SEALED vs UNSEALED ROAD SPEEDS

A study of speeds on sections of rural roads before and after seal extension

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EXECUTIVE SUMMARY

Project Objective

This research investigated speeds on rural roads before and after seal extension works were undertaken.

The key research objective was to provide output superseding Table A7.1 of the Transfund (formerly Transit New Zealand) Project Evaluation Manual, which provided default values of the increase in vehicle speeds on an unsealed rural road once it was sealed, based on the road terrain (alignment) and carriageway width both before and after sealing.

Surveys

The research involved initially identifying suitable seal extension works in the 1995 / 96 National Land Transport Programme. Of the 32 sites identified, 16 were in the far north of New Zealand and 16 elsewhere. These were all surveyed using an observer at each end of the road section manually recording relevant details.

Site Analysis

The vehicle data were manually matched and entered onto computer spreadsheet, whereupon the data was checked. Analysis concentrated on the difference in the average travel speed of light vehicles prior and subsequent to sealing.

Interpretation of Results

Two key trends were drawn from the analysis results:

- the effect of sealing on travel speeds was greater for the slower speed sites, and
- additionally as the carriageway widening increased after sealing the average speed increased.

From the results a simplified replacement table for the Project Evaluation Manual was proposed.

Conclusion and Recommendations

A number of surveys providing comparative speeds on unsealed and sealed roads has been undertaken from which a provisional table has been proposed and recommended to replace the current Project Evaluation Manual table.

It is also recommended that the occupancy by vehicle class data, also collected during the speed surveys, be utilised for updating relevant portions of the appropriate Project Evaluation Manual tables.

ABSTRACT

A comparison of average vehicle speed on lengths of rural roads prior and subsequent to sealing extension works was undertaken during 1996 for thirty one sites.

The results indicated speeds on unsealed roads are generally lower than those currently presumed in the Project Evaluation Manual (July 1994), and the effect of sealing "as is" (no increase in carriageway width) also not as great as assumed.

A provisional replacement for table A7.1 is proposed for use when predicting increase in average travel speed when an unsealed road is sealed.

1. INTRODUCTION

1.1 Background

Over half of the public roads in New Zealand are unsealed, the vast majority of which occur in rural areas. In recent years there has been increasing pressure to seal certain unsealed roads although sealing did not meet the benefit / cost cut-off ratio required.

Transit New Zealand introduced a policy to seal all remaining sections of unsealed state highway by 1997/98. At the same time revisions were made to the Project Evaluation Manual effectively improving the economics of seal extension works.

This research project Sealed vs Unsealed Road Speeds, which seeks to determine the likely increase in traffic speeds on unsealed sections of road once they are sealed, can be considered as a natural progression of the investigation into the treatment of unsealed roads and continuation of revisions and improvements to the Project Evaluation Manual.

1.2 Study Objectives

The primary objective of the study was:

- to provide an updated table replacing Table A7.3 of the Project Evaluation Manual July 1994 (corresponding to Table A7.1 in the PEM (1997) and referred to hereafter as Table A7.1.)

1.3 Target Parameters

The research brief proposed the following survey targets:

- survey of about 30 sites with a minimum length to be sealed of 2.0 km; and
- a minimum survey time of two hours and desirable minimum sample size of 30 vehicles.

The brief recognised that not all of the terrain category/seal width combinations of PEM Table A7.1 would be able to be surveyed.

2. METHODOLOGY

2.1 Basic Process

The basic methodology involved the following steps:

- identifying potentially suitable sites from the seal extension works in the Transit NZ 1995/96 National Land Transport Programme;

- contacting Transit NZ and local authorities to confirm when sealing was planned to proceed, the length of works, precise location etc and topography and seal width;
- arranging before surveys being an observer stationed near each end of the length due for sealing;
- matching the vehicle observations and deriving average journey speed as the key parameter;
- cleaning the data to remove for example vehicles which had obviously stopped along the section being surveyed;
- determining appropriate action for any sites with unsuitable data;
- conducting after surveys once sealing has been completed, processing and cleaning data as before;
- analysing the difference between before and after speeds; and
- reporting.

Each of the above is discussed in further detail.

2.2 Site Identification

The Transit NZ 1995/96 National Land Transport Programme (now Transfund National Roading Programme) was used as the basis for initially providing a potential list of sites.

From these all seal extension works involving lengths of 2.0 km or greater were identified and the appropriate road controlling authority contacted to obtain further details. Sites for which sealing had already begun or which had been pre-treated (for example, smoothing treatment) were generally excluded. In some cases, sites not on the NLTP were highlighted by the local authority but most were under 2.0 km in length.

In all 32 sites were identified, of which 16 were in the far north of New Zealand and 16 elsewhere.

2.3 Before Survey Technique

The basic survey technique involved stationing an observer more than 2 km apart on the length of road to be sealed. The observations were carried out by contractors in the local areas.

The observer at each station was instructed to record the following details:

- numberplate
- vehicle type / description
- observation time
- direction of travel
- number of occupants (adult / children)
- comments

The observers synchronised watches, determined the distance between their observation points, and recorded details for use when undertaking the after surveys.

For the far north sites there were four vehicle types specified as: car/light truck; medium truck (up to 6 wheels); heavy truck (8 or more wheels); and other (specify).

For the other sites the vehicle types were described and included: car, utility, van, 4-wheel-drive, station wagon, truck, logging truck etc.

The numbers of vehicle occupants were recorded for the nationwide sites, and further divided into adults and children for the far north sites.

The survey period for the far north sites was generally restricted to two hours in order to be able to conduct three surveys in a day to minimise costs. The surveys elsewhere were up to four hours long in an attempt to record sufficient vehicle numbers on typically low volume roads[1].

2.4 Processing Procedures

2.4.1 Data Entry

The survey forms were returned to Traffic Design Group. The matching of vehicles recorded at each station was undertaken manually as the number of records were low and errors could be easily spotted and rectified. The matched data were then entered into a standard spreadsheet format which derived the Project Evaluation Manual vehicle type (CAR, LCV, MCV, HCV, BUS) with CAR and LCV being deemed Light Vehicles and the remainder Heavy Vehicles. Some manual determination of the vehicle type was necessary for unusual vehicle types (eg crane, tractor).

2.4.2 Cleaning Data

Spurious data records were excluded from the analysis by specifying minimum and maximum speeds considered acceptable for each site. These minima and maxima were selected by judgement.

In a limited number of cases checks indicated that the observers' watches had not been properly synchronised. Accordingly adjustments were made by comparing journey times for vehicles which had been observed travelling in each direction. These results are still valid.

2.4.3 Analysis

The analysis procedure adopted derived the mean, standard deviation, and number of clean observations for light vehicles, and heavy vehicles separately and combined. As well, the average number of occupants and number of each vehicle type for all matched records was determined.

[1] These observation time constraints were reached in agreement with the original Transit NZ research project. manager.

3. RESULTS

3.1 Vehicle Speeds : Before and After

The results for the before and after surveys are summarised in the tables in the appendix. Further discussion is given below.

Only one site (9, Queenstown - Glenorchy Road) had an average unsealed speed exceeding 60 km/h. Several sites had an average before speed around 30 km/h. Overall the average before (and after) speeds are generally lower than those presumed in the current table A7.1 of the Project Evaluation Manual.

At one site (8, Magatu Road, Gisborne) there were a large number of logging trucks observed comprising more than half of the matched observations. In general however there were fewer than five heavy vehicles observed at each site.

Unfortunately the number of matched light vehicles with clean data was also lower than hoped resulting in standard deviations of "before" light vehicle speeds of between 5 and 14 km/h. However the low matching rates could not be avoided without a considerable increase in expenditure. The results for each site are set out in the appendix and summarised in section 3.2.

3.2 Vehicle Speeds : Differences

Due to the paucity of observed heavy vehicles, the examination of the differences between the before and after speeds has concentrated on the light vehicles. The results are summarised in Table 1 with fuller details provided in the appendix.

Table 1 : Summary Results

site	location	before seal width	before mean light veh speed	before light veh	after seal width	after Mean light veh speed	after light veh	difference carriageway width	difference mean light veh speed
		m	km/h		m	km/h		m	km/h
	NATIONWIDE 95/96								
1	Port Underwood Road-Blenheim	5.2	29.8	23	5.5	32.5	15	0.3	2.7
2	Carrs Road-Waimakariri	5-6	46.4	15	7	64.7	17	1.5	18.3
3	Mangatutu Road-Hamilton	6	54.3	10	6	61.0	8	0.0	6.7
4	Puketawai Road-Hamilton	6	59.1	31	6	76.6	9	0.0	17.5
5	SH43-Stratford: Tatu	3.7	48.9	21	6	66.7	127	2.0	17.8
6	Hangatiki-Hamilton	6	47.3	11	6		0	0.0	*
7	SH87-Dunedin	5.5	46.4	32	7	72.5	29	1.5	26.1
8	Magatu-Gisborne (logging route)	5.5	50.3	16	6	72.5	16	0.5	22.2
9	Glenorchy Road-Queenstown	7	73.1	84	7	72.8	83	0.0	-0.3
10	SH52-Ekatahuna	4.2-4.5	56.0	13	6	59.7	12	1.5	3.8
11	Long Beach Creek-Balclutha	6	48.7	20	6.5	51.7	15	0.5	3.1
12	SH43-Stratford: Tahora	3.7	31.3	9	6		0	2.0	*
13	Waiotahe Valley-Opotiki	7.0-7.5	30.0	7	6!	43.2	12	-1.0	13.2
14	Klondyke Road	5-6	28.6	12	6	43.5	13	0.5	14.9
15	Tennyson Inlet, Marlborough	4.5	29.6	33	4.5	34.5	16	0.0	4.9
16	Wakamarina Road	3.5-4.5	38.2	18	3.5-4.5	47.0	12	0.0	8.8
	FAR NORTH 95/96								
20	Ngapipito Road	6	48.1	10	6	61.7	22	0.0	13.6
21	Waimate North Road	6	52.1	11	6	84.5	32	0.0	32.4
22	Pungaere Road	5.2	54.1	31	6.5	55.0	19	1.3	0.9
23	Opito Bay Road	5	39.0	18	6	33.1	5	1.0	-5.9
24	Te Wahapu Road	6	43.7	5	6.5	63.5	10	0.5	19.7
25	Russell Road	5.5	30.3	21	6.5	56.3	27	1.0	26.0
26	Koutu Loop Road	6	44.5	8	5.5	60.0	7	-0.5	15.5
27	SH12-Te Matua	5.5	58.3	25	6.5	55.0	26	1.0	-3.3
28	SH12 southern nd	5.5	33.7	18	6.5	43.3	44	1.0	9.6
29	Hihi Road	6	54.5	39	6	47.4	24	0.0	-7.1
30	Uretiti Road		N/A	1		N/A			N/A
31	Pataua North Road	5.5	39.6	25	6.5	54.8	17	1.0	15.2
32	Fairburn Road	5.5-6	50.0	27	5.5	53.9	26	0.0	3.8
33	Horeke/Taheki Road	6	55.2	8	6	58.8	11	0.0	3.6
34	Kaimaumau Road	6	53.6	14	6	60.4	12	0.0	6.8
35	Whalers / Hukatere Road	5.0	50.9	8	6	43.2	10	1.0	-7.7

*Sites for which an after survey has not yet been completed.

Note that due to the low sample sizes, statistical testing of the significance of the differences has not been undertaken.

3.3 Occupancy by PEM Vehicle types

The analysis of the (weekday) occupancy surveys and percentages of PEM vehicle types is not part of the research project brief, and accordingly the findings which would be particularly useful in updating the appropriate parts of tables A2.1 and A2.2 of the Project Evaluation Manual are not presented in this report.

4. INTERPRETATION OF RESULTS

When combined with the typical before and after carriageway widths, the results given in Table 1 above can be rearranged and summarised as follows:

Table 2 : Observed change in light vehicle speed

BEFORE LIGHT	BEFORE	AFTER INCREASE IN WIDTH			
		0	0.5	1	1.5+
70 - 75	7	0			
45 - 60	≤ 5.0 5 – 6 > 6	 5,5,5 -5,15,15,30,*		-5 -5,0	5,20 20,20,25
35 - 45	≤ 5.0 5 - 6 > 6	10 15 30	20,20	-5 15	
< 35 km/h	≤ 5.0 5 - 6 > 6	5,15 15	15	10,25	*

Notes:

1. * indicates not yet sealed
2. speed differences rounded to nearest 5 km/h
3. width increases are nominal values
4. shading represents change in vehicle speed for each site

Examination of the above table reveals that there are a variety of observed effects. There are some presumed unusual effects which lead to the apparent decrease in after speeds for four of the sites, all of which are in the far north. However overall the following general trends are summarised:

- where there is no increase in carriageway width ("seal as is") there is minimal change in speeds for the higher speed environments but a reasonable increase for the lower speed environments; and
- as the carriageway width increases the after speed increases.

It is also observed that generally the unsealed average speeds are lower than those presently presumed, with only one site having an average speed before sealing exceeding 60 km/h.

Based on the above trends, it is considered that for nationwide application a potential replacement of Table A7.1 of the Project Evaluation Manual could take the following form and subsumed values.

Table 3 : Projected increase in average speed for seal extension projects

UNSEALED SECTION: AVERAGE LIGHT VEHICLE SPEED	INCREASE IN CARRIAGEWAY WIDTH		
	0 m	1 m	2 m
	Speed increase (km/h)		
> 60 km/h	0	5	10
45 - 60 km/h	5	10	20
35 - 45 km/h	10	15	25
< 35 km/h	15	20	30

Note that the shading represents extrapolated or subsumed values.

5. CONCLUSION

Given the range of sites acceptable and the effect of budget constraint on the survey procedures and observation time, the undertaking of the surveys on sections of rural road prior and subsequent to sealing extension works has been successful.

The derived data has enabled a new table to be developed in accordance with the key research objective, to replace Table A7.1 of the Project Evaluation Manual, being the prediction of average speed on an unsealed rural road after sealing extension works have been completed.

6. RECOMMENDATION

6.1 It is recommended that the proposed replacement table is initially adopted to supersede Table A7.1 of the Project Evaluation Manual.

6.2 It is recommended that surveys of those sections where sealing has yet to be completed is undertaken in due course, and advised to Transit NZ / Transfund.

6.3 It is also recommended that Transfund utilise the occupancy data per vehicle type in order to update the appropriate portions of the relevant tables in the Project Evaluation Manual.

7. REFERENCES

Project Evaluation Manual. Formerly produced by Transit NZ now under the ownership of Transfund.

APPENDIX

	BEFORE		NATIONWIDE			AFTER						BEFORE		FAR NORTH			AFTER			
SPEED	light	all	heavy	excl.	SITE	light	all	heavy	excl.		SPEED	light	all	heavy	excl.	SITE	light	all	heavy	excl.
mean	29.8	27.9	22.9		NO.	32.5	30.9	23.0			mean	48.1	45.5	19.8		NO.	61.7	60.1	51.4	
std dev	5.1	6.5	7.1			5.0	5.9	3.5			std dev	5.8	10.2	#DIV/0!			12.1	12.0	7.8	
number	23	32	9	3	1	15	18	3	0		number	10	11	1	2	20	22	28	4	0
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	46.4	48.2	61.2			64.7	63.8	62.6			mean	52.1	52.1	#DIV/0!			84.5	83.5	75.3	
std dev	11.0	12.4	19.5			10.1	11.3	13.1			std dev	22.8	22.8	#DIV/0!			7.7	8.0	5.6	
number	15	17	2	3	2	17	29	12	6		number	11	11	0	3	21	32	36	4	8
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	54.3	47.7	36.6			61.0	65.2	81.8			mean	54.1	54.1	#DIV/0!			55.0	57.7	74.7	
std dev	9.1	12.6	9.7			17.5	17.9	6.5			std dev	14.0	14.0	#DIV/0!			8.0	10.3	5.5	
number	10	16	6	3	3	8	10	2	0		number	31	31	0	6	22	19	22	3	1
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	59.1	59.1	#DIV/0!			76.6	74.1	72.1			mean	39.0	39.0	#DIV/0!			33.1	33.1	#DIV/0!	
std dev	11.2	11.2	#DIV/0!			11.0	11.8	12.5			std dev	12.9	12.9	#DIV/0!			7.7	7.7	#DIV/0!	
number	31	31	0	1	4	9	20	11	2		number	18	18	0	3	23	5	5	0	1
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	48.9	48.6	43.0			66.7	64.5	57.1			mean	43.7	43.7	#DIV/0!			63.5	63.5	#DIV/0!	
std dev	7.4	7.3	#DIV/0!			14.8	15.6	16.0			std dev	10.7	10.7	#DIV/0!			10.4	10.4	#DIV/0!	
number	21	22	1	5	5	127	165	38	107		number	5	5	0	2	24	10	10	0	1
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	47.3	47.3	#DIV/0!								mean	30.3	30.3	#DIV/0!			56.3	56.3	#DIV/0!	
std dev	9.4	9.4	#DIV/0!			#DIV/0!	#DIV/0!	#DIV/0!			std dev	7.4	7.4	#DIV/0!			6.5	6.5	#DIV/0!	
number	11	11	0	3	6	0	0	0	0		number	21	21	0	0	25	27	27	0	2
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	46.4	47.2	52.8			72.5	71.2	68.6			mean	44.5	43.1	31.9						
std dev	13.2	13.0	11.7			8.2	9.3	10.8			std dev	14.2	13.9	#DIV/0!			#DIV/0!	#DIV/0!	#DIV/0!	
number	32	36	4	16	7	29	44	15	10		number	8	9	1	3	26	0	0	0	0
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	50.3	43.9	42.0			72.5	66.2	61.8			mean	58.3	58.3	#DIV/0!			55.0	54.8	49.8	
std dev	9.9	11.2	10.9			13.1	15.6	15.9			std dev	11.0	11.0	#DIV/0!			10.9	10.8	#DIV/0!	
number	16	70	54	0	8	16	39	23	0		number	25	25	0	1	27	26	27	1	0
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	73.1	73.7	78.3			72.8	72.4	65.1			mean	33.7	33.7	#DIV/0!			43.3	43.2	42.3	
std dev	12.3	12.0	9.1			13.5	13.9	19.5			std dev	7.7	7.7	#DIV/0!			9.2	8.9	2.5	
number	84	94	10	1	9	83	88	5	6		number	18	18	0	1	28	44	47	3	1
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	56.0	55.0	48.8			59.7	58.8	53.4			mean	54.5	54.5	#DIV/0!			47.4	47.2	40.7	
std dev	9.7	10.9	21.2			11.7	11.0	2.8			std dev	11.3	11.3	#DIV/0!			12.9	12.7	#DIV/0!	
number	13	15	2	2	10	12	14	2	0		number	39	39	0	2	29	24	25	1	8
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	48.7	48.9	50.7			51.7	51.7				mean	#DIV/0!	#DIV/0!	#DIV/0!			#DIV/0!	#DIV/0!	#DIV/0!	
std dev	14.0	13.4	7.0			11.8	11.8	#DIV/0!			std dev	#DIV/0!	#DIV/0!	#DIV/0!			#DIV/0!	#DIV/0!	#DIV/0!	
number	20	22	2	0	11	15	15	0	5		number	0	0	0	0	30	0	0	0	0
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	31.3	31.9	37.3								mean	39.6	39.6	#DIV/0!						
std dev	4.8	4.9	#DIV/0!			#DIV/0!	#DIV/0!	#DIV/0!			std dev	12.3	12.3	#DIV/0!			#DIV/0!	#DIV/0!	#DIV/0!	
number	9	10	1	0	12	0	0	0	0		number	25	25	0	6	31	0	0	0	0
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	30.0	31.6	37.2			43.2	42.4	37.3			mean	50.0	50.0	#DIV/0!			53.9	53.5	51.1	
std dev	5.9	6.0	2.2			11.6	11.0	4.3			std dev	6.5	6.5	#DIV/0!			5.0	4.8	2.3	
number	7	9	2	5	13	12	14	2	4		number	27	27	0	1	32	26	30	4	0
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	28.6	27.8	25.5			43.5	40.6	33.1			mean	55.2	55.2	#DIV/0!			58.8	56.6	48.3	
std dev	7.1	6.5	3.6			6.5	7.7	5.2			std dev	12.0	12.0	#DIV/0!			12.2	12.7	13.2	
number	12	16	4	2	14	13	18	5	2		number	8	8	0	1	33	11	14	3	4
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	29.6	29.5	25.3			34.5	34.5				mean	53.6	52.9	47.4			60.4	60.8	63.1	
std dev	5.4	5.4	#DIV/0!			3.2	3.2	#DIV/0!			std dev	6.3	6.3	0.9			12.1	11.6	#DIV/0!	
number	33	34	1	0	15	16	16	0	3		number	14	16	2	2	34	12	13	1	1
SPEED	light	all	heavy			light	all	heavy			SPEED	light	all	heavy			light	all	heavy	
mean	38.2	38.2	#DIV/0!			47.0	45.8	38.1			mean	50.9	50.9	#DIV/0!			43.2	42.5	35.3	
std dev	8.7	8.7	#DIV/0!			5.4	5.9	0.5			std dev	11.0	11.0	#DIV/0!			15.1	14.5	#DIV/0!	
number	18	18	0	3	16	12	14	2	2		number	8	8	0	5	35	10	11	1	5
all sites	light	all	heavy			light	all	heavy			all sites	light	all	heavy			light	all	heavy	
except 8														20,26,34					sites 1 & 34	
mean spd	44.5	44.2	43.3			54.6	53.9	53.1			mean spd	48.4	48.1	33.0			55.0	54.7	57.3	