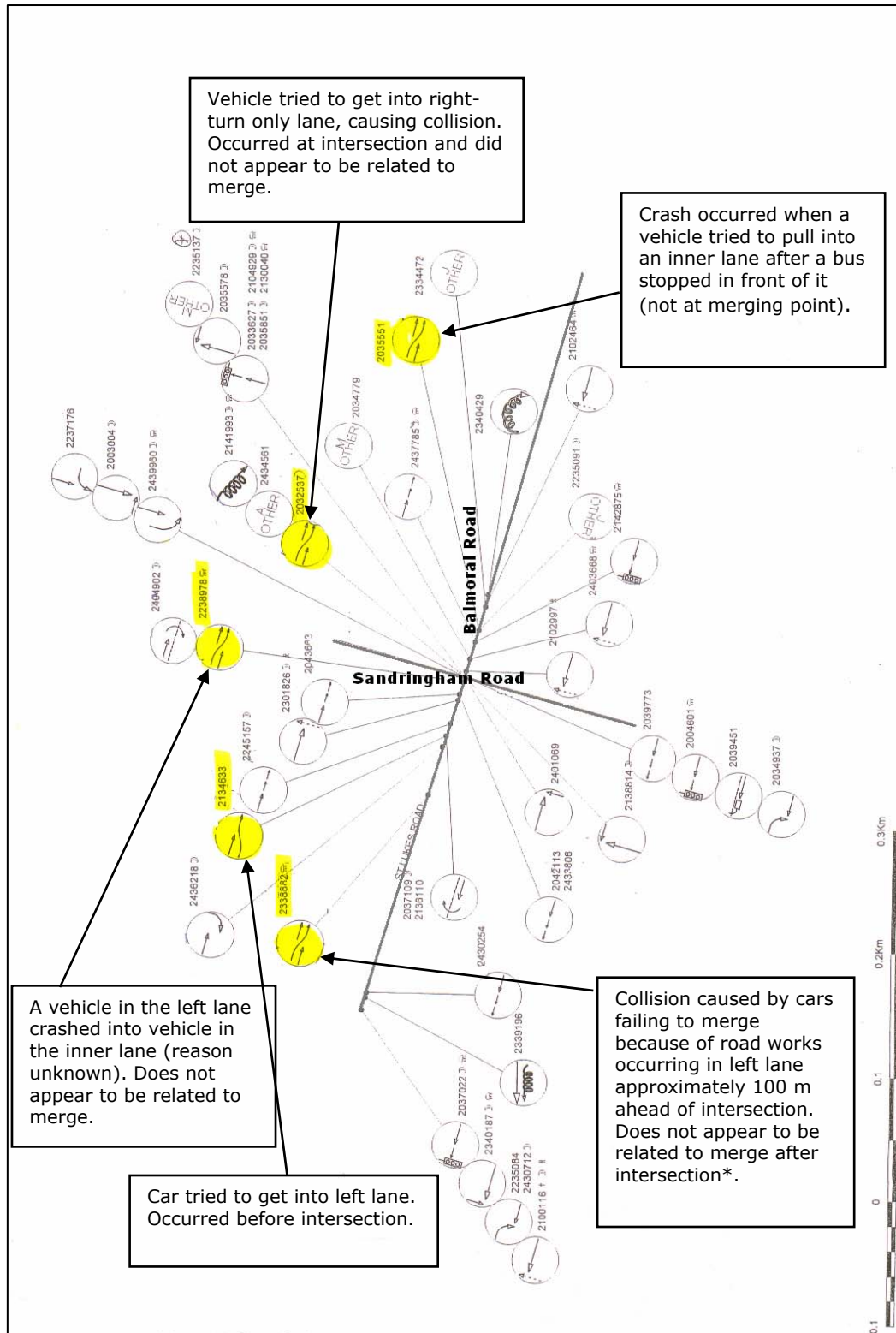


Figure E2 Injury and non-injury accidents on Balmoral Road at the Sandringham/Balmoral intersection 2000–2004.

* This is an accident caused by lanes merging because of works, but it did not occur at the merging site we are focusing on.

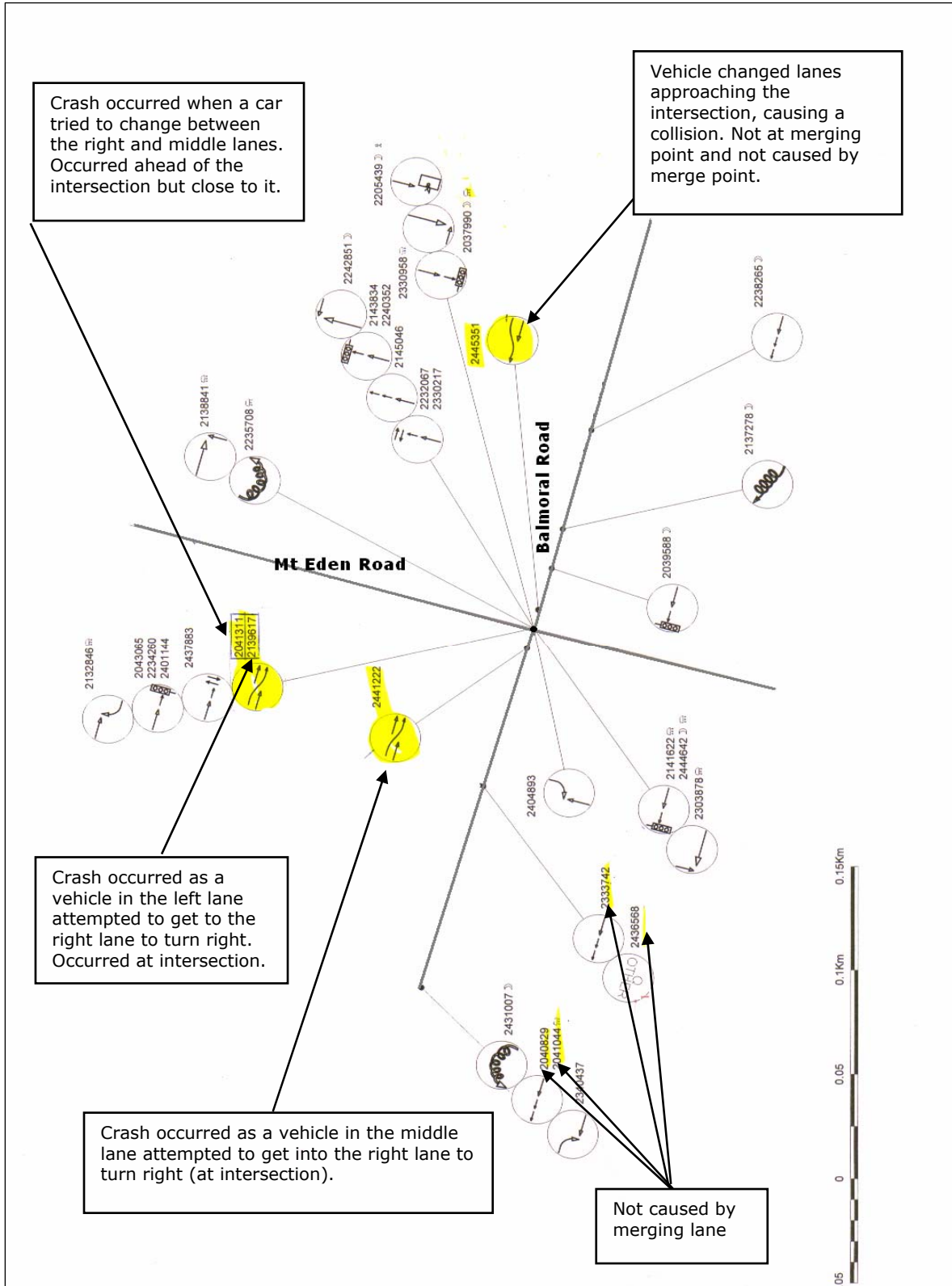


Figure E3 Injury and non-injury accidents on Balmoral road at the Mt Eden/Balmoral intersection 2000–2004.

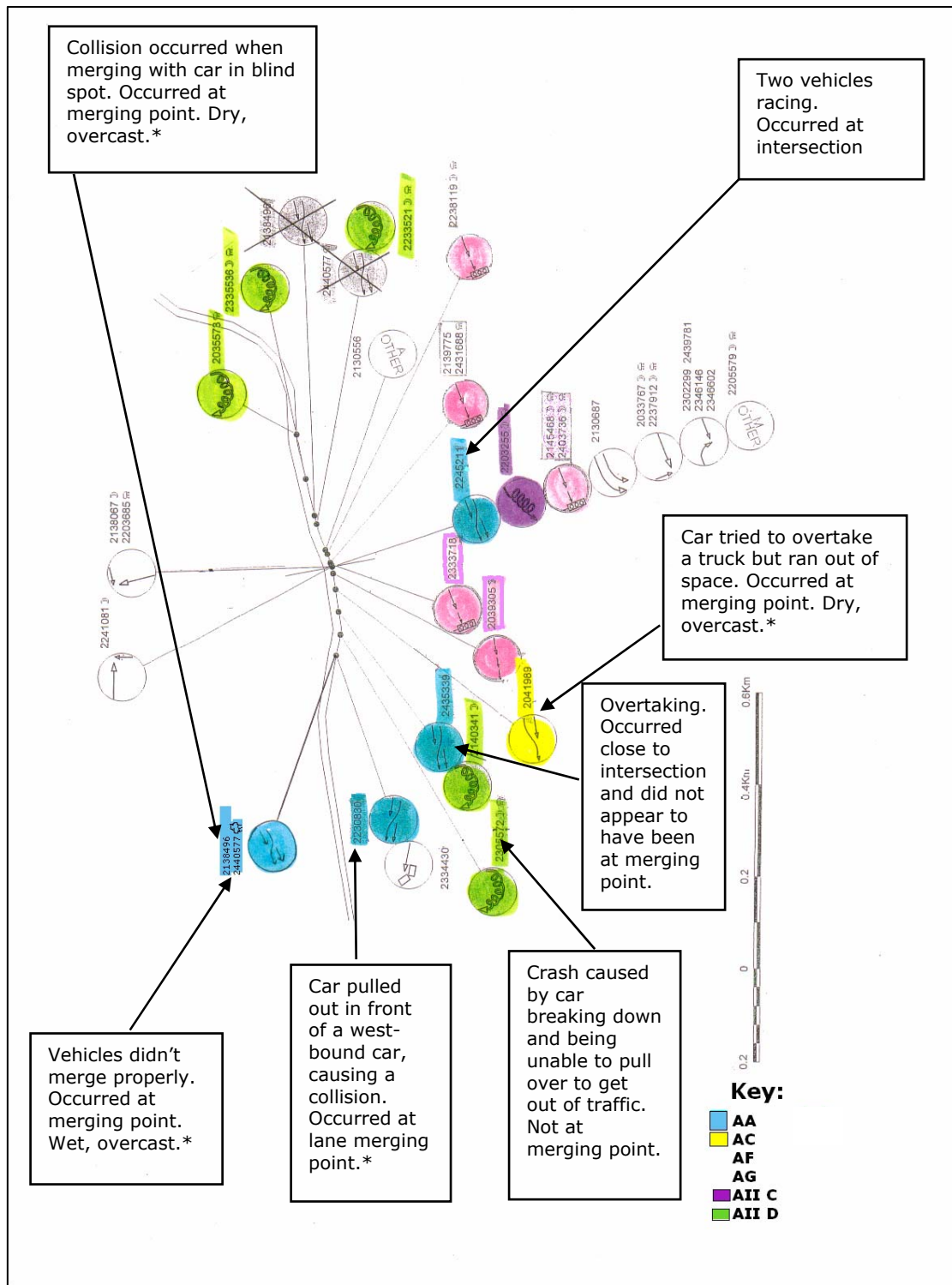


Figure E4 Injury and non-injury accidents on the westbound lanes of SEART at the SEART/Carbine intersection 2000–2004.

* Failure to merge at right-hand merge point (4 non-injury).

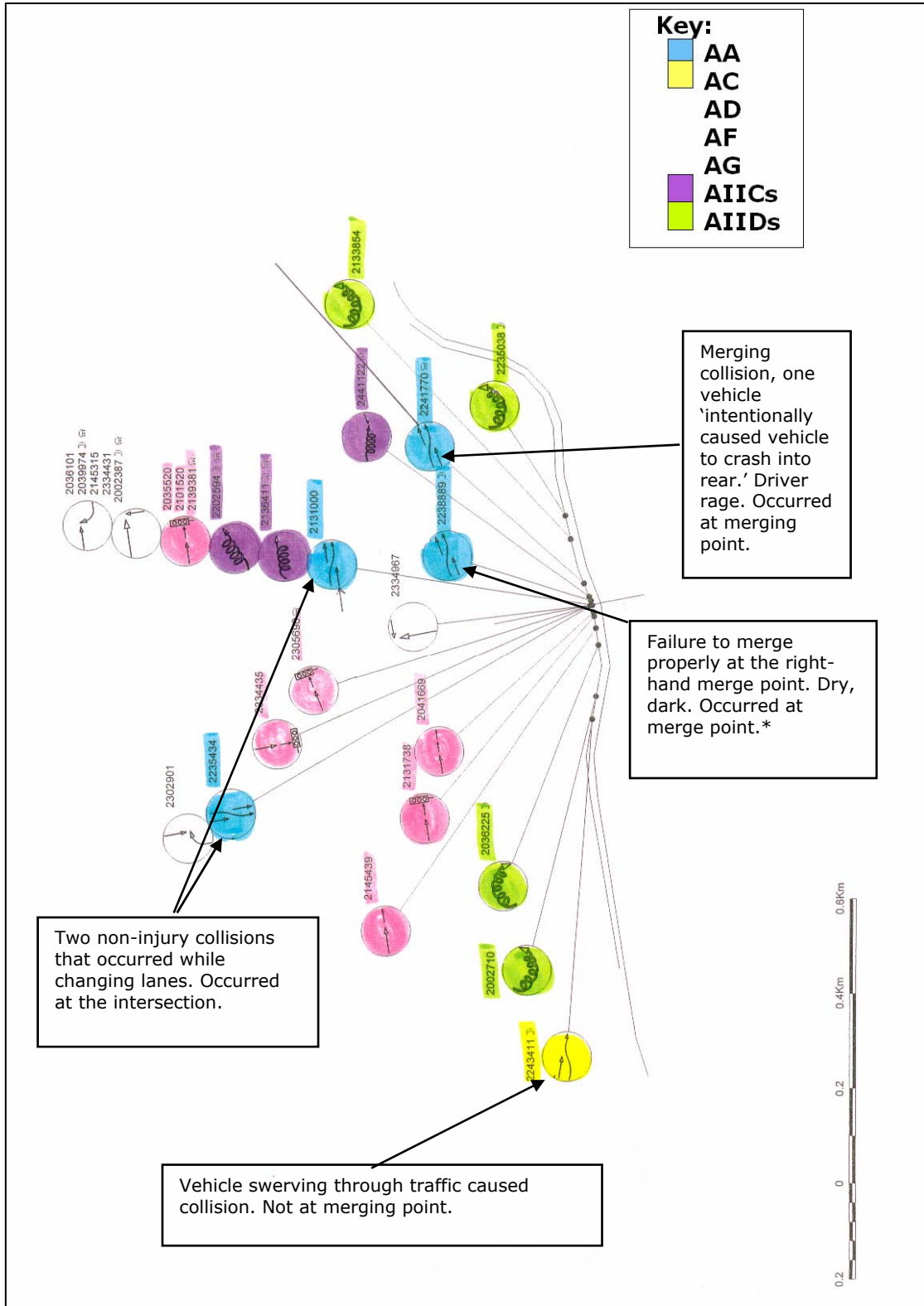


Figure E5 Injury and non-injury accidents on the eastbound lanes of SEART at the SEART/Carbine intersection 2000–2004.

*Failure to merge at right-hand merge (1x non-injury)

Appendix F Short lanes in New Zealand: ten proposed plans

All aerial photos in this appendix have been provided by Auckland City's GIS network. They are not to scale. A key to these diagrams is shown in Table F1.





Symbol/colour	Meaning
	New or altered kerbing
	Existing kerbing prior to land-take
	New clearway
	Bus advance lane

Table F1 Key to interpreting the intersection diagrams in Appendix F.

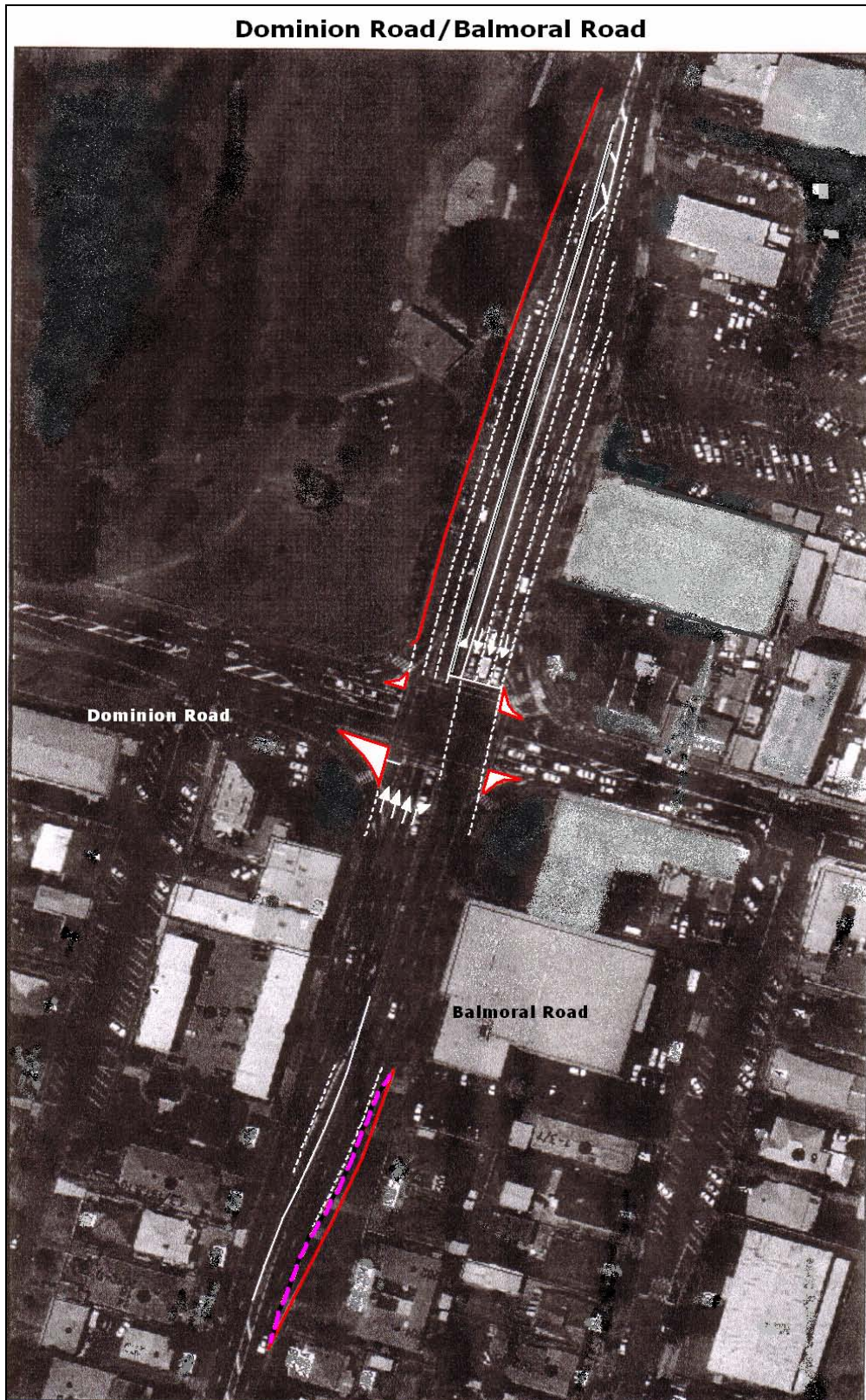


Figure F1 Feasibility plan of the Dominion Road/Balmoral Road intersection (not to scale).

This design (F1) features additional lanes on Balmoral Road, longer downstream merges, with relatively minor road widening.

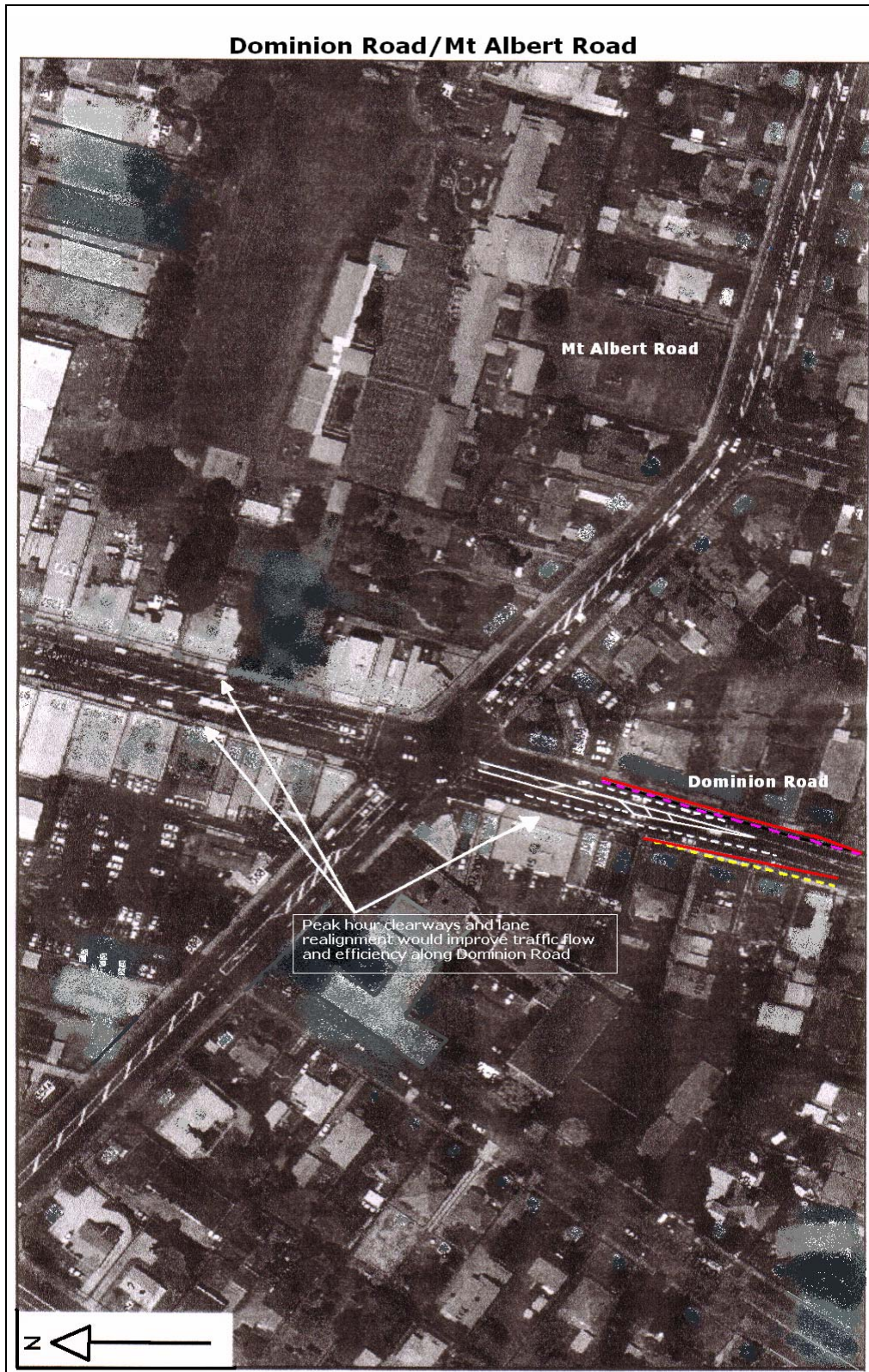


Figure F2 Feasibility plan of the Dominion Road/Mt Albert Road intersection (not to scale).

This design (Figure F2) features road widening and the removal of on-street parking in order to lengthen the approach and departure lanes on Dominion Road south of Mt Albert Road.

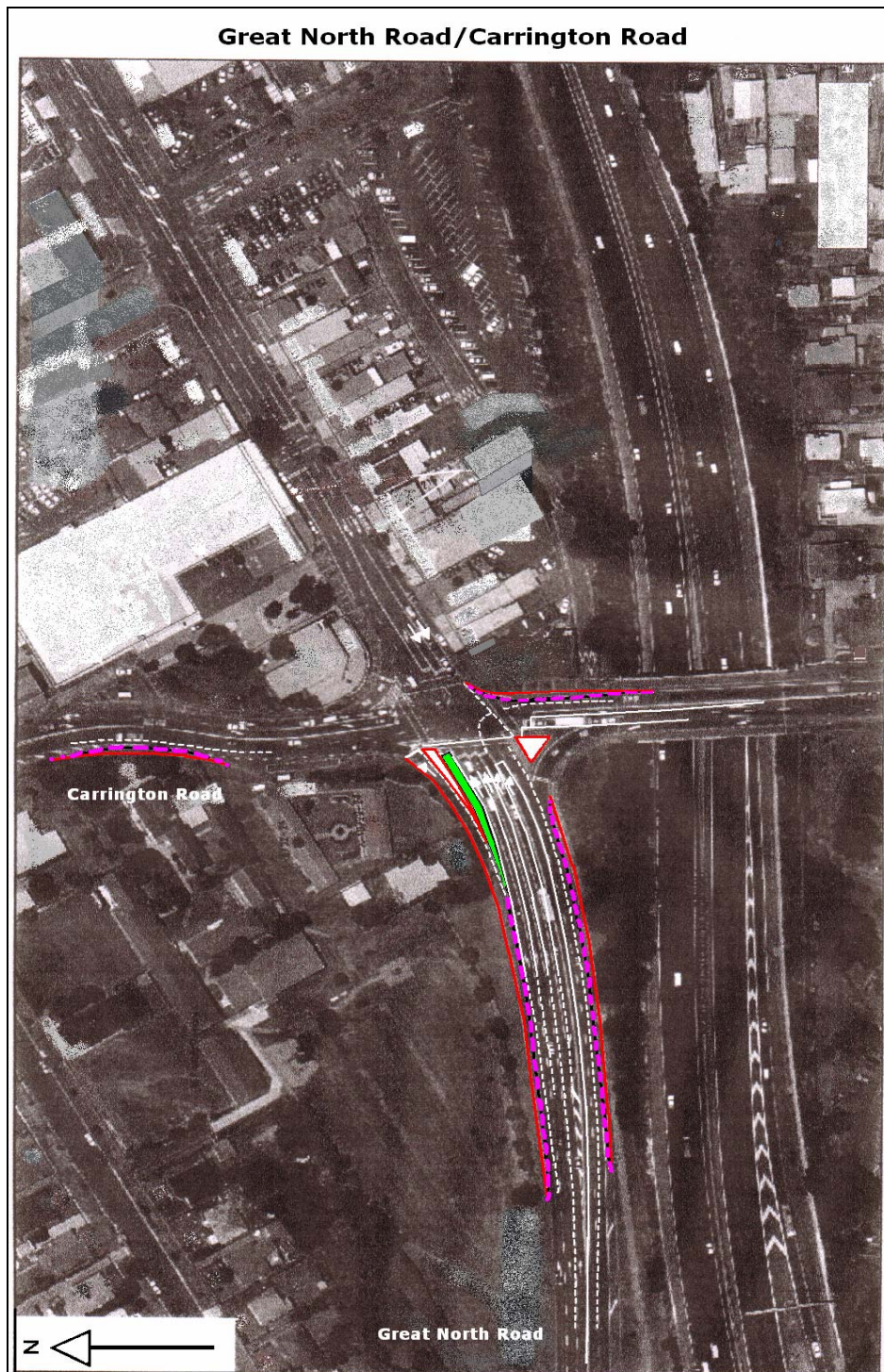


Figure F3 Feasibility plan of the Great North Road/Carrington Road intersection (not to scale).

This design features additional right-hand-turn pockets on Great North Road eastbound, an extended right-turn pocket and an extended bus advance lane. Extending merge areas on Pt Chevalier Road (not shown on the diagram) is another recommended step. Peak hour clearways along Great North Road and lane realignment would also assist traffic flow along Great North Road.

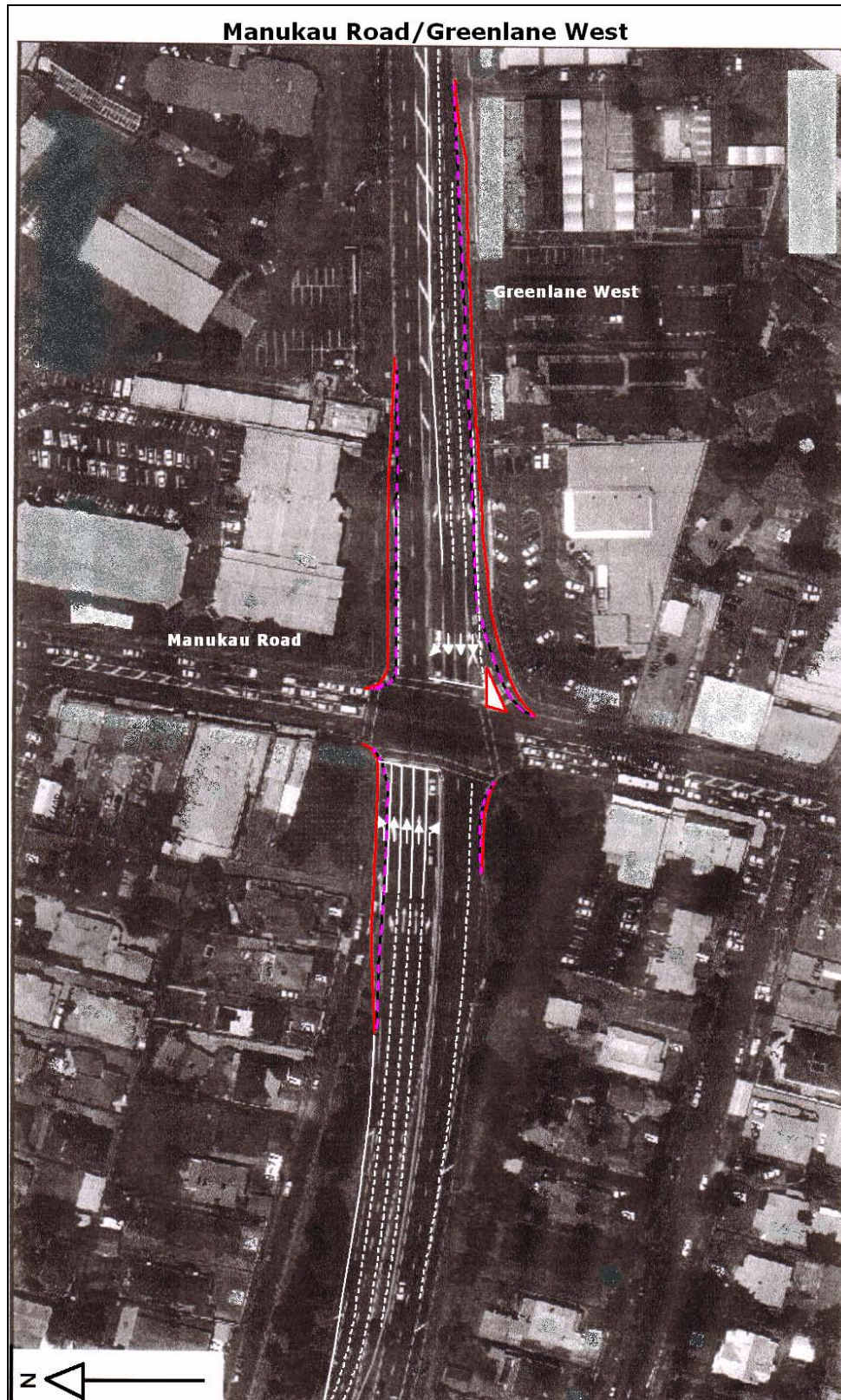


Figure F4 Feasibility plan of the Manukau Road/Greenlane West intersection (not to scale).

The plan shown in Figure F4 features additional through-lanes along Greenlane West which use the existing hatched shoulder, the raised central island and road widening.

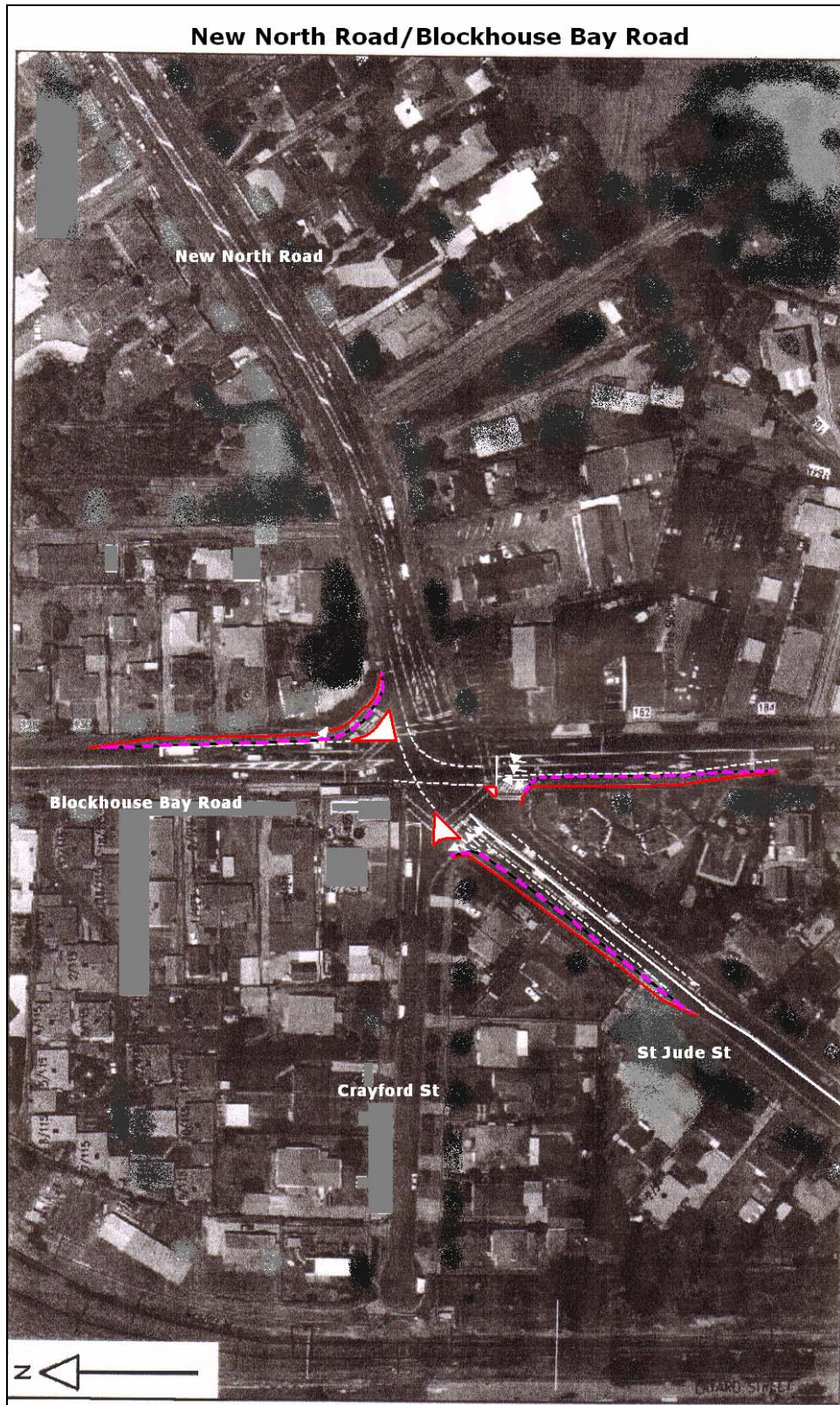


Figure F5 Feasibility plan of the New North Road/Blockhouse Bay Road intersection (not to scale).

This design (Figure F5) features longer lanes on three of the approaches to the intersection.

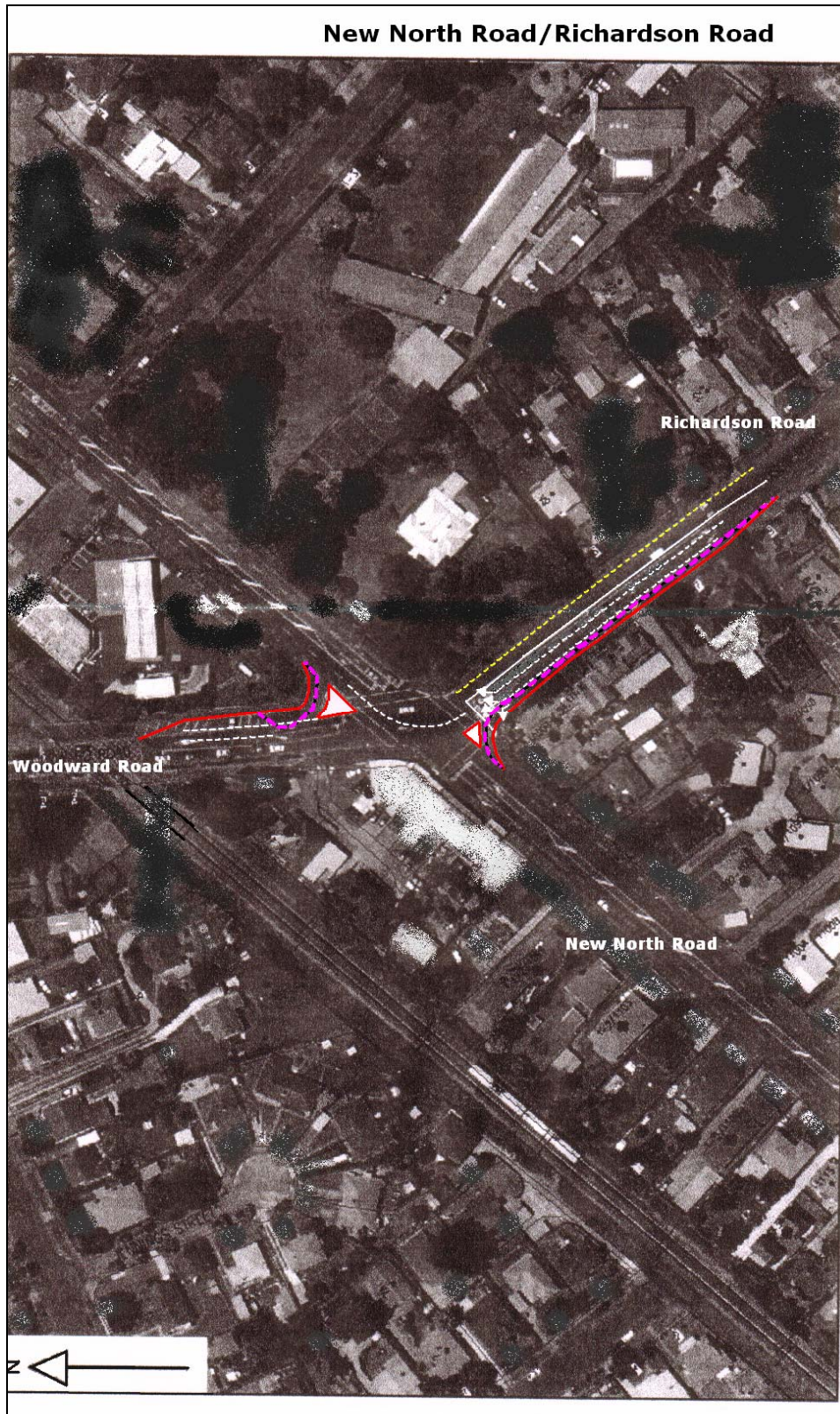


Figure F6 Feasibility plan of the New North Road/Richardson Road intersection (not to scale).

This design (Figure F6) features longer approach lanes and a free left turn on Richardson Road southbound.



Figure F7 Feasibility plan of the New North Road/Sandringham Road intersection (not to scale).

This design (Figure F7) features longer approaches on Sandringham Road, Bond Street and New North Road.



Figure F8 Feasibility plan of the New North Road/St Luke's Road intersection (not to scale).

The design shown in Figure F8 features a new left-turn slip lane on St Lukes (northbound) and a longer left-turn slip-lane on St Lukes (southbound).

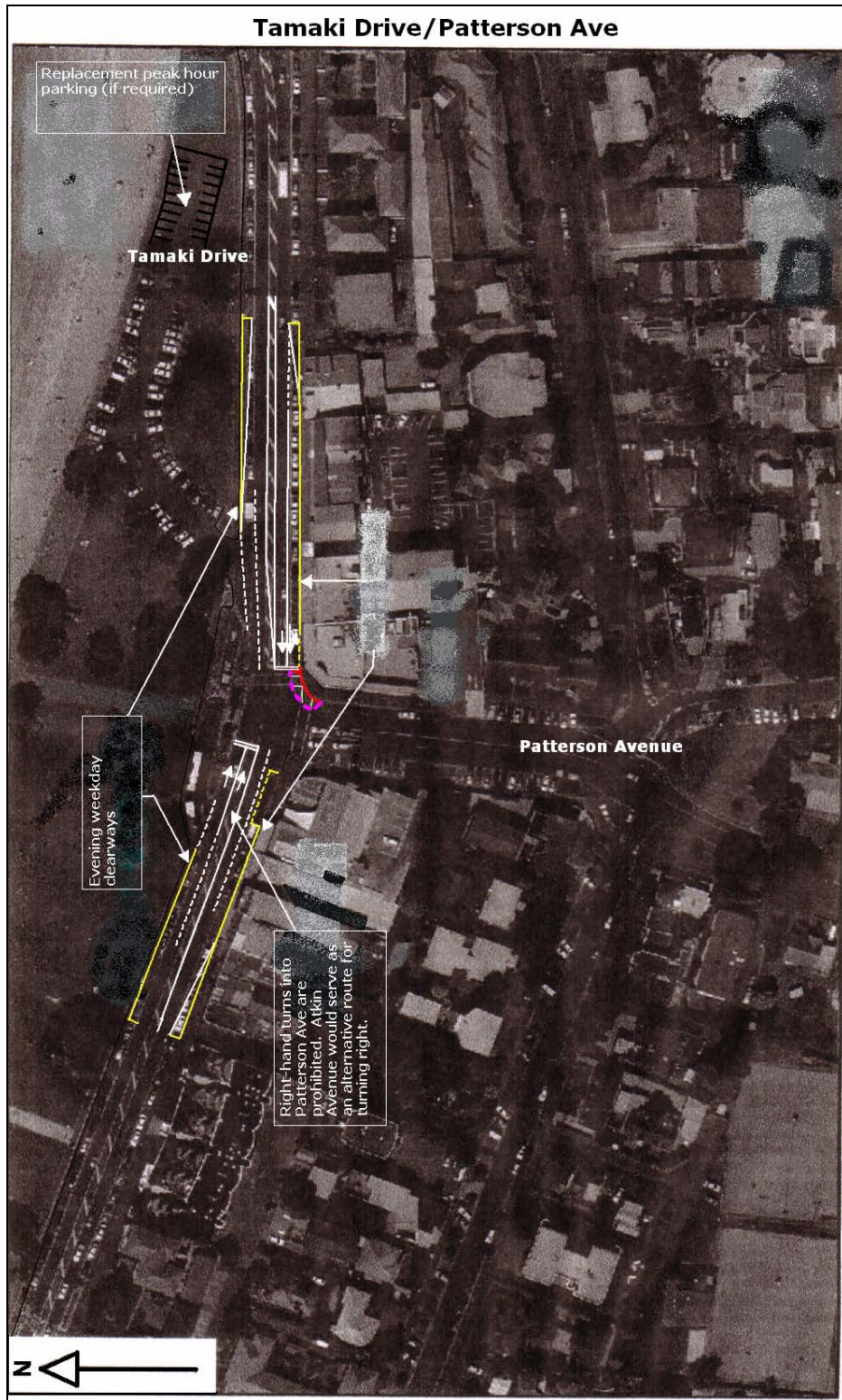


Figure F9 Draft feasibility plan of the Tamaki Drive/Patterson Avenue intersection (not to scale).

This design (Figure F9) features additional through-lanes on Tamaki Drive at its intersection with Patterson Avenue during peak commuter hours. Traffic flow efficiency along Tamaki Drive would be improved significantly during weekday commuter peaks. The tracking curves for this diagram need to be checked.



Figure F10 Feasibility plan of the Great South Road/Greenlane West intersection (not to scale).

This design (Figure F10) features new left-turn slip lanes on Greenlane and Great South Road southern approaches. It also features lengthened left-turn lanes on Greenlane and Great South Road northern approaches.

Appendix G Further research

G1 Short lane database – lane length versus use

Signalised intersections throughout New Zealand have short through-lanes. Currently, we have no technical design data that accurately predict the expected rate of use for a short lane based on its length. Technical designers generally rely on traffic models to reach such assessments. However, as discussed in Chapter 5, analytical traffic models frequently used by technical designers generally appear to over-estimate how short through-lanes are used. More accurate technical data are required.

Useful technical data could be acquired by expanding upon the data contained in Figures 4.1, 4.2 and 4.3, and preparing more accurate graphs comparing the lengths of upstream and downstream short lanes to their associated rates of use. The relative importance of approach and departure lane lengths could also be studied. Furthermore, the effects of traffic congestion and other influences could be quantified.

If the database was extensive enough to achieve statistical significance, then the resulting database would enable engineers to predict the expected rate of use of proposed short lanes at intersections accurately. This information could be used during the process of calibrating traffic models, enabling improved design and greater accuracy in modelling and economic analysis.

G2 An alternative short lane configuration

As part of this investigation, the traffic surveys undertaken at the SEART/Carbine intersection have provided preliminary indications that short through-lanes on the right are likely to be used more than short through-lanes on the left. The data is conclusive for the site studied and would probably achieve similar results for similar sites. However, the database is limited, being restricted to analysis at merely one approach at one intersection – the result could not be generally applied to all sites. Also, converting short lanes to off-side lanes may adversely affect accident statistics. Because of these factors, this research topic should be investigated further.

Consideration should be given to conducting a trial and analysis of short lanes on the right. The results could enable significant cost-effective improvements in how short lanes are used and how efficiently intersections operate.

G3 A model for predicting rates of use

The current research has concentrated on through-lane use at intersections with three through-lanes. Further research is required to include shared short through-lanes for various situations including:

- a short through- and left-lane, and one, two or three other through-lanes;
- a short through- and right-lane, and one, two or three other through-lanes.

A definition for shared through-lane use would be required along the lines of Equation G1.

$$U = \frac{T_s \text{ (vehicles)}}{T/n \text{ (vehicles)} - kL \text{ (vehicles)}}$$

where:

U = use,

T_s = through volume in shared lane,

T = the total through volume,

k = a constant to convert vehicles turning left to through-vehicles,

L = shared turning volume, and

n = number of through-lanes.

[Equation G1]

A model would be developed to predict U from key variables, such as short lane length, level of congestion and downstream turning volumes. The current data would be combined with data collected from a larger, carefully selected sample of intersections and subjected to regression analysis. Equation G2 is a regression model specimen:

$$U = aX + bC + cR + d$$

Where:

U = use,

X = the average length of (roughly equal) arrival and departure short lanes,

C = congestion, measured as the average queue in the through-lane with the longest queue,

R = ratio of downstream left-turn volume to downstream right-turn volume,

a , b , c & d = regression constants to be determined by data analysis.

[Equation G2]

The use of Equation G2 has been explored using the data collected for the exclusive short through-lanes on Balmoral Road at the Sandringham/Balmoral and Mt Eden/Balmoral intersections, for which $k=0$ and $c=0$. The result is presented in Figure G1. This indicates that enlarging the database would be a very worthwhile step in researching short through-lane use.

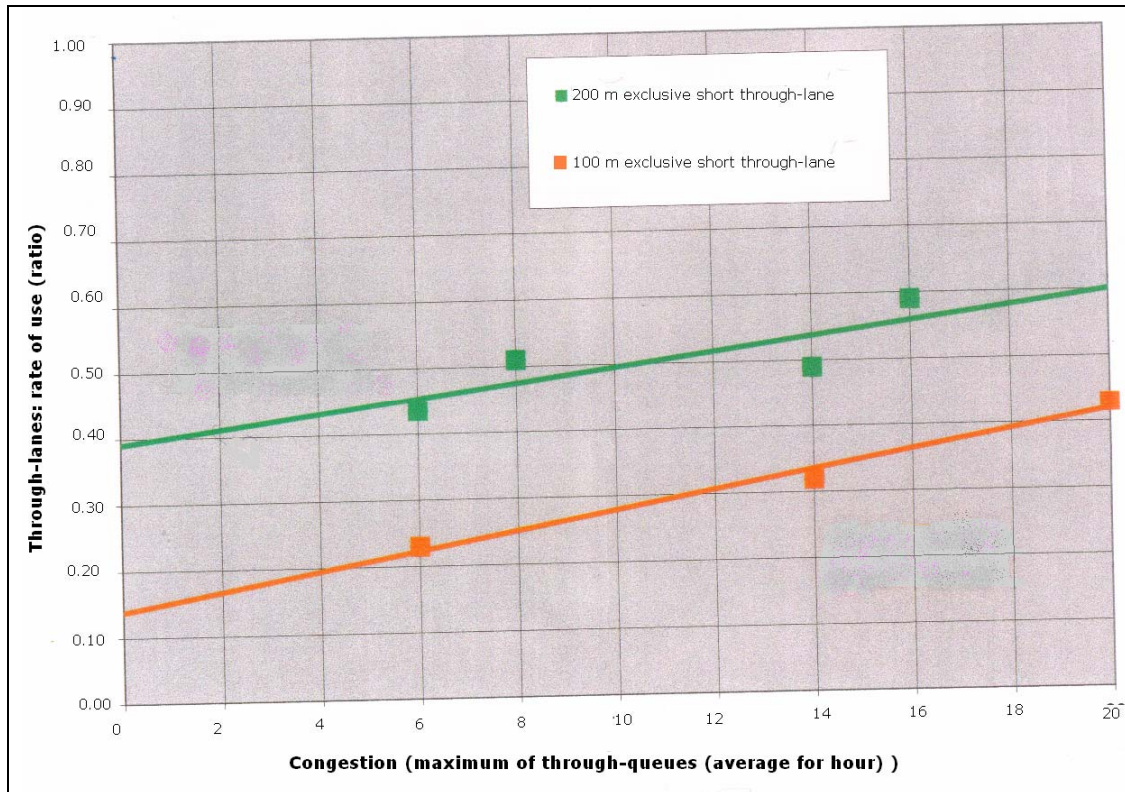


Figure G1 Exploratory model for use of exclusive short through-lanes on the left side of Balmoral Road at the Sandringham/Balmoral and Mt Eden/Balmoral intersections.

Notes to Figure G1:

- (a) For the 200 m line, $y = 0.0105x + 0.3906$ and $R^2 = 0.6078$.
- (b) For the 100 m line, $y = 0.0141x + 0.1384$ and $R^2 = 0.9805$.
- (c) Data were taken from the Sandringham/Balmoral and Mt Eden /Balmoral intersections.

Appendix H Preliminary guide for predicting and improving short through-lane use

H1 Introduction

The key finding from the research is that, in general, short slip lanes and short approach and departure through-lanes cause short through-lanes to be used less. Consequently, lengthening such lanes would increase their rate of use, and thus make intersections operate more efficiently. Until more detailed technical information is available, we suggest that practitioners use the guidelines outlined in this chapter when designing short through-lanes at signalised intersections:

H2 Short approach through-lanes

The required length of short through-lanes depends upon the amount of storage required for vehicle queues. Diverge tapers should provide for a rate of lateral movement no greater than 1.0 metres per second (m/s) (AUSTROADS 1988). The authors recommend that short through-lane approaches have adequate queuing space to accommodate 95th percentile peak hour vehicle queues and which would not be blocked by 95th percentile queues in adjacent lanes.

H3 Short downstream departure merge lanes

Short downstream departure merge lanes should preferably be around 100 m long, followed by a merge taper at the end providing for a rate of lateral movement of preferably no more than 0.6 m/s (AUSTROADS 1988). The authors also recommend that departure lanes should not be shorter than 1½ times the length of the 95th percentile approach queues to make merging easier for motorists. If vehicle queues cannot discharge fully during the green signal phase then the length of the approach queue can be measured as the number of vehicles that can traverse the intersection during the 95th percentile green signal phase. This departure lane length is measured from the limit line to the end of the merge (including merge taper).

H4 Short lanes (approach and merge)

Figures H1 and H2 should be used as a traffic modelling guide to the likely short through-lane use for a signalised intersection with three through-lanes (slip lane length ignored):

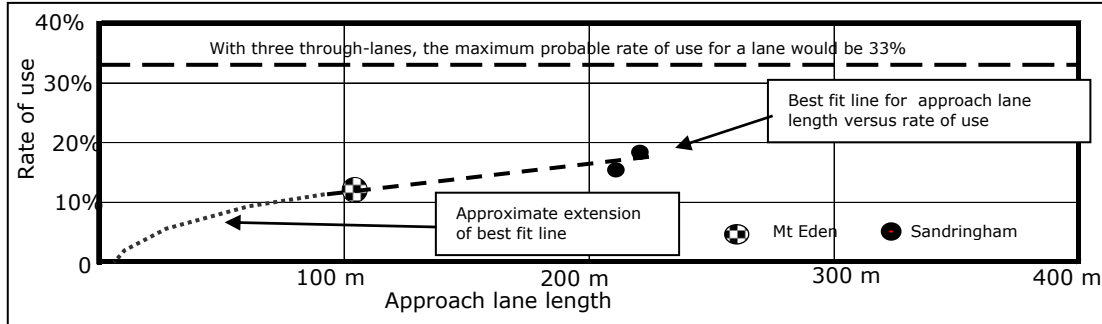


Figure H1 Short through lanes – approach length versus rate of use based on data from the Mt Eden/Balmoral and Sandringham/Balmoral intersections.

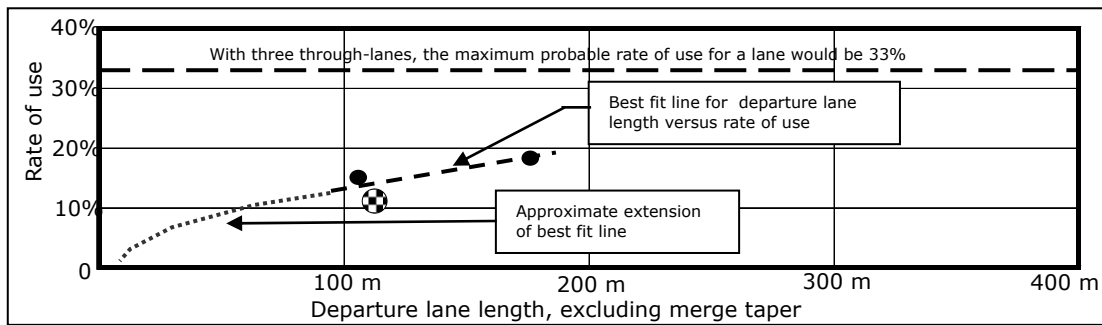


Figure H2 Short through lanes – departure length versus rate of use based on data from the Mt Eden/Balmoral and Sandringham/Balmoral intersections.

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