University of Southern Queensland

Faculty of Engineering and Surveying

RURAL ARTERIAL ROAD OPERATING SPEED ASSESSMENT

A dissertation submitted by

Timothy Noel Taylor

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Abstract

From the early last century, engineers have been designing roads to cater for the speed of motorised transport. This led to the development of the design speed approach, where a road link is designed based on a single theoretical speed. International research over the past few decades has found that actual speeds of vehicles often exceeded the design speed and that this has contributed to poor safety performance of some roads.

Since the 1970's road authorities around the world have been developing methodologies for predicting the actual speed that vehicles will travel on a road. In Australia, this began with the development of the Speed Environment Model in 1980 and continues with the ongoing evolution of the Operating Speed Model.

This dissertation has reviewed current international practice regarding the use of operating speed and design speed and has compared it with the methodology currently used in Australia. The Operating Speed Model has been reviewed in detail.

A new spreadsheet tool was developed to provide assistance to designers using the Operating Speed Model. This is the Operating Speed Interactive Spreadsheet Tool or OSIST. OSIST was used in a case study to apply the Operating Speed Model to a rural arterial road upgrade being planned by the Queensland Department of Main Roads.

The Operating Speed Model is a robust methodology for predicting operating speeds (or 85^{th} percentile speeds) along a road alignment. However, this dissertation has highlighted areas where the details of the methodology need to be further developed.

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Timothy Noel Taylor

Student Number: 0019220677

Signature

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Date

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1. Introduction

Predicting the speed of a vehicle on a proposed road alignment is a critical part of the road design process. Research over the past few decades around the world has found that predicting the operating speed along the alignment is an iterative process. Previously roads have been designed by setting a design speed for a road alignment. Minimum horizontal curves and superelevation would then be designed based on this design speed. Minimum vertical curves and sight distance analysis would also be based on the design speed.

The issue with design speed is that on long straights and large radius curves it has little meaning. A vehicle travelling on such elements is not going to be constrained by the design speed. The operating speed of vehicles travelling on these elements may tend to exceed the design speed. The motorist will increase to a speed that they feel is appropriate for the road geometry, surrounding terrain and to some extent the speed limit. This speed may exceed the design speed which has been used to design the tighter radius curves. This results in an inconsistent design, where a vehicle is approaching a curve at a speed that exceeds the safe operating limit of that curve, an example of which is shown in Figure 1.1.

This has led to the development of an iterative design process to predict the actual driver speed and ensure that:-

1. the alignment is consistent with the expectations of motorists using the alignment;
2. superelevation and sight distance design is based on the predictions of actual driver speed rather than an arbitrary design speed.

In Australia this design process is the Operating Speed Model. This was first introduced by VicRoads in 1994. This model has been included as a national road design approach by Austroads in 2003, after some development of the Speed Environment Model. The Queensland Department of Main Roads is also now using the Operating Speed Model with some minor modifications.

The objectives of this dissertation are:-

- to examine the development of speed analysis methods used internationally
- to compare speed analysis methodologies currently employed in Australia
- to develop a design tool that complies with the Operating Speed Model used by the Queensland Department of Main Roads
- highlight areas of for further development with the Operating Speed Model used by the Queensland Department of Main Roads
- conduct a case study using the developed design tool

Figure 1.1 Example of Design Inconsistency

2. Literature Review

2.1 Operating Speed

2.1.1 Definition of Operating Speed

Operating speed is based on a statistical measure of actual driver speeds on roadways with various characteristics. The statistical measure that appears to be almost universally accepted is the 85th percentile of the speed distribution curve, as shown in Figure 2.1.

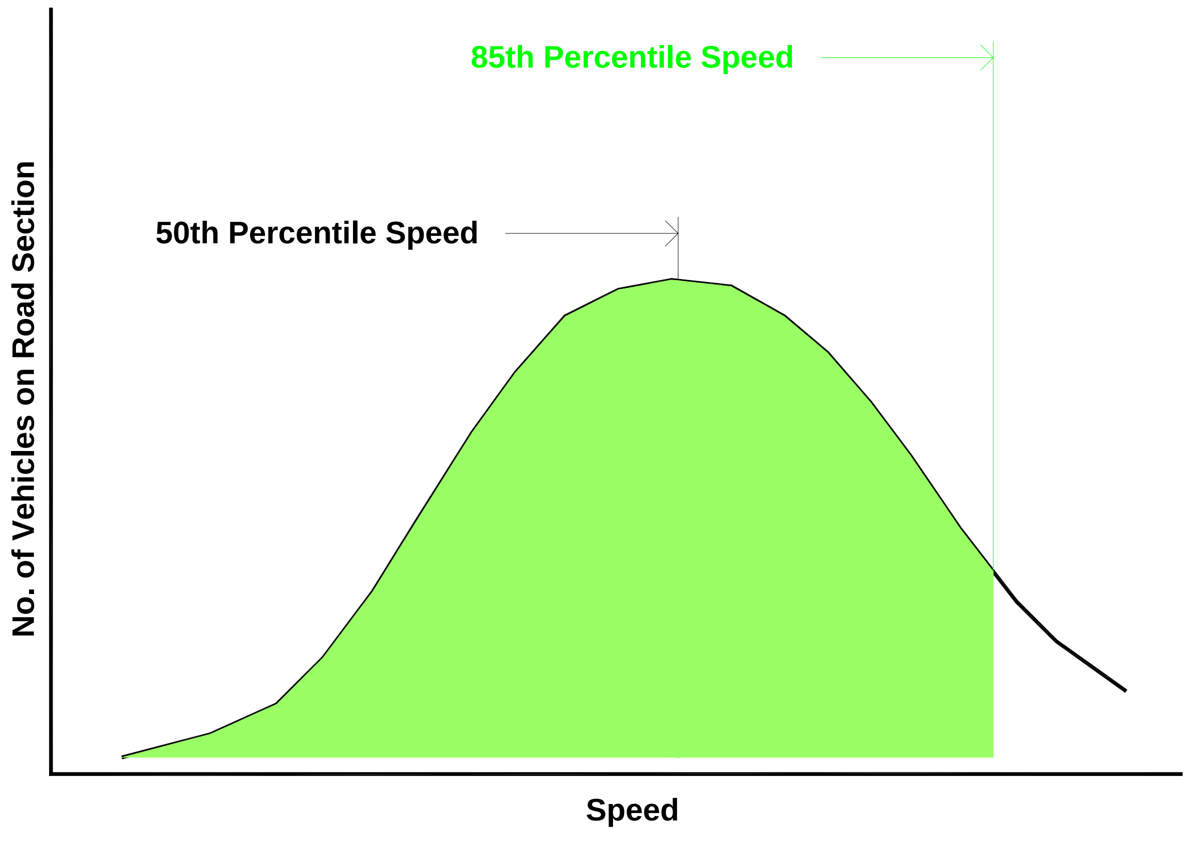


Figure 2.1 – Typical Speed Distribution Curve

An additional characteristic of the operating speed is that occurs under free flow conditions, where the driver is able to select what he feels to be an appropriate speed.

NCHRP[8] defined the operating speed as "the speed at which drivers are observed operating their vehicles during free flow conditions. The 85th percentile is the most frequently used descriptive statistic for the operating speed associated with a particular location or geometric feature."

Both of the Australia publications reviewed in this dissertation agree with this definition. Refer to Chapter 3 for a detailed discussion of these publications.

Fitzpatrick et al[6] provides a comprehensive list of definitions for operating speed since the 1950's. AASHTO[9] stated that the operating speed will not exceed the safe speed as determined by the design speed. Commenting on this definition, Fitzpatrick et al[6] said that this assumptions loses validity as the functional classification of the roadway decreases.

2.1.2 Relationship with Posted Speed Limit

Fitzpatrick et al[6] discusses the relationship between operating speed and the posted speed limit. The 85th percentile operating speed is generally accepted to exceed the posted speed limit and most research seems to suggest by around 10%. Even the 50th percentile speed (that is the mean speed) is noted to be just above the posted speed limit.

With regard to a link between operating speed and posted speed limit, there appear to be two sides to the debate. One states that drivers will operate their vehicles at a comfortable and safe speed with little regard paid to the speed limit. Others argue that the abovementioned statistical relationships between operating speed and speed limit are as a result of the average motorist's perception of the level of enforcement of the posted speed limit to avoid a fine.

Parker[10] has studied this in some detail at a site where the speed limit was changed and stated that resultant change in operating speed was "not sufficiently large to be of practical significance".

However, Parker[10] qualified this conclusion by stating that the sites selected were determined by local agencies according to certain criteria and therefore could not be considered a random sample.

Fitzpatrick et al[6] conducted a more conclusive study and did find a relationship between posted speed limits and operating speed. Table 38 of that report details regression equations for various functional classes of road. For example, for rural arterial roads this relationship is defined by:-

$$ES_{85} = 36.453 + (0.517 \times PSL) \quad (2.1)$$

where ES_{85} is Estimated 85th Percentile Speed (mph)

PSL is Posted Speed Limit (mph)

2.2 Design Speed

2.2.1 Development of the Design Speed Approach

Historically, geometric road design has been undertaken on the basis of a selected “design speed”. Traditional design speed methodology applies a selected speed to a road link which is then designed to suit that speed. The use of design speed was developed in the 1930’s. Young[11] sated that roads should be planned with “all curves superelevated for the same theoretical speed. Barnett[12] stated that design speeds should be selected based on “the reasonable uniform speed that would be adopted by the faster driving group of vehicle operators”.

Hans Lorenz used this approach in the 1930’s designing autobahns in Germany with smooth continuous mathematically defined road curves that could be driven at a constant speed. The curves were designed based on a specific design speeds (typically 80, 100 and 130km/h). Interestingly, in Germany in the 1970’s research found that actual vehicle speeds often exceed these traditional design speed values.

2.2.2 Definition of Design Speed

The definition of “design speed” has varied and developed around the work since geometric road design using applied scientific principles commenced in the 1930’s. To illustrate the development of this definition it is interesting to note the following definitions from North American design manuals.

“The maximum safe speed that can be maintained over a specified section of highway when conditions are so favourable that design features of the highway govern. The assumed design speed should be a logical one with respect to the character and terrain of the type of highway. Every effort should be made to use as high a design speed as practicable to attain a desired degree of safety, mobility and efficiency”. (AASHO[13])

“A speed selected as a basis to establish appropriate geometric design for a particular section of road” (TAC[14])

A selected speed used to determine the various geometric features of the roadway”. (AASHTO 2001)

Morrall and Robinson[4] noted that three common principles are found in most definitions of design speed:-

1. Highest speed a motorist can travel
2. Speed at which a motorist is safe or comfortable
3. Speed resulting from the influence of geometric features

They also note that research from around the world has found that actual speeds often exceed traditional arbitrarily selected design speeds less than about 90km/h.

2.2.3 Design Speed Safety Issues

The under-estimation of design speeds is a critical safety issue. The energy to be dissipated by a vehicle and the sight distance required it’s driver is proportional to the square of the speed of the vehicle. The energy to be dissipated and the sight distance required for a vehicle travelling at 130km/h is twice that for a vehicle travelling at 90km/h.

Morrall and Robinson[4] stated that 75,000 people are killed on rural roads in OECD countries each year, 35% of which are single vehicle accidents. These accidents are predominant due to excessive speeds that cannot be safely maintained over the length of the alignment. Many such roads (especially in developing countries) have historical origins and inconsistent design characteristics which require constant monitoring and adaptation by the driver, increasing the risk of errors in judgement. As driving speeds are strongly influenced by geometric elements it should be possible in principle to control speed through the appropriate selection of geometric design standards.

2.3 Design Consistency

2.3.1 Inconsistent Design Implications for Road Safety

There has been considerable study undertaken over the last decade with regard to the consistency of the geometric design of a road with what the driver would expect from the road. Inconsistent design introduces an unexpected situation to the driver – usually a curve with a smaller radius and higher side friction demand than expected. This requires a higher level of decision making and attention by the driver and therefore increases the probability of the driver making an error in judgement, undertaking an unsafe manoeuvre and causing an accident.

For these reasons, Lamm et al[17] introduced measures of road design safety that relate directly to design consistency. These are as follows:-

- Safety Criterion I – Achieve Design Consistency
- Safety Criterion II – Achieve Operating Speed Consistency
- Safety Criterion III – Individual Curved Roadway

These criteria incorporate the concept of "relation design" which provides a quantitative measure of the alignment's consistency. This concept is not discussed further in this dissertation.

2.3.2 Limitations of Design Speed

Krammes[5] discussed the selection of appropriate design speeds as outlined in AASHTO[15], which states in part that "the design speed should fit the travel desires and habits of nearly all drivers" and should "be a high percentile value in the speed distribution curve". This definition does correspond to a degree with the operating speed definition discussed previously.

However, AASHTO[15] also states that "there should be no restriction on the use of flatter horizontal curves … where such improvements can be provided as part of an economical design". Such design freedom does not take into account the need for design consistency in the alignment.

The design speed concept presumes that a design will be consistent if each element of the alignment shares the same design speed. The fundamental limitation with this design philosophy is that the design speed has no practical meaning on straights.

McLean[16] found that 85th percentile speeds for curves with design speeds less than 90km/h were consistently faster than the design speed. Interestingly, for curves with design speeds greater than 90km/h, the 85th percentile speeds were consistently less.

Krammes[5] also noted that curves with lower design speeds have 85th percentile speeds greater than the design speeds. The side friction demand for 85th percentile speeds are substantially greater than the maximum side friction nominated for curves with design speeds less than 90km/h.

Fitzpatrick et al[6] also found that operating speeds on rural roads were higher than design speeds when the design speed was less than about 90km/h.

2.3.3 Design Consistency on Successive Horizontal Elements

Design consistency is especially relevant to the operating speed on successive horizontal elements, for example, a long straight followed by a tight curve. FHWA[3] demonstrated clearly that there is a much stronger link between accident frequency and speed reduction between successive elements than on horizontal curvature alone. Where the speed reduction was between 10 and 20km/h the accident frequency is over three times higher than when the speed reduction is less then 10km/h. Where the speed reduction is greater than 20km/h, the accident frequency is over six times higher.

FHWA[3] had the objective of providing a basis for predicting the operating speed for different combinations of horizontal and vertical geometry. Data was gathered from over 200 sites on two-lane rural highways. Statistical analysis was undertaken to determine 85th percentile speeds for free flowing traffic conditions. The study found that operating speeds on large radii curves (>800m) and long straights varied from 93 to 104km/h. The operating speed drops dramatically when the curve radius drop below about 250m.

This study also found that there is a strong relationship between design consistency and safety. This does provide clear evidence that inconsistent geometric design is a significant contributor to accidents on two lane rural roads. Minimising such speed reduction on successive elements provides are more effective (and usually more economical) method of improving the safety performance of rural roads.

2.3.4 Effectiveness of Advisory Signs

Design consistency issues could be resolved by increasing driver expectancy with appropriate signage. Krammes[5] discussed the use of advisory speed signs on curves. He stated that they have the lowest compliance rates of all traffic control devices. At most curves, posted advisory speeds were well below prevailing traffic speed.

Signage should therefore be considered no more than a supplement to other methods to solve design consistency issues. The most effective solution is to introduce speed reduction curves.

2.3.5 Design Consistency in the United Kingdom

Morrall and Robinson[4] discussed design consistency methodology used in the United Kingdom. In England, rural road alignments are used which are based on roads that have been in existence for centuries and are often constrained by landmarks and features of historical and cultural importance. U.K. design standards place a limit on a "bendiness" value which is a function of the degree of curvature per kilometre and the harmonic mean of available sight distance.

Design speeds are related to statistical measures of actual design speeds. A design speed is corresponds with the 85th percecntile speed, while the next lowest design speed with the 50th percetile speed and the next highest design speed with the 99th percetile speed.

2.3.6 Design Consistency and the Operating Speed Model

Morall and Robinson[4] found that European countries and Australia incorporate a feedback loop into the design process to identify and resolve design consistency issues. In Australia, this iterative process is part of the Operating Speed Model, which will be discussed in the next chapter.

3. Australian Speed Assessment Practice

3.1 Introduction

This section reviews the development of speed assessment methodologies in Australia. The review specifically reviews the speed assessment methodologies currently implemented by Austroads and the Queensland Department of Main Roads.

3.2 Speed Assessment Philosophy

Determining the operating speed of vehicles on a section of road is intrinsic to geometric road design. All the geometric parameters of the road are based on the "design speed" of a section of road. This is related to the operating speed or 85th percentile speed – that is the maximum speed at which 85% of drives will choose. Austroads[1] states that the 15% of drivers who exceed this speed are assumed to be aware of the increased risk they are taking and will thus reduce their reactions times. Both Austroads[1] and Main Roads[2] highlight the impracticability (particularly in economic terms) of designing roads to cater for 100th percentile speed.

Where geometric elements are designed for 100km/h or less, drivers will vary their speed over different sections of the road. However, on these roads, the operating speed on straights and large radius curves will exceed the design speed of isolated elements with more constrained geometry. Main Roads[2] states that this situation results in an increase of accidents.

3.3 The Speed Environment Model

Prior to the development of the Speed Environment Model, the design speed of a significant length of road would be based on the safe operating speed of the more constrained sections of road. However, the operating speed on less constrained sections of the road would then surpass the design speed, resulting in vehicles attempting to negotiate constrained geometric sections at a speed higher than the design speed.

Main Roads[2] states that research in the late 1970's led to the development of the Speed Environment Model. This research showed that drivers' choice of an operating speed is primarily due to their perception of horizontal geometry and also the surrounding topography. It also found that vertical geometry and sight distance have little effect on the operating speed.

The Speed Environment Model was not well implemented in Australia due to its complexity and the subjectiveness with which it can be applied. VicRoads, the road authority for the State of Victoria, developed the Operating Speed Model in 1994. For the abovementioned reason, it was adopted by Austroads and the Queensland Department of Main Roads in lieu of the Speed Environment Model in 2003.

3.4 The Operating Speed Model

Main Roads adopted a modified version of the Operating Speed Model in 2003. Until 2007, Main Roads stipulated that the operating speed was to be assessed element by element. However, the 2007 update of Main Roads[2] incorporates the use of "section operating speeds" as defined in Austroads[1]. This is an area where Australian practice appears to differ from international practice. These are discussed later in this dissertation.

3.4.1 Definitions and Implementation

Main Roads[2] and Austroads[1] have similar definitions of operating speed. Austroads[1] states that operating speed is the 85th percentile speed of vehicles when traffic volumes are low. Main Roads[2] states that the operating speed is the 85th percentile speed of vehicles under free flowing conditions past a nominated point.

Main Roads[2] states that an improvement to the cross section as a result of a widening project will increase operating speed. This relates to the width of the entire pavement formation. Austroads[1] discussion of cross section is limited to lane widths – it actually stipulates a reduction in operating speed of 3km/h for lane widths less than 3m.

Austroads[1] also recommends reducing operating speed estimates by 5 to 10km/h on poor pavements. So, the implication is that a pavement rehabilitation project which renews a poor pavement could increase operating speed by the same amount, moving the operating speed closer to the practical limits of the geometry.

3.4.2 Additional Speed Definitions

Main Roads[2] introduces further speed definitions as part of the speed assessment process.

Target Speed

The "target speed" is an indicative operating speed for a road link that is set at the network planning level and is generally related to road function as well as community and political aspirations for the link.

Desired Speed

The "desired speed" is numerically equivalent to the Speed Environment under the previous Speed Environment Model. It is the speed drivers will choose for less geometrically constrained elements of a reasonably uniform section of road and generally relates to the surrounding topography, road characteristics and the speed limit. There may be an isolated element of the section of road through which a driver will typically travel faster (e.g. an overtaking lane) or slower (e.g. tight radius) than the desired speed for the section.

The desired speed is measured as the 85th percentile speed on long less constrained sections of the road. These lengths need to be long enough so drivers will settle into a constant speed.

On sections of road of a high geometric standard, the speed limit is more influential on desired speed and this will generally be 10km/h more than the speed limit. The driver's perception of speed enforcement activity also has a bearing on operating speed, as Main Roads[2] states that in remote areas operating speed may be up to 20km/h higher than the speed limit.

On sections of road with a lower geometric standard, the horizontal geometry will have a greater influence on the desired speed. On these roads, drivers will increase speed on straights and large radius curves and reduce speed as required by their perception of horizontal curvature. Main Roads[2] highlights the importance of not exceeding the maximum decrease in design speeds between successive horizontal elements. Austroads[1] focuses on the use of Section Operating Speeds, where a section is a combination of reasonably similar geometric elements. When entering a curve a driver will reduce speed to suit the curve or match the section operating speed.

Main Roads[2] notes that when realigning a section of road it is necessary to take into account the desired speed of the existing road 1.5km beyond each end of the realignment, including likely future upgrades of these sections. Main Roads[2] suggests that on steep grades, horizontal geometry should be used to limit the desired speed in order to minimise speed differentials between light and heavy vehicles.

Design Speed and Design Value

The “design speed” is the speed adopted for the calculation of various design parameters and it must be greater than or equal to the operating speed for the particular horizontal element.

The “design value” as defined in Austroads[1] is similar, although being greater than or equal to the operating speed is implied rather than stated. It states that the operating speed for each element of the road will in effect set the design value for that element.

Limiting Curve Speed

The “limiting curve speed” is the maximum speed that the curve can be negotiated given a particular combination of radius and superelevation. It is the case where the side friction demand equals the absolute maximum.

Section Operating Speed

Main Roads[2] and Austroads[1] have a similar methodology for identifying sections of reasonably consistent geometry and determining if individual elements should be stand alone sections. Both publications also have the same table of Section Operating Speeds with a corresponding range of curve radii, or a corresponding single curve radius. Main Roads[2] relates "section operating speed" with "desired speed", indicating that the "section operating speed" may be capped at the desired speed rather than that shown in the table.

3.4.3 Speed Prediction Graphs

Both publications have the same graph for predicting vehicle acceleration on straights or large radius curves (Main Roads[2] Figure 6.9.2(a) and Austroads[1] Figure 7.2) and the same deceleration on curves graph (Main Roads[2] Figure 6.9.2(b) and Austroads[1] Figure 7.3).

The exception is that Main Roads[2] provides for increased acceleration rates at speeds less than 70km/h up to about 80km/h. This is a significant increase from the acceleration rates shown in Figure 7.2 in Austroads[1]. This discussed in more detail in Chapter 5 of this dissertation.

Copies of these figures from both publications are included in Appendix B.

4. Speed Assessment Design Tools

4.1 Interactive Highway Safety Design Model (U.S.)

The Interactive Highway Safety Design Model (IHSDM) is a suite of software developed by the Federal Highway Administration in the U.S. It is specifically for the evaluation of geometric design decisions on two-lane rural highways. The software contains various modules such as crash prediction, intersection and traffic analysis, driver behaviour, automatic checks of design values and design consistency.

The latter is the module of most relevance to this dissertation. The Design Consistency Module of the IHSDM produces a speed profile at each point along the road alignments based on 85^{th} percentile speeds on curves, desired speeds on long straights, acceleration and deceleration rates, and also takes into account vertical grades. The module identifies two design consistency issues:-

- Differences between assumed design speed and 85^{th} percentile speed
- Differences in 85^{th} percentile speeds between successive elements.

Horizontal curves that don't meet design criteria (or design 'policy' to use U.S. terminology) are highlighted so that the designer can make corrective adjustments to the alignment design.

4.2 OSroad (Australia)

The Queensland Department of Main Roads is currently finalising the development of OSroad software that can develop an operating speed profile along a road alignment. This will enable alignments to be assessed quickly, particularly as part of the concept phase so that operating speed inconsistencies can be identified and addressed before designs are further developed into preliminary design.

The software can work within the 12D road design software and follows the methodology outlined in Main Roads[2]. It also highlights any horizontal element that does meet certain design criteria or rules so these can be addressed.

4.3 Development of a New Design Tool

4.3.1 Objectives of the Design Tool

Conducting and operating speed assessment on a long road alignment is a demanding iterative process and can be particularly time exhaustive if a number of options need to be assessed. Main Roads recent development with OSRoad will save designers and engineers considerable time.

It is not the objective of this project to produce a design tool to compete with OSRoad in terms of functionality. The main purpose of this tool is to allow designers to conduct an operating speed assessment interactively and clearly observe the workings of the operating speed model. The process of compiling this tool enabled the author to review the operating speed model in considerable detail and find aspects of the methodology that may require further explanation and possibly research.

4.3.2 Choice of Development Software

One of the key objectives of this project is to prepare a design tool for use by technicians and engineers for the assessment of operating speed on two lane rural roads. This was to be developed in accordance with the operating speed assessment methodology outlined in Main Roads[2]. There was a choice of two proprietary software products in which to develop the tool: MATLAB and Microsoft Excel.

MATLAB has a much higher level of mathematical modelling capability than Excel. It can be used to produce regression curves for statistical relationships between various design parameters (for example, operating speed and curve radius). The desired functionality of the design tool may likely be produced more efficiently in MATLAB.

Routines developed in MATLAB can be readily transferred into standard programming languages such as Visual Basic or C++.

Microsoft Excel is more cumbersome for mathematical modelling. However, it has a strong advantage with its availability. The software is readily available by almost everyone and is comparatively inexpensive. MATLAB is more expensive software that is generally used for high level statistical analysis and mathematical modelling. Generally, it is only available and familiar to specialist users.

Microsoft Excel has the functionality and flexibility to produce an interactive design tool. It also has adequate logic, referencing and linear regression capability which was important to the development of the design tool.

Determination of operating speed is an approximation and prediction of actual driver speeds along a road alignment, so precise calculations are not critical. The information provided in Main Roads[2] with respect to changing operating speed between alignment elements is generally tabulated or could easily be derived by linear interpolation. This was decided to be an effective strategy for the development of an interactive design tool.

Microsoft Excel was chosen to develop an interactive design tool due to its general availability, its almost universal familiarity, and the nature of the data provided by Main Roads. The design tool was named the Operating Speed Interactive Spreadsheet Tool (OSIST).

5. Operating Speed Interactive Spreadsheet Tool (OSIST)

5.1 Functionality and Limitations of OSIST

The Operating Speed Interactive Spreadsheet Design Tool (OSIST) requires the designer to input the horizontal alignment data, that is, the radius and the length of each element (transitions are not entered). OSIST is currently limited to fifty horizontal alignment elements.

Based on this horizontal alignment data, OSIST:-

- Determines a "desired speed" for the alignment;
- Splits the alignment into sections; and
- Determines the Section Operating Speed for each section.

The user is then also required to input the approach speed to the start of the alignment. The user may also enter acceleration parameters, but there are default values as set out in Main Roads[2]. OSIST will then determine an operating speed for each element. There are a number of checks to ensure that the operating speed is not underestimated.

Using the operating speeds along the alignment, the tool analyses the alignment for design inconsistencies in terms of maximum side friction increases and speed reduction between successive elements.

OSIST allows the user to change the horizontal alignment data, the approach speed or the acceleration parameters interactively and the above analysis will update instantly.

There are other critical alignment design parameters which are not assessed by OSIST. For example, the use of reverse curves, compound curves, curve transitions and broken back curves are not analysed. Also, the coordination of horizontal and vertical geometry, and the design of vertical curves and sight distance is not included.

5.2 OSIST Operations

5.2.1 Horizontal Alignment Data Entry

After initially entering project data into OSIST, the user inputs the horizontal alignment information for each individual element. That is, the radius and length. These are entered as shown in the Table 5.1, which is an extract from the data entry table in OSIST. Radii for straights are entered as "inf" denoting an infinite radius. Elsewhere in the spreadsheet the radii for straights are given values of 1,000,000 to allow numerical calculation.

Table 5.1 – Horizontal Alignment Data Entry

Element	Radius	Length
1	inf	210
2	410	530
3	inf	400
4	2000	510
5	inf	120
6	550	170
7	750	230
8	inf	100
9	510	90
10	360	250

As data for each element is entered, the elements are automatically numbered.

5.2.2 Determination of Desired Speed

After the user has input the horizontal data into OSIST, a "Start Speed" and "Terrain Type" must be entered as shown in Table 5.2. Based on all the information entered, OSIST completes the rest of the information in Table 5.2.

Table 5.2 – Start Speed and Terrain Type

Enter Start Speed	110
Enter Terrain Type	Hilly
Total Length (m)	4640
Radii Range (m)	>600
Desired Speed (km/h)	110

"Start Speed" is the operating speed of vehicles approaching the start of the alignment. This may be derived from an statistical analysis of actual speed readings taken from the section of road approaching the start of the alignment. However, it would usually be based on another speed assessment. Areas to be assessed are usually "problem" areas with constrained alignments that require a detailed assessment to prioritise alignment improvements or other remedial works. The approach sections would tend to be on less constrained alignments and therefore much easier to assess. For example, Main Roads[2] states that a rural road with reasonable pavement condition, long sweeping curves and straights with a speed limit of 100km/h will likely have a consistent operating speed of 110km/h.

The "Terrain Type" is simply the closest description to the surrounding terrain that can be provided by the following options (which the user accesses via a pull down menu):-

- Flat
- Undulating
- Hilly
- Mountainous

The "Total Length" is simply the sum of the lengths of all the horizontal elements entered. "Range Radii" and "Desired Speed" are based on Table 5.3.

Table 5.3 – Desired Speed

Desired Speed					
Horizontal Curve Radii (m)		Design Speed (km/h)			
Range		Flat	Undulating	Hilly	Mountainous
0	75	80	80	75	75
75	300	90	90	85	80
150	500	110	105	95	90
300	500	110	110	110	105
600	inf	110	110	110	110

This table is based on Main Roads[2], Table 6.3.1(b), but modified slightly with extrapolated values to allow OSIST to access information required to determine the desired speed. This table can be edited in the spreadsheet as more information based on further research is provided.

OSIST will analyse each element and determine which ranges of horizontal curve radii it falls within. The ranges overlap so each element will fall within more than one range. The total length of the alignment that fits into each range of curve radii is calculated. The range of curve radii with the greatest length of matching alignment is then used along with user selected terrain type to reference the matching “Desired Speed” from Table 5.3.

5.2.3 Determination of Section Operating Speed

Section Parameters

Table 5.4 shows the range radii of sections that will allow the alignment to be separated into sections. This table is based on Main Roads[2], Table 6.9.2. To aid the analysis process within OSIST, this table also allocates a section category number to each range of curve radii.

Section Assignment

One of the more complex processes within OSIST is the automatic separating of the alignment into sections. To do this, OSIST analyses each element and determines which range of curve radii it would fit within.

Table 5.4 – Section Operating Speeds

Section Operating Speeds				
Category	Radii Range(m)		Single Curve Section Radii (m)	Sect Operating Speed (km/h)
1	45	65	55	50
2	50	70	60	52
3	55	75	65	54
4	60	85	70	56
5	70	90	80	58
6	75	100	85	60
7	80	105	95	62
8	85	115	100	64
9	90	125	110	66
10	100	140	120	68
11	105	150	130	71
12	110	170	140	73
13	120	190	160	75
14	130	215	175	77
15	145	240	190	79
16	160	260	210	82
17	180	285	235	84
18	200	310	260	86
19	225	335	280	89
20	245	360	305	91
21	270	390	330	93
22	295	415	355	96
23	320	445	385	98
24	350	475	410	100
25	370	500	440	103
26	400	530	465	105
27	425	560	490	106
28	450	585	520	107
29	480	610	545	108
30	500	640	570	109
31	530	inf	600	110

Main Roads[2] states that a section may consist of the following characteristics:-

1. A single curve
2. A series of similar curves linked by short straights
3. A long straight
4. A large radius curve

However, Main Roads[2] would appear to allow for additional characteristics of the sections. For example, large radius curves are considered to be practically equivalent to straights. So, OSIST modifies the second characteristic to allow the series of similar curves to also be linked by short large radius curves (that is, lengths less than 200m and radii greater than 530m). So in this case, the short large radius curves have no bearing on the operating speed of the section. They just link the series of similar curves which determine the section operating speed. This is due to the larger radius curves being able to accommodate speeds larger than the smaller radius curves in the section. Also, the length of these curves is short enough that no significant acceleration will occur.

OSIST also allows for a curve of less than 200m in length, with a greater radius than adjacent curves (yet not necessarily greater than 530m) to be included in the same section as the adjacent curves. The reasons for this are the same as for above. It must be noted that this is only for the setting of an operating speed for the element. It does not determine that the series of curves linked by shorter large radius curves is either appropriate or safe. OSIST will also analyse the increase in side friction demand between curves, which will form part of the safety assessment of the alignment.

200m is the critical length stated in Main Roads[2] so that when an element is shorter than this length it may be deemed to be included in adjacent sections. OSIST uses a critical radius of 530m rather than 600m as implied in Main Roads[2]. This is because 530m is at the minimum of the radii range of the highest section category (that is, the category that includes straights) that has a section operating speed of 110km/h. Using 530m as the critical radius will allow OSIST to provide more conservative and yet still reasonable predictions of operating speed along the alignment.

OSIST will assess each short element to see if it meets any of the following criteria:-

- o Criterion 1: Radii > = 530m and Length < 200m

- o Criterion 2: Radii < 530m and Radii >= Radius of previous element and Length < 200m
- o Criterion 3: Radii < 530m and Radii >= Radius of following element and Length < 200m

Elements that meet any of the above criteria will have additional sections assigned as follows:-

- o If the element meets criterion 1, than it will also apply to the section category of the element before or after it.
- o If the element meets criterion 2, than it will also apply to the section category of the element before it.
- o If the element meets criterion 3, than it will also apply to the section category of the element after it.

Note that the maximum Section Operating Speed from Table 5.4 is 110km/h. Main Roads[2] notes that this is the desired speed for “most intermediate speed rural roads and even some low speed rural roads”. So OSIST limits the desired speed and Section Operating Speed to 110km/h.

The result of the section assignment process is that each element will have a number of section categories that they may be assigned to; with the section categories ranked with the highest section category number first. This is shown in Table 5.5.

Section Ranking

The ranking is required because the higher the section category number, the higher the operating speed. So as OSIST groups the elements into sections, it will attempt to form sections with the highest section categories first. Also, where there is a choice for an element to be assigned to a section either before or after it, OSIST will pick the section with the highest operating speed. The sections assigned to each element are ranked as shown in Table 5.5.

Table 5.5 – Ranked Section Categories for Each Element

Element	1	2	3	4	5	6	7	8	9	10
1	**31**	0	0	0	0	0	0	0	0	0
2	**26**	25	24	23	22	0	0	0	0	0
3	**31**	0	0	0	0	0	0	0	0	0
4	**31**	0	0	0	0	0	0	0	0	0
5	**31**	30	29	28	27	0	0	0	0	0
6	**31**	30	29	28	27	0	0	0	0	0
7	**31**	0	0	0	0	0	0	0	0	0
8	**31**	30	29	28	27	26	0	0	0	0
9	**30**	29	28	27	26	0	0	0	0	0
10	**24**	23	22	21	20	0	0	0	0	0
11	**31**	24	23	22	21	20	0	0	0	0
12	**31**	0	0	0	0	0	0	0	0	0
13	**21**	20	19	18	17	0	0	0	0	0
14	31	**21**	20	19	18	17	16	15	14	0
15	**18**	17	16	15	14	0	0	0	0	0
16	31	**21**	20	19	18	17	16	15	14	0
17	**21**	20	19	18	17	0	0	0	0	0
18	**31**	30	29	28	27	21	20	19	18	17

Selected Section Categories are in **bold.**

Section Placement

To place the elements into sections, OSIST matches section categories with the elements before and after. It initially conducts a forward match where it will firstly look for the highest ranking section category of the element in the following element. If it does not find it, it will look for the next highest section category. For example, note Element 16 in Table 5.5. OSIST firstly attempts to find section category 31 in Element 17. It does not find it, so it looks for the next highest section category, 21, which it does find, so a link is created between the two elements.

OSIST will then conducts a reverse match using the same methodology, but starting at the last element and finding links back through the alignment. The reverse match may find different section links to the forward match. For example, Element 11 would link section category 24 with Element 11. So Element 11 has a forward match link of section category 31 with Element 12 and a reverse match link with section category 24 with Element 10. OSIST will select the highest section category, so in this case Element 11 will be grouped with Element 12, with section category 31 (that is, a section operating speed of 110km/h). If Element 11, was grouped with category 24, it would have a section operating speed of only 100km/h which would result in an underestimate of the prediction of the operating speed for Element 11. Considering that Element 11 is a 150m long, 1800m radius curve, followed by a long 8300m radius curve the higher section operating speed is appropriate.

Based on the section categories into which the elements are placed, OSIST will group the elements into sections and determine section operating speeds derived from Table 5.4. This shown in Table 5.6 which builds on the data entered into Table 5.1.

Table 5.6 – Derived Section Operating Speeds

Element	Radius	Length	Section	Section Operating Speed (km/h)
1	inf	210	1	110
2	410	530	2	100
3	inf	400	3	110
4	2000	510	3	110
5	inf	120	3	110
6	550	170	3	110
7	750	230	3	110
8	inf	100	3	110
9	510	90	4	106
10	360	250	5	96
11	1800	150	6	110
12	8300	430	6	110
13	275	120	7	93
14	inf	30	7	93
15	200	70	8	79
16	inf	50	9	93
17	280	130	9	93
18	inf	40	10	110
19	540	100	10	110
20	inf	150	10	110

5.2.4 Determination of Element Operating Speed

The Section Operating Speed is the speed that the 85th percentile driver will attempt to negotiate that section of road. However, based on the approach speed to the section, the actual speed of the first elements of the section may be somewhat higher than the section operating speed.

Also, if the approach speed is lower than the section operating speed, the driver will tend to accelerate through the section (including curves) until section operating speed is achieved.

Classification of Horizontal Elements

In order to conduct the appropriate analysis for each element, OSIST classifies each element according the classes defined in Table 5.7.

Table 5.7 – Horizontal Element Classification

Class A	As<=Os	AND	As<Hs
Class B	As<=Os	AND	As>=Hs
Class C	As>Os	AND	Re<=600
Class D	As=Os	OR	(Re>600 AND Le<200)
As is Approach Speed (km/h) Os is Section Operating Speed (km/h) Hs is lower limit of High Speed Acceleration Zone (km/h) – see Fig 5.1 Re is curve radius (m) Le is element length (m)			

OSIST will conduct an appropriate speed analysis based on the class of the element. The departure speed derived from the speed analysis is then compared with the section operating speed. So, OSIST determines the amount of acceleration or deceleration between each element with respect to the section operating speed. That is the element operating speed will only increase or decrease to match the section operating speed.

Acceleration Zones

OSIST follows the methodology outlined in Main Roads[2]. As highlighted in Chapter 3, the recent release of Main Roads[2] provides a significant addition to the assessment of vehicle acceleration on straights and large radius curves. Main Roads[2] Figure 6.9.2(a) and Figure 7.2 Austroads[1] show the same figure for the prediction of speed increases on straights and large radius curves, except that Main Roads[2] adds a condition for approach speeds less than 70km/h. Main Roads[2] states that when accelerating from speeds of less than 70km/h that acceleration rate will be 1km/h per 5m travelled. This is a substantial increase from the approx 1km/h per 30m travelled provided by Figure 6.9.2(a).

Main Roads[2] does not provide information on the research used to substantiate this increase in acceleration rates for low speeds, but it intuitively seems closer to actual driver behaviour. The desired speed on most rural roads would be tend to be above 90km/h, so if a driver enters a section of road that tends to match that desired speed, it is a reasonable assumption that the driver will accelerate more quickly if the approach speed is lower. This is an area that should be subject to further research and study.

OSIST splits vehicle speeds into three acceleration zones; low speed, transition speed and high speed. The low speed zone is for speeds up to a default value of 70km/h and the acceleration for this zone will be a default value of 1km/h per 5m travelled. The high speed zone is for speeds above the default value of 80km/h. The default values can be changed by the user. The acceleration rates for the high speed zone will match those determined by Main Roads[2] Figure 6.9.2(a). These values have been tabulated by interpolation and are shown in Table 5.8.

Table 5.8 – Speed Increase for High Speed Zone

Initial Speed	Length of Tangent								
	200	300	400	500	600	700	800	900	1000
10	28	38	42	48	54	58	62	66	70
20	33	40	46	52	57	61	64	68	71
30	39	44	50	55	60	64	67	70	73
40	49	52	56	60	64	68	71	74	77
50	58	60	63	66	69	73	76	78	80
60	67	70	72	74	75	79	82	84	85
70	76	79	81	82	83	86	89	91	92
80	85	88	90	91	92	95	97	99	100
90	94	96	99	100	101	103	105	106	107
100	103	106	108	109	110	112	113	114	114
110	112	114	116	117	118	119	120	120	120

The transition speed zone is for speeds between 70km/h and 80km/h. The acceleration rate will vary by linear regression from 1km/h per 5m travelled to the rate determined by Table 5.8. The three acceleration zones are illustrated in Figure 5.1.

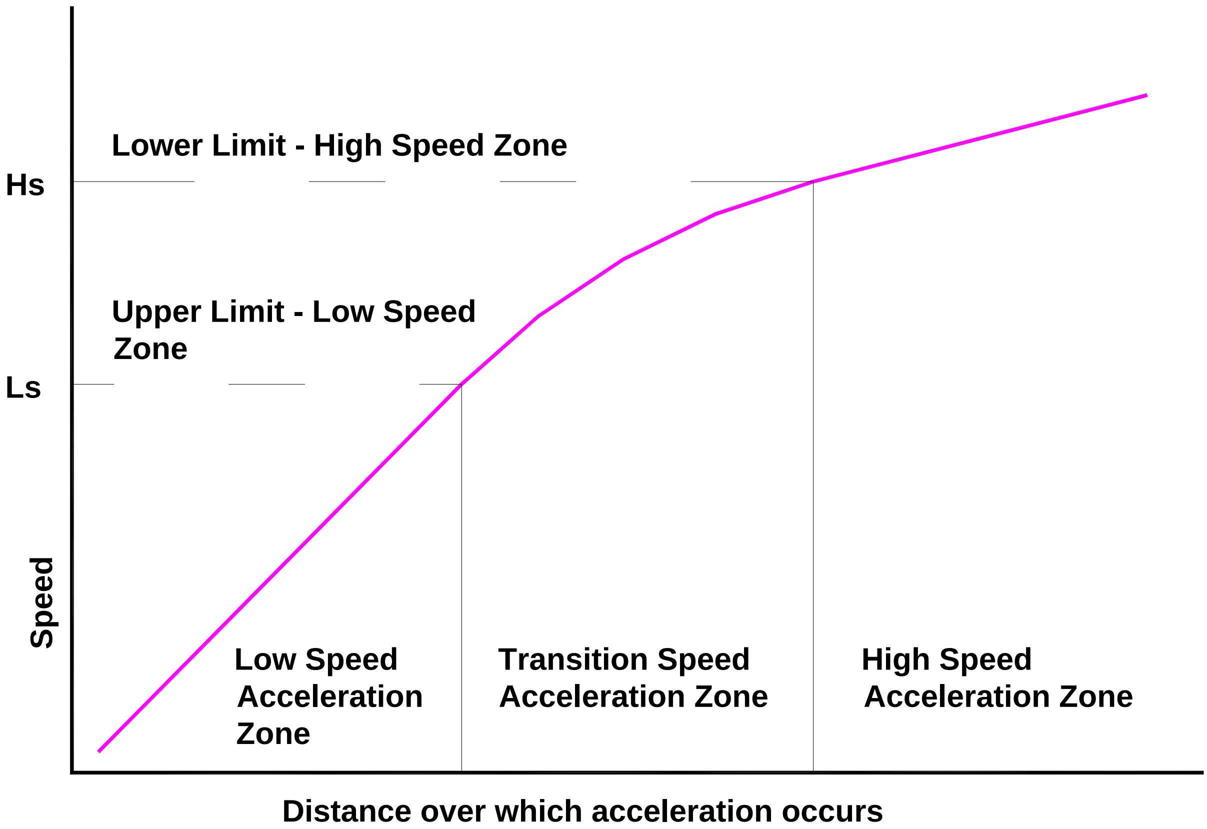


Figure 5.1 – Acceleration Zones

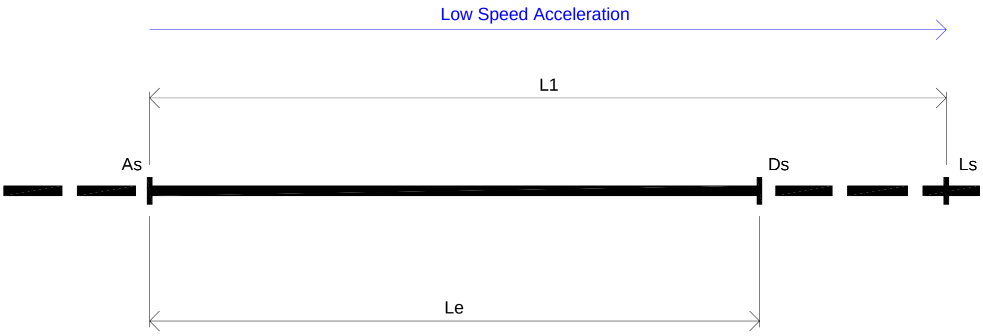
Low Speed Acceleration Analysis

OSIST conducts low speed acceleration analysis for the element if the element classification is A from Table 5.7. The speed at the end of an element will depend on the acceleration rate and the length of the element. If the approach speed to an element is less than lower limit of the high speed zone (default is 80km/h) and is lower than the Section Operating Speed for that element, OSIST conducts a Low Speed Acceleration Analysis for that element.

Low Speed Acceleration Analysis has 5 possible scenarios, each with a different formula for calculating the departure speed from the element. OSIST will determine which of the five different scenarios matches the element. These are illustrated in Figures 5.2(a) – 5.2(e).

OSIST calculates the following acceleration lengths in order to establish which scenario matches the characteristics of the element and therefore the appropriate formula to calculate the departure speed from the element.

- L1 – Acceleration Length 1 – distance travelled from approach speed to Low Approach speed Upper Limit
- L2 – Acceleration Length 2 – distance travelled while accelerating through transition speed zone.
- L3 – Acceleration Length 3 – distance travelled from Low Approach Speed Upper Limit to the end of the element
- L4 – Acceleration Length 4 – distance travelled from approach speed to Transition Approach Speed Upper Limit
- L5 – Acceleration Length 5 – distance travelled from Transition Approach Speed Upper Limit



Scenario 1 - Le < L1

Figure 5.2(a) Low Speed Acceleration Analysis – Scenario 1

Scenario 1 is where the approach speed (As) is lower than the upper limit of the low speed zone (default is 70km/h) and the element length (Le) is shorter than the length required to accelerate to the upper limit of the low speed zone (L1). So, the vehicle accelerates with the low speed acceleration rate (default is 5m per 1km/h) though the entire length of the element. For Scenario 1, the formula for the departure speed is:-

$$Ds = As + ((Le/L1) \times (Ls-As)) \tag{5.1}$$

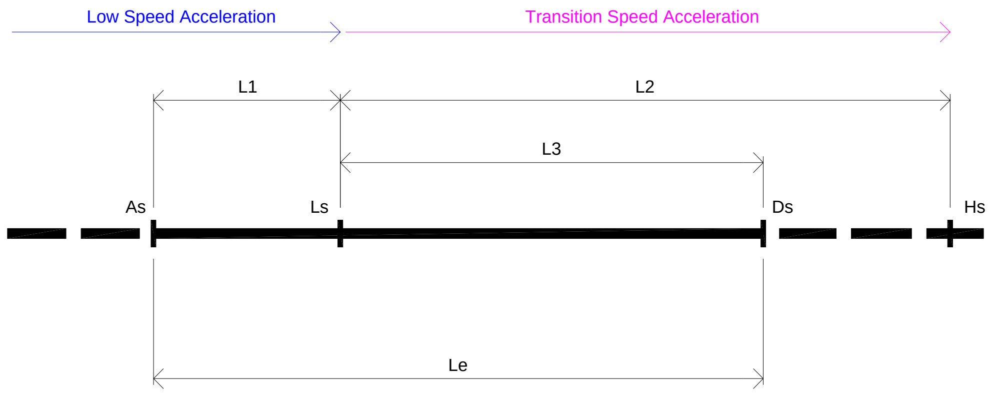
where Ds is departure speed (km/h)

As is approach speed (km/h)

Le is element length (m)

L1 is acceleration length 1 (m)

Ls is upper limit of low speed zone (km/h)



Scenario 2 - Le < L1 + L2

Figure 5.2(b) Low Speed Acceleration Analysis – Scenario 2

Scenario 2 is where the approach speed (As) is lower than the upper limit of the low speed zone (default is 70km/h) and the element length (Le) is longer than the length required to accelerate to the upper limit of the low speed zone (L1), but the length remaining is less than the length required to accelerate through the transition speed zone (L2). So the vehicle begins accelerating with the low speed acceleration rate, but the acceleration rate begins to drop before the vehicle reaches the end of the element. The vehicle does not reach the lower limit of the high speed zone (default is 80km/h). For Scenario 2, the departure speed is:-

$$Ds = Ls + ((L3/L2) \times (Hs-Ls)) \quad (5.2)$$

where Ds is departure speed (km/h)

As is approach speed (km/h)

L2 is acceleration length 2 (m)

L3 is acceleration length 3 (m)

Ls is upper limit of low speed zone (km/h)

Hs is lower limit of upper speed zone (km/h)

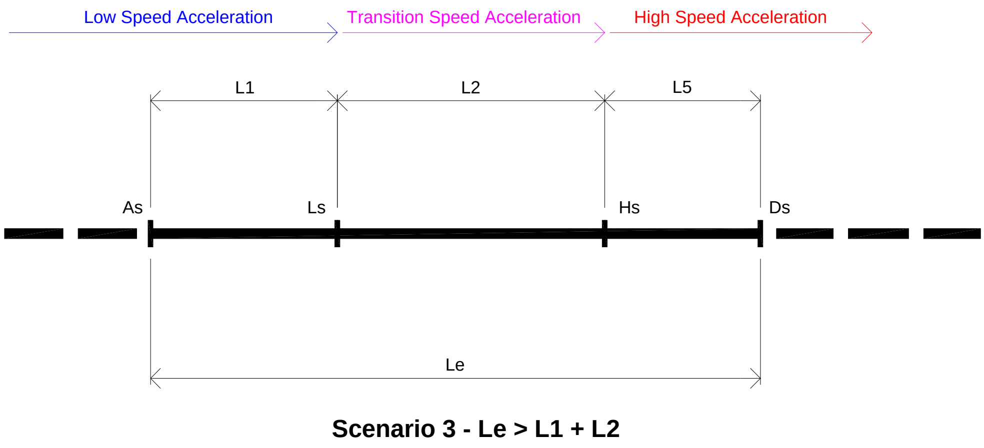


Figure 5.2(c) Low Speed Acceleration Analysis – Scenario 3

Scenario 3 is where the approach speed is lower than the upper limit of the low speed zone (default is 70km/h) and the element length (Le) is longer than the length required to accelerate to the lower limit of the high speed zone (L1 + L2). So the vehicle begins accelerating at the low speed rate and the acceleration rate decreases so that by the end of the element, the acceleration rate is in accordance with Table 7 (RH). For Scenario 3, the departure speed is calculated with the following formula:-

$$Ds = Hs + (L5/Acl_H) \qquad (5.3)$$

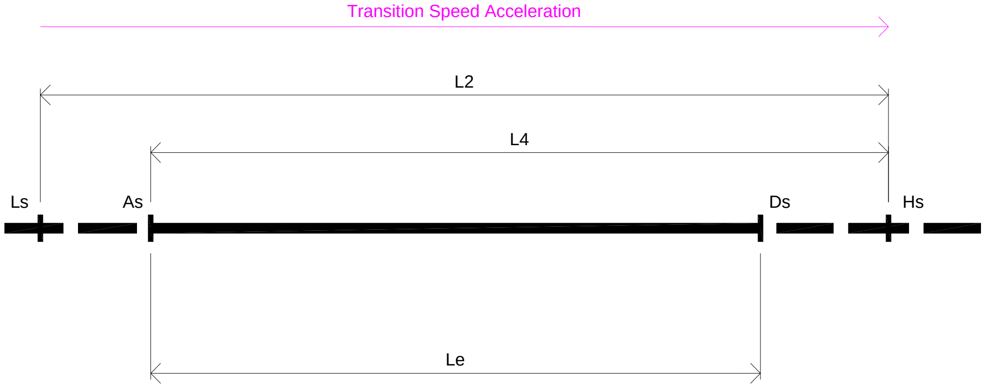
where Ds is departure speed (km/h)

L5 is acceleration length 5 (m)

Acl_H is the acceleration rate of the high speed zone (m per km/h)

L3 is acceleration length 3 (m)

Hs is lower limit of upper speed zone (km/h)



Scenario 4 - Le < L4

Figure 5.2(d) Low Speed Acceleration Analysis – Scenario 4

Scenario 4 is where the approach speed is higher than the upper limit of the low speed zone (Ls), but the element length (Le) is shorter than the length required to accelerate to the lower limit of the high speed zone (L4). So the vehicle accelerates at a rate that decreases as it moves along the element, starting at a rate that is less than the low speed acceleration rate (RL) and finishing on a rate that is higher than the high speed rate (RH). For Scenario 4, the departure speed is calculated with the following formula:-

$$Ds = As + ((Le/L4) \times (Hs-As)) \tag{5.4}$$

where Ds is departure speed (km/h)

As is approach speed (km/h)

Le is element length (m)

L4 is acceleration length 4 (m)

Hs is lower limit of upper speed zone (km/h)

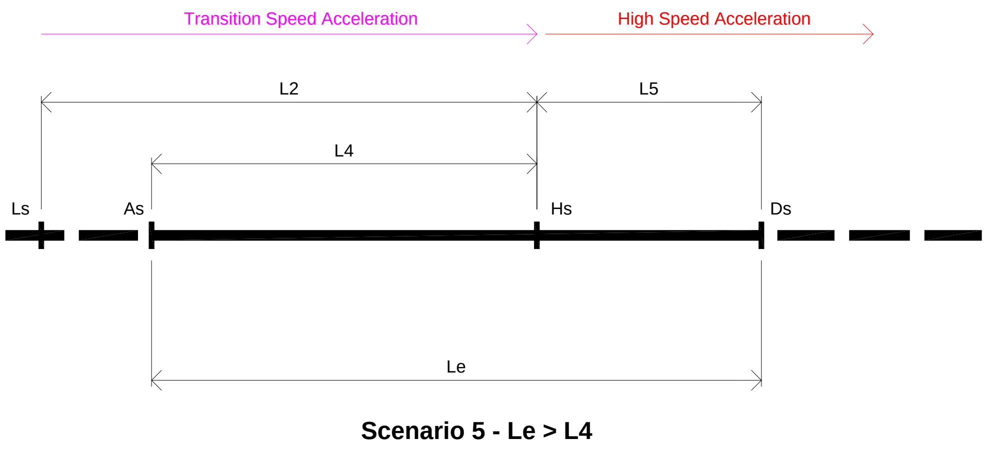


Figure 5.2(e) Low Speed Acceleration Analysis – Scenario 5

Scenario 5 is where the approach speed (As) is higher than the upper limit of the low speed zone (Ls) and the element length (Le) is longer than the length required to accelerate to the lower limit of the high speed zone (L4). So the vehicle begins accelerating at a rate less than the low speed acceleration rate and this rate decreases until it matches the high speed acceleration rate derived from Table 7. For Scenario 5, the formula for determining the departure speed from the element is as follows:-

$$Ds = Hs + (L5 / Acl_H) \qquad (5.5)$$

where Ds is departure speed (km/h)

L5 is acceleration length 5 (m)

Acl_H is the acceleration rate of the high speed zone (m per km/h)

Hs is lower limit of upper speed zone (km/h)

OSIST uses the following default values which are based on RPDM:-

Ls = 70km/h (upper limit of low speed zone)

Hs = 80km/h (lower limit of high speed zone)

Acl_L = 5m per 1km/h (acceleration rate of the low speed zone)

However, OSIST allows the user to modify these defaults to suit local conditions. For example, the road geometry and the surrounding terrain may indicate a lower desired speed which may dictate lower acceleration parameters.

High Speed Acceleration Analysis

Where the approach speed (As) to en element is higher then the lower limit of the high speed zone (Hs) and less than the Section Operating Speed (Os) for that element, OSIST conducts a high speed acceleration analysis. So this is for Class B elements as defined in Table 5.7. OSIST will determine an appropriate acceleration rate based on interpolation of the values in Table 5.8.

The length over which acceleration increases is not just the length of the element, but the remaining length of the section. This is appropriate as a vehicle travelling through the section will continue to accelerate through the whole length of the section or until it reaches the Section Operating Speed.

OSIST will determine the speed increase over the remaining length of the section, which will then be used to calculate an acceleration rate which is applied over the length of the element to determine a departure speed for the element.

Deceleration Analysis

Where the approach speed (As) to en element is higher then it's section operating speed and the radius of the element is less than 600m the vehicle will decelerate. These are Class C elements as defined in Table 5.7. On these elements, OSIST will conduct a deceleration analysis.

Deceleration on the element is based on Main Roads[2] Figure 6.9.2(b) which is the same as Figure 7.3 Austroads[1]. Departure speed values have been interpolated from this figure and included in Table 5.9.

Table 5.9 – Deceleration on Curves

Approach Speed	Curve Radius											
	50	100	150	200	250	300	350	400	450	500	550	600
60	50	55	56	57	58	59	60	60	60	60	60	60
70	56	62	64	66	67	68	68	69	70	70	70	70
80	59	69	72	74	75	76	77	78	79	79	80	80
90	61	74	79	82	84	85	86	87	88	88	89	89
100	60	78	84	89	92	93	95	96	97	97	98	98
110	60	82	92	95	97	100	102	103	104	104	105	105
120	60	90	100	102	104	107	109	111	112	113	114	114

OSIST only applies deceleration analysis to curves with a radius under 600m. Main Roads[2] Figure 6.9.2(b) does indicate deceleration on curves with a radius of up to 900m with an approach speed of 110km/h. According to Figure 6.9.2(b), a vehicle travelling at 110km/h will decelerate to 105km/h through a radius 600m curve. However, this is inconsistent with the section operating speed assigned to curves with a 600m radius in Table 6.9.2 RPDM. The section operating speed assigned is 110km/h, which indicates that an 85th percentile vehicle will not decelerate from 110km/h on a 600m radius curve.

Main Roads[2] does allow for this when providing direction as to the use of Figure 6.9.2(b), "follow the approach speed line … to the intercept with the radius or the section operating speed (whichever comes first)".

Also, as stated previously, OSIST does not allow for operating speeds greater than 110km/h. So, the deceleration analysis is limited to curves with radii less than 600m.

5.2.5 Design Consistency Checks

OSIST now has operating speeds for each horizontal element of the alignment and can now perform design consistency checks on the alignment.

Side Friction Demand

The only information that the user has been required to enter into OSIST is the horizontal geometry data. Crossfall and superelevation has not been entered. However, to determine side friction demand on a vehicle the crossfall is required. To save the user producing a superelevation assessment and entering crossfall data OSIST will provide a range of side friction coefficient values based on maximum superelevation of 0.06 m/m and normal crossfall of -0.03 m/m. This maximum superelevation value is based on Main Roads[18] Table 11.2. Side friction coefficient (unitless) is given by:-

$$f = (V^2/(127R)) - e \qquad (5.6)$$

where V is element operating speed (km/h);

R is element radius (m)

e is superelevation (m/m)

The calculated side friction coefficients are then compared with the desirable and absolute maximum of side friction for the element operating speed provided by Main Roads[18] Table 11.1A. This is reproduced in Table 5.10, which has also included interpolated values for every 5km/h. OSIST then looks up the nearest value to the element operating speed.

The minimum side friction value calculated above (usually corresponding to the maximum superelevation value) is compared with the absolute and desirable side friction values in Table 5.10. As part of the side friction check, if the side friction value is less than the desirable maximum it is labelled “Ok”. If the value is less than the absolute maximum, but more than the desirable maximum it is labelled “Undesirable”. If the value is greater than the absolute maximum it is labelled “Unacceptable”.

Table 5.10 – Maximum Side Friction Values

Speed	Max Side Friction Values	
	Absolute	Desirable
40	0.35	0.30
45	0.35	0.3
50	0.35	0.30
50	0.34	0.27
60	0.33	0.24
65	0.32	0.22
70	0.31	0.19
75	0.29	0.18
80	0.26	0.16
85	0.22	0.15
90	0.20	0.13
95	0.18	0.13
100	0.16	0.12
105	0.12	0.12
110	0.12	0.12
115	0.11	0.11
120	0.11	0.11
130	0.11	0.11

The second side friction check relates to the maximum increase in side friction demand between elements. Main Roads[18] sets a desirable limit of a 25% maximum increase in side friction between successive elements, but does indicate that there are some situations where a greater increase may be acceptable. However, it acknowledges that the 25% increase is a good check. So, OSIST checks the increase between successive curves. If it is less than 25% it is labelled “Ok”. If it is more than 25% it is labelled “Check”. The user will then need to check the alignment in accordance with Main Roads[18] to determine if the increase in side friction demand is acceptable.

OSIST also considers curves to be successive if they are separated by a short straight. Main Roads[18] says that for reverse curves separated by a straight with a length of about two times the operating speed (Os km/h) the straight is long enough to revert to normal crossfall. If the straight is shorter than this value (2 x Os) crossfall will transition evenly between the curves. So, when intermediate straights between curves are shorter than two times the operating speed (2 x Os) than the curves are considered to be successive.

Speed Reduction

The final check that OSIST performs is to assess the speed reduction between successive elements. This is a straightforward calculation. The spreadsheet completes some conditional formatting on the results; speed reduction values greater than 5km/h are changed to a red colour; speed reduction values greater than 10km/h are highlighted in bold red.

OSIST does not have user input for direction of horizontal curves, so it is not able to determine if curves are reverse or compound. Main Roads[2] Table 6.7.2 notes that while the desirable maximum decrease in speeds between successive elements is 10km/h, it also notes that the maximum decrease in speed for compound curves is 5km/h. So OSIST highlights the speed reduction as noted above and as shown below in Table 5.11. This should alert the designer to check these elements.

Table 5.11 Design Consistency Checks – Output Sample

Side Friction Check	Side Friction Increase	Speed Reduction
Unacceptable	Ok	7
Ok	Ok	-3
Ok	Ok	-4
Ok	Ok	0
Ok	Check!	0
Unacceptable	Ok	1
Undesirable	Ok	**10**

5.2.6 Reverse Direction Check

OSIST automatically conducts the same analysis in the reverse direction. The user is only required to input the starting speed for this direction.

5.2.7 Potential Future Development of OSIST

OSIST has currently been developed to provide assistance with using the operating speed model and conducting some design consistency checks. The design tool could possibly be developed further to integrate more of the alignment design process. Some suggested developments are:-

- Importing design information from design packages
- Checking vertical alignment and sight distance
- Providing suggested superelevation including development
- Flagging additional issues with horizontal alignment – broken back curves
- Entering chainages to match results with design plans
- Creating a speed profile – that is determining operating speed at say 5m intervals

6. Case Study: Mt. Nathan Road

6.1 Background

Mt Nathan Road is the local road name for part of Beaudesert-Nerang Road in the Gold Coast hinterland. This two lane arterial road is managed by the Department of Main Roads. A map of the case study area is shown in Figure 6.1.

The properties either side of Mt Nathan Road have undergone considerable development over the last 15 years in the form of residential acreage subdivisions.

The southern end of the road links to the western limits of Nerang at the intersection of Nerang-Murwillumbah Road. Over the last 10 years, Nerang has experienced significant growth in terms of residential developments and in terms of its importance as a commercial centre.

The northern end of Mt Nathan Road links to Maudsland and Oxenford, which have undergone rapid expansion in terms of medium to low density residential developments.

Mt Nathan Road has become part of important western north-south corridor serving growing communities of Nerang and Oxenford. It is also has an important function in providing a western link from the Gold Coast to Tamborine, Canungra and Beaudesert.

Traffic figures from August 2007 (included in Appendix E), indicate an Average Daily Traffic (ADT) of 6200. They also indicate peak hourly traffic volumes of almost 600, which would provide a Level of Service (LOS) B with continuous overtaking sight distance (Main Roads[19] Fig 5.12). However, the horizontal and vertical alignment of this road place significant limitations on available overtaking sight distance.

Traffic figures from November 2001 (also included in Appendix E) give an ADT of 5300, so the growth rate on Mt Nathan Road is a moderate 2.8% per annum.

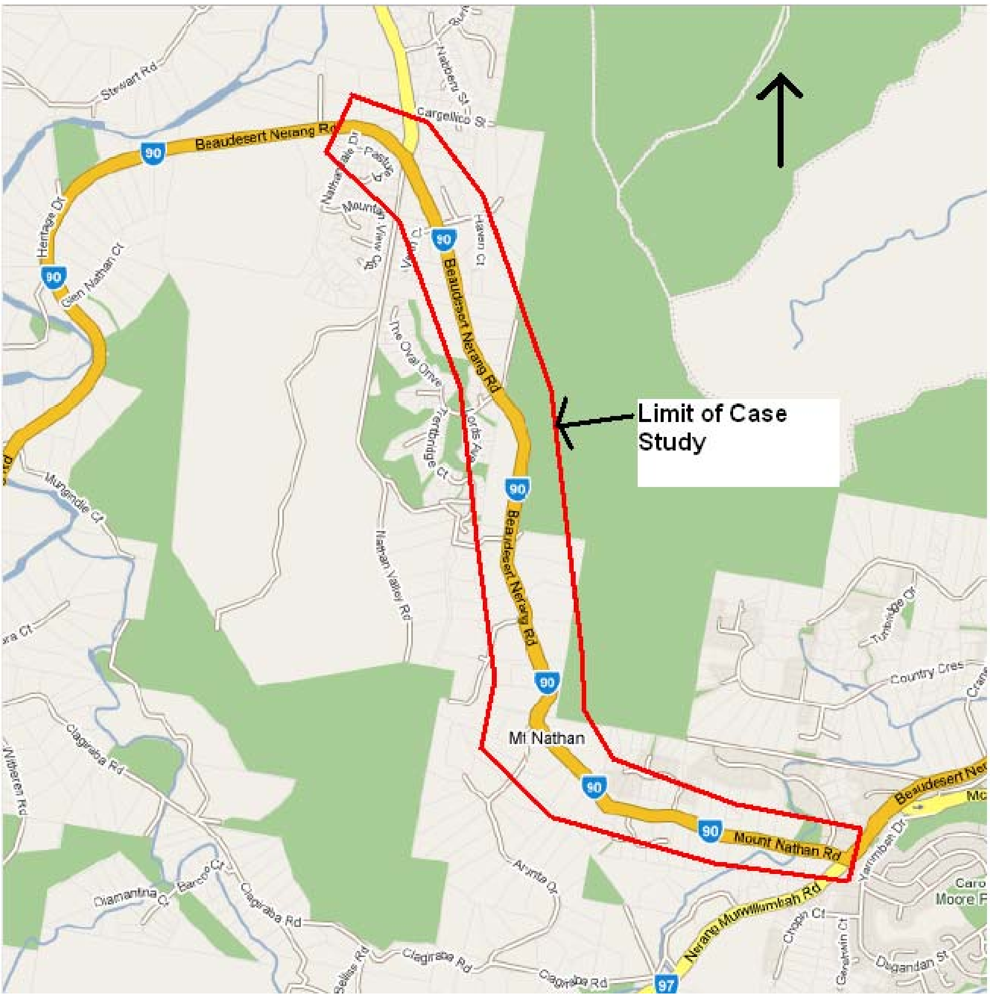


Figure 6.1 – Case Study Map

Traffic figures also indicate the proportion of heavy vehicles has grown from 4.4% to 7.1%. This represents a significant growth in the volume of heavy vehicles at 11.7% per annum. This, along with the steep vertical grades on sections of this road, indicates that providing overtaking opportunities along this road is a priority. This is also shown in Main Roads[20] Table 15.2, which indicates that a two lane road with this volume of traffic and proportion of commercial vehicles requires overtaking opportunities along at least 70% of the road alignment. While this case study does not evaluate the limits of existing overtaking sight distance, the existing horizontal and vertical alignment would likely not provide even close to that level of overtaking opportunities. While current traffic volumes and growth do not appear to warrant duplication of Mt Nathan Road, there does seem to be adequate justification for the provision of overtaking lanes along with possibly some realignment to provide more overtaking opportunities.

Mt Nathan Road traverses hilly terrain and this along with the location of the aforementioned acreage residential developments will constrain what can reasonably and economically be achieved to improve the safety performance of this road. This case study uses operating speed assessment to evaluate and prioritise the horizontal elements of the alignment, so that funds can be directed to the most critical sections of the road.

6.2 Operating Speed Assessment

An operating speed assessment was undertaken on Mt Nathan Road using the Operating Speed Interactive Spreadsheet Tool (OSIST), in both directions. The operating speeds determined by OSIST are the predictions of the 85th percentile speeds of vehicles driving through each element of the alignment. OSIST then highlighted elements of particular concern. The outputs from the OSIST analysis of Mt Nathan Road are included in Appendix G. The following discussion relates to elements of particular concern in each direction.

6.2.1 Eastbound Assessment

The 85th percentile speed for vehicles travelling from the west toward the study area would be 110km/h. This is consistent with the characteristics of the roadway and surrounding terrain.

The first element of concern is the Element 3 as shown in Figure 6.2. This is a curve of radius 410m. This results in a reduction in operating speed to 103km/h which results in a side friction demand just above the acceptable maximum.

OSIST highlighted Element 13 as having design consistency issues. This is a curve with a radius of 275m. The approach speed to this element is 110km/h, and OSST indicates that a vehicle will drop more than the desirable maximum of 10km/h to 99km/h.

This speed is too high for this element. It's side friction would be well beyond the acceptable limit, even with 6% superelevation.

OSIST also indicates that the increase in side friction demand from the previous element is greater than 25%. However, as the previous curve is a long 8300m radius curve this could really be considered a straight. The visual queue of the sharp curve ahead should alert the driver to an increased demand in side friction. The main concern with this element is that the side friction demand is over 25% higher than the maximum acceptable side friction for 100km/h.

Figure 6.2 – Eastbound Approach to Element 3

Elements 15, 17 and 21 are also of some concern. The side friction demand of vehicles negotiating these curves at the predicted operating speeds would be just beyond the acceptable range (that is, within 10%).

It is noted that the speed limit reduces to 80km/h in Element 12. Using Equation 2.1 based on research in the U.S. the operating speed is still about 100km/h where there is a posted speed of 80km/h. However, OSIST makes no allowance for the change in posted speed limit.

The next element of serious concern is Element 23, a short tight curve with a radius of 95m. The main design consistency issue with this element is that the predicted operating speed drops dramatically by from 103km/h to 80km/h. This is well beyond the absolute maximum decrease in operating speed between successive elements of 15km/h. The reduced speed is also well beyond the safe limit for this radius curve. The side friction demand is 0.48, almost twice the absolute maximum value of 0.26.

Figure 6.3 – Eastbound Approach to Element 23

Once a vehicle has moved beyond the low speed Section 12, OSST predicts that a vehicle will accelerate back up to 100km/h. Elements 30 and 34 have design consistency issues within the remainder of the alignment which generally has an operating speed of about 100km/h. These elements are short tight curves with radii of 190m and 140m respectively. At the predicted operating speeds, both of these curves place side friction demands on the vehicles that are well beyond the absolute maximum. There also concerns with the increase in side friction demand and decrease in operating speed from the previous element.

6.2.2 Westbound Assessment

The 85th percentile speed for vehicles travelling from the west will be substantially lower, as the vehicles are coming from an intersection and an urban environment. The alignment effectively stops at a t-intersection, so the starting speed arguably could be close to zero. However, for this assessment, the starting speed was set at 50km/h. The lower starting speed and the constrained horizontal alignment tends to keep the predicted operating speed at lower than the opposite direction.

The first element of concern in this direction is Element 34, a curve with a radius of 140m. At the predicted operating speed of 82km/h, this element imposes a side friction demand 20% higher than the absolute maximum side friction value. This element has the same issue in the reverse direction. As the element has a length of only 65m, it is likely that motorists will attempt to drive a flatter curve, possibly even crossing the road centreline.

Element 30, a curve with a radius of 190m also results in a side friction demand 30% higher than the absolute maximum side friction demand.

The element which has the most serious concern on the alignment in this direction is Element 25, a tight curve with a radius of 95m. This forms a reverse curve arrangement with a similar curve, Element 23 which has the same issues in the reverse direction.

Figure 6.4 – Westbound Approach to Element 34

Figure 6.5 – Westbound Approach to Element 30

Figure 6.6 – Westbound Approach to Element 25

Element 15, a short 200m radius, is also a concern in terms of the side friction demand on a vehicle travelling at the predicted operating speed. The side friction value would be 25% more than the absolute maximum accepted value. The increase in side friction from the preceding curve would also need to be checked.

6.2.3 Critical Horizontal Elements

While the operating speed assessment indicated a dozen or so horizontal elements that may have undesirable characteristics, the forward and reverse assessments did highlight elements of particular concern that should be given priority for correction. These are shown in Table 6.1.

Table 6.1 – Critical Horizontal Elements

Element	Type	Length
13/15	Reverse Curves with 275/200 radii	220
23/25	Reverse Curves with 95/95 radii	290
30	Single Curve - 190 radius	135
34	Single Curve - 140 radius	65
Total		**710**

6.2.4 Comparison with Road Crash Data

Accident data from 1992 to October 2008 was sourced from the Department of Main Roads and is included in Appendix F. The data was extracted and collated into Table 6.2. The extracted data was taken between the two major intersections at either end of the alignment: Nerang-Murwillumbah Road and Oxenford-Coomera Gorge Road.

The accident numbers at these intersections were ignored, as the objective of this review was to determine the safety performance of the alignment characteristics. There are significant numbers of accidents at the intersections. The type of accidents at these intersections differs form those on the through alignment. Also the safety performance of the intersections is also strongly influenced by the design of the intersection and the available sight distance. The horizontal design of the through alignment, while contributing to the accidents at the intersection, would play a lesser role. The accident data at the intersections would skew the data that applies to the through alignment alone. It is for these reasons, that the assessment excludes the accident data that applies to the major intersections at either end of the study area.

This collated accident data is shown in Table 6.2. An interesting observation from this data is that 54% of the accidents are single vehicle accidents resulting from vehicles leaving the road. An additional 21% of the accidents are head-on resulting from vehicles entering the opposing lane (excluding those caused by overtaking manoeuvres). This means that 75% of accidents along this alignment are the result of vehicles leaving the travelled lane.

Table 6.2 – Collated Accident Data

DCA Code	Description	No
0	Pedestrian	2
10	Intersection	3
20	Head On	11
30	Rear End/Side Swipe	4
40	Manoeuvring	2
50	Overtaking	1
60	Obstacles	2
70	Leave Road - Straight	6
80	Leave Road - Curve	22
	Total	53

The predominant reason for vehicles leaving the travelled lane is that the driver loses control of the vehicle. As discussed in Chapter 2 of this dissertation, inconsistent design has a strong if not direct relationship with drivers losing control of their vehicles due the higher cognitive demand and the increased risk of errors in judgement.

The other reason why a vehicle may leave the travelled lane would be that the driver losing the ability to control the vehicle (for example, losing consciousness), but this would only apply to a small minority of these cases.

The accident data is consistent with the results of the analysis that show 14 curves on the alignment have less than desirable characteristics for the predicted operating speeds and are inconsistent with driver expectations.

The data for accidents that occurred within 100 metres of the critical horizontal elements was collated into Table 6.3.

Table 6.3 – Accident Data at Critical Elements

Element	Accidents	% Leave Road	% Head-On
13/15	3	100	0
23/25	6	66	16
30	5	80	20
34	4	50	25
Total	**18**	**67**	**17**

This data is consistent with the findings of the operating speed assessment and the prioritisation of critical horizontal elements. These elements, while representing only 10% of the length of the alignment, account for over a third of the accidents along the alignment. Table 6.3 also shows that 84% of these accidents result from a vehicle leaving the travelled lane. This confirms the concern and the priority that should be given these critical horizontal elements.

6.3 Recommendations

There are 14 horizontal curves that have less than desirable characteristics on this alignment. The terrain and to a lesser extent the surrounding development, will make realignment difficult and expensive.

The findings of this case study recommend that the critical horizontal elements listed in Table 6.1 should be given priority. Improving these elements should substantially improve the safety performance of Mt Nathan Road. There are two strategies that could be applied to the improvement of these elements:-

- Increasing the radius of the curve
- Introducing speed reducing curves

A combination of these two strategies would likely have the most effective outcome.

It must be noted, however, that this case study has not considered the vertical geometric elements as these have a minimal impact on operating speed, although the affect of grades could be considered.

The vertical geometry also determines sight distance, so the available sight distance should be compared with the minimum safe sight distance (and safe intersection sight distance where appropriate) for the operating speeds predicted by OSIST.

Therefore, it is recommended that a detailed analysis of the existing vertical geometry be completed. This may shift priorities if it is found that existing intersections have available sight distance that is well below the minimum required.

7. Conclusion

7.1 Review of the Operating Speed Model

7.1.1 Overview and Comparison with International Practice

This project has involved a detailed review of the Operating Speed Model as currently outlined by Main Roads[2] for use in Queensland. The model does provide a detailed and comprehensive analysis of horizontal alignments to predict 85th percentile speeds on two lane rural roads. It provides a prediction of actual driver speeds based on statistical distributions of speeds on various combinations of horizontal curves and straights.

These statistical distributions and regression relationships are based on field measurement of actual vehicle speeds at a sample of road sites. The reliability of the prediction will be based on the quality of the source data and the size of the sample. As vehicle performance and pavement technology have changed over time, the age of this data will also be a measure of its reliability.

The Operating Speed Model is generally consistent with worldwide practice for analysing the safety performance of road alignments, this being described broadly as:-

1. Determine 85th percentile speed on horizontal elements;
2. Check for design consistency (in terms of side friction demand and reduction in speed);
3. Adjust alignment to cater for design consistency issues; and
4. Feedback loop to Step 1.

7.1.2 Areas for Development

Fitzpatrick et al[6] did find a statistically significant relationship between operating speed and the posted speed limit. The Operating Speed Model currently makes no reference to speed limit. The "desired speed" and "section operating speed" are based only on horizontal geometry and surrounding terrain.

The Operating Speed Model as outlined in Austroads[1] and Main Roads[2] also require more detailed discussion and guidance for separating the alignment into sections of reasonably similar curves. There appears to be a level of subjectivity in the guidance currently provided which could be compensated by the experience of the designer. However, there is potential for the operating speed to be under-estimated.

The speed deceleration on curves figures in both Australia publications should be revised to be consistent with "section operating speeds". For example, using "section operating speeds" allows a vehicle to maintain a 110km/h desired speed through a curve radius of 600m. However, the speed deceleration figures indicate the speed will reduce from 110km/h on any curve with a radius less than 900m. It does suggest that the regression plots on these figures are based on unreliable data.

Main Roads[2] recent inclusion of a provision for higher acceleration rates from lower speeds, while intuitively closer to actual driver behaviour, does require further discussion. Further explanation and direction is required on exactly how to apply these higher acceleration rates within the context of the acceleration regression plots provided in Main Roads[2] and Austroads[1]. Again, it does suggest that the regression plots on these figures are based on unreliable data.

7.2 Further Work

This project has found that the following additional research should be undertaken to further develop the Operating Speed Model:-

- Include the posted speed limit into the analysis to determine “desired speed”
- Develop more comprehensive guidance for separating the alignment into sections
- Conduct further research to revise regression plots for speed increase and decrease along the alignment which should provide consistency with the use of section operating speeds

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Appendix A

Project Specification

Project Specification
ENG4111/4112 - Research Project

For:-

Timothy Noel TAYLOR
Student No 0019220677

Topic:-

ASSESSMENT OF OPERATING SPEED ALONG A CURVILINEAR ROAD ALIGNMENT

Supervisor:-

Trevor Drysdale

Sponsor:-

Parsons Brinckerhoff

Issue A (25th March 2008)

Project Aim

To review and compare operating speed assessment methodologies, develop a simulation program for operating speed and apply this to a real project case study.

Programme

1. Review of the "Operating Speed Model" as detailed in the recently released Chapter 6 of Main Roads Road Planning and Design Manual: "Speed Parameters".
2. Comparison of speed assessment methodologies used nationally and globally.
3. Research from national and global road authorities concerning the impact of steep vertical grade on the operating speed of general traffic (not trucks) and how this may impact on speeds determined by Main Roads Operating Speed Model.
4. Development of simulation program in MATLAB that:
    a. Uses horizontal geometric information for an existing road and completes a speed analysis (in both directions) based on Main Roads Operating Speed Model
    b. Uses vertical geometric information to complete sight distance calculations based on speeds calculated in previous step
    c. Highlights and prioritises geometric elements that have safety concerns
5. Case Study: Mt Nathan Road, Gold Coast Hinterland
    a. assess the existing geometry
    b. prioritise elements along that alignment that are unsafe and require remedial work
    c. review accident history to assess correlation with assessment results
    d. review realignment options that have been developed by Main Roads
6. Prepare and submit academic dissertation

Programme (cont)

7. As time permits:-
    a. Include impacts of steep grades into simulation program
    b. Include superelevation and curve widening into simulation program

Agreement

______________________ 25/3/08
Student Date

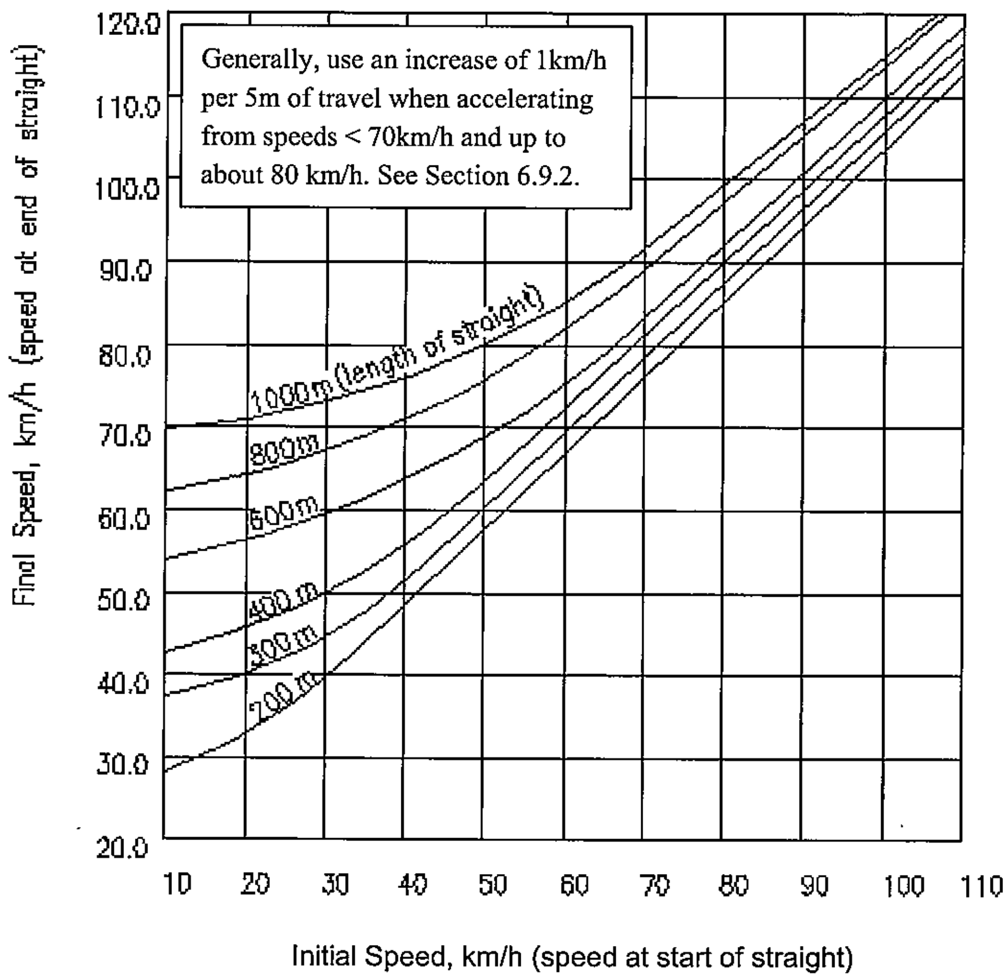
______________________ ____________
Supervisor Date

______________________ ____________
Examiner/Co-examiner Date

Appendix B

Operating Speed Model Reference Material

6



Note: To use graph - enter the base of the graph at initial speed of the vehicle, project vertically up to the line representing the length of the straight, then project horizontally left to read the speed at the end of the straight.

Figure 6.9.2(a) Increase in Speed on Straights

Details of Example

For the road section under consideration:

- It is in flat to undulating terrain.
- The link strategy has set a target speed of 110km/hr for the link, but recognises that a lower operating speed will be likely over this section because of local topographic constraints.
- It has horizontal curve radii ranging between 165m and 320m.
- It has a posted speed limit of 100km/h.
- The pavement conditions are constant.
- The type cross section is the same for the entire length.

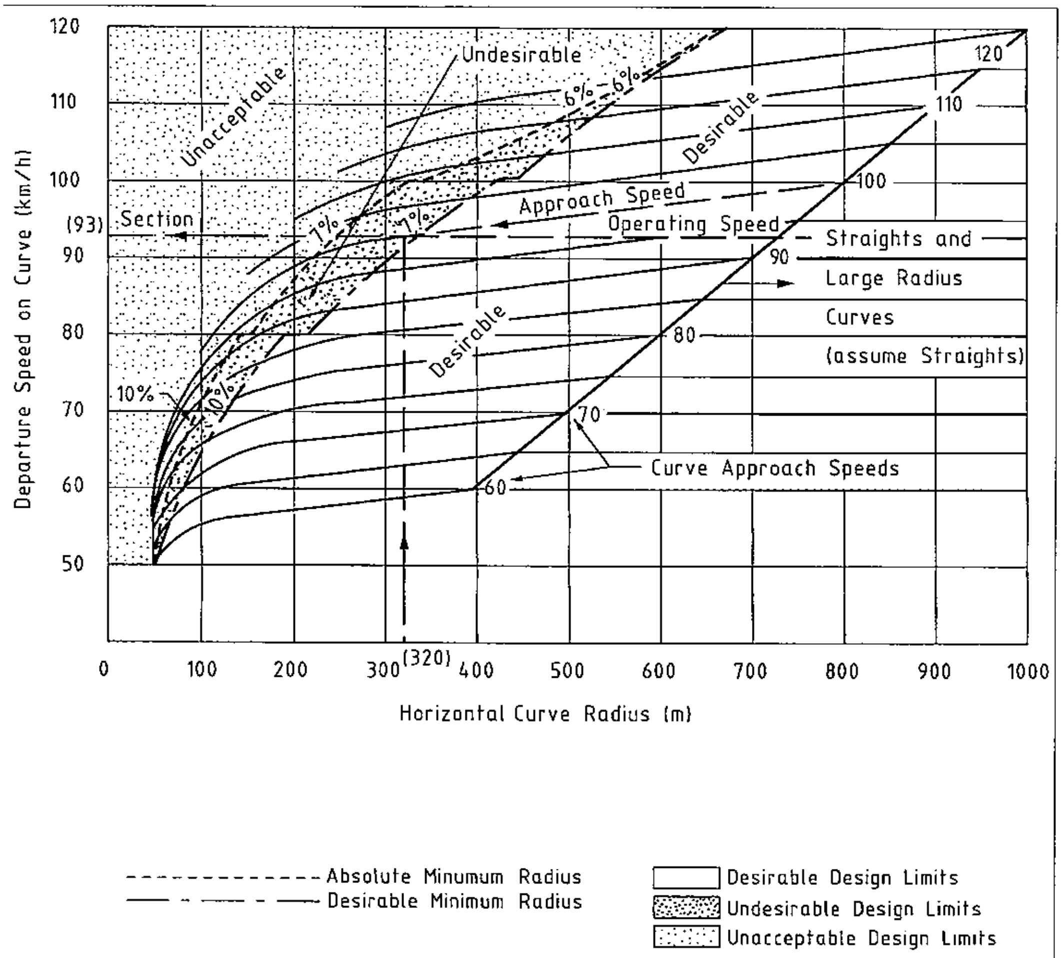


Figure 6.9.2(b) Deceleration on Curves Graph

Determination of Desired Speed

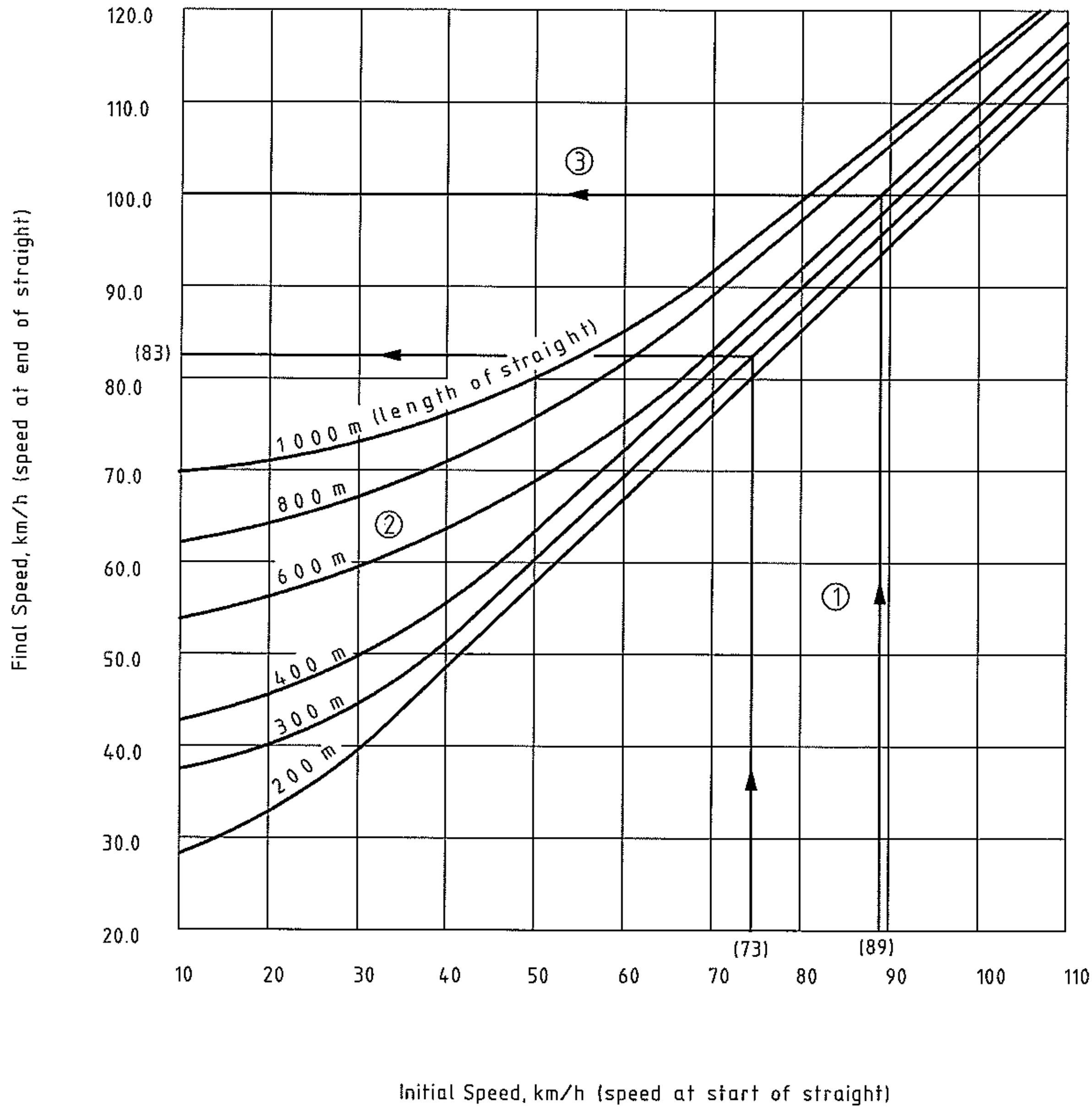
Given a combination of flat to undulating terrain and horizontal curve radii ranging between 165m and 320m, Table 6.3.1(b) indicates a desired speed of 110km/h. This is reinforced by note 'c' in the table, which indicates a desired speed of 110km/h for the 100km/h speed limit in this example.

Length of Road to be Analysed

As a first step, it is necessary to include segments that are approximately 1km to 1.5km at each end of the length of road for which speed estimates are required. This helps ensure more accurate approach speeds for the alignment that is being assessed. It also helps ensure that there are no problems created downstream due to increases in operating speed. If the adjoining 1km to 1.5km lengths are likely to be upgraded in the future, the analysis of speeds should also cover the short term and long term scenarios.

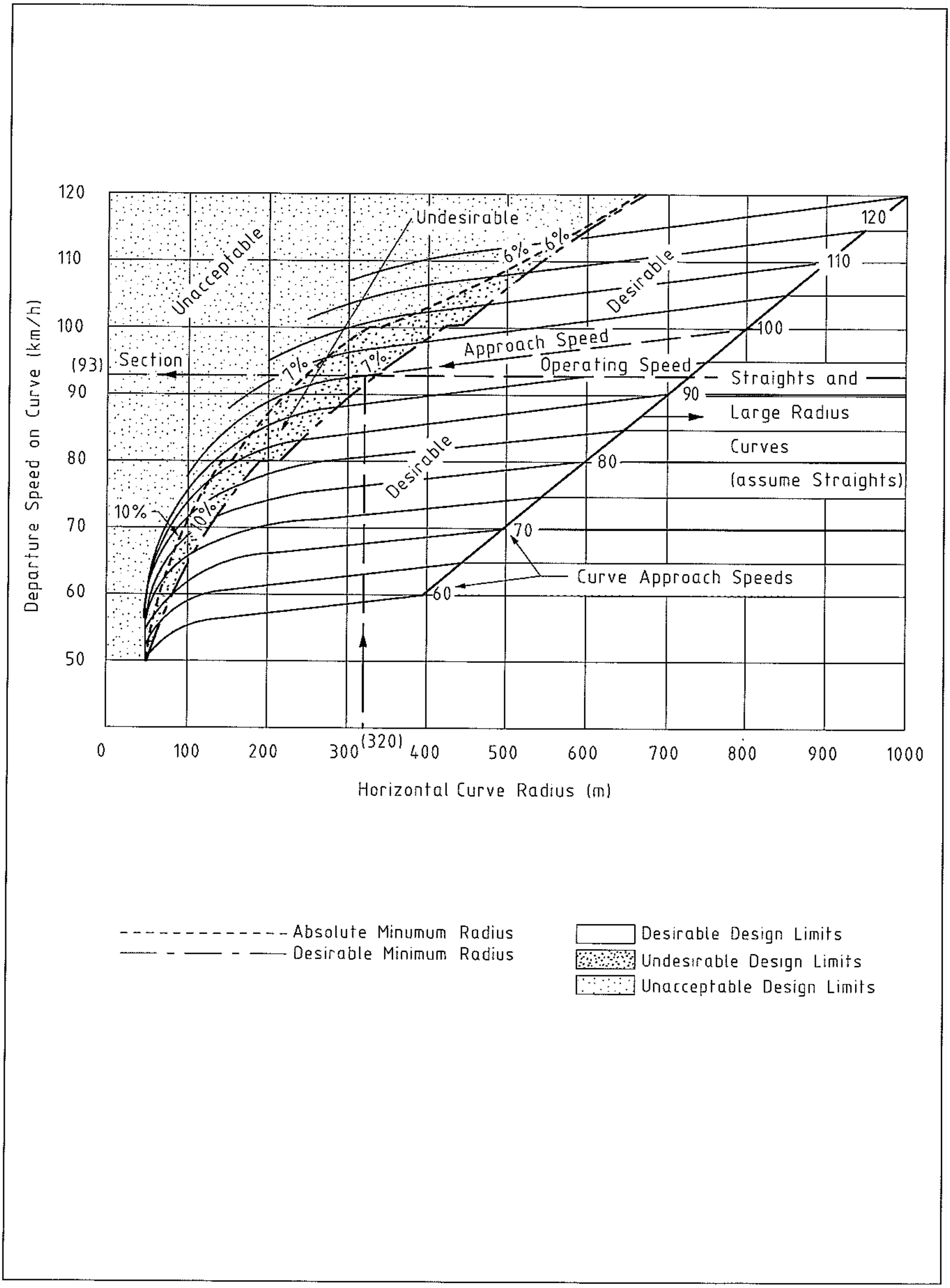
If, for example, speed estimates were required for the curves between C and I in Figure 6.9.3(a), the speed study would extend from A to L, with speeds being assessed in each direction of travel on a two-way road.

Figure 7.2: Acceleration on Straights (Hilly to Mountainous Terrain)



Note: To use graph - enter the base of the graph at initial speed of the vehicle, project vertically up to the line representing the length of the straight, then project horizontally left to read the speed at the end of the straight.

Figure 7.3: Deceleration on Curves



Appendix C

OSIST Tables

PARSONS BRINCKERHOFF

SS Name: **Operating Speed Interactive Spreadsheet Tool (OSIST) - Forward Direct**

Project: USQ Research Project Designer: Tim Taylor
Case Study - Mt Nathan Road

Client: Main Roads

Author: Tim Taylor	Verified:
Date: 30-Oct-08	Date:

Rev #	**Description**	**Editor**	**Verifier**	**Date**
1				
2				
3				
4				

tion

PARSONS BRINCKERHOFF

Desired Speed	110					Starting Speed	110		Low Speed Acceleration Assessment						
Element	**Radius**	**Length**	**Section**	**Section Length**	**Section Length Remaining**	**Op. Speed (km/h)**	**Element Speed**	**Element Class**	**Length Index**	**Higher Speed Accel (m per km/h)**	**Transition Speed Accel (m per km/h)**	**L1 - up to low speed upper limit**	**L2 - transition length**	**L3 - from low speed upper limit to end**	**L4 - up to high speed lower limit**
1	1000000	210	1	210	210	110	110	D	-	-	-	-	-	-	-
2	410	530	2	530	530	100	103	C	-	-	-	-	-	-	-
3	1000000	400	3	1530	1530	110	106	B	-	-	-	-	-	-	-
4	2000	510	3	1530	1130	110	110	B	-	-	-	-	-	-	-
5	1000000	120	3	1530	620	110	110	D	-	-	-	-	-	-	-
6	550	170	3	1530	500	110	110	D	-	-	-	-	-	-	-
7	750	230	3	1530	330	110	110	D	-	-	-	-	-	-	-
8	1000000	100	3	1530	100	110	110	D	-	-	-	-	-	-	-
9	510	90	4	90	90	106	109	C	-	-	-	-	-	-	-
10	360	250	5	250	250	96	99	C	-	-	-	-	-	-	-
11	1800	150	6	580	580	110	102	B	-	-	-	-	-	-	-
12	8300	430	6	580	430	110	110	B	-	-	-	-	-	-	-
13	275	120	7	150	150	93	102	C	-	-	-	-	-	-	-
14	1000000	30	7	150	30	93	93	D	-	-	-	-	-	-	-
15	200	70	8	70	70	79	88	C	-	-	-	-	-	-	-
16	1000000	50	9	180	180	93	89	B	-	-	-	-	-	-	-
17	280	130	9	180	130	93	93	B	-	-	-	-	-	-	-
18	1000000	40	10	290	290	110	94	B	-	-	-	-	-	-	-
19	540	100	10	290	250	110	96	B	-	-	-	-	-	-	-
20	1000000	150	10	290	150	110	100	B	-	-	-	-	-	-	-
21	420	70	11	160	160	105	101	B	-	-	-	-	-	-	-
22	1000000	90	11	160	90	105	104	B	-	-	-	-	-	-	-
23	95	120	12	290	290	66	80	C	-	-	-	-	-	-	-
24	1000000	30	12	290	170	66	66	D	-	-	-	-	-	-	-
25	95	140	12	290	140	66	66	D	-	-	-	-	-	-	-
26	1400	170	13	510	510	110	91	A	5	42	5	20	233	490	0
27	1000000	140	13	510	340	110	95	B	-	-	-	-	-	-	-
28	570	100	13	510	200	110	96	B	-	-	-	-	-	-	-
29	1000000	100	13	510	100	110	100	B	-	-	-	-	-	-	-
30	190	135	14	135	135	79	90	C	-	-	-	-	-	-	-
31	1000000	140	15	315	315	100	94	B	-	-	-	-	-	-	-
32	360	110	15	315	175	100	96	B	-	-	-	-	-	-	-
33	1000000	65	15	315	65	100	100	B	-	-	-	-	-	-	-
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35	1000000	200	17	200	200	110	93	B	-	-	-	-	-	-	-
36	265	90	18	90	90	86	89	C	-	-	-	-	-	-	-
37	1000000	150	19	250	250	107	93	B	-	-	-	-	-	-	-
38	470	100	19	250	100	107	96	B	-	-	-	-	-	-	-
39	750	150	20	330	330	110	100	B	-	-	-	-	-	-	-
40	1000000	180	20	330	180	110	103	B	-	-	-	-	-	-	-
41	310	110	21	150	150	96	97	C	-	-	-	-	-	-	-
42	1000000	40	21	150	40	96	96	D	-	-	-	-	-	-	-

PARSONS BRINCKERHOFF

Desired Speed	110						High Speed Acceleration Assessment													Deceleration Ass
Element	Radius	Length	Section	L5 - from high speed lower limit to end	Assessment Scenario	Departure Speed	Length Index	Speed Index	Look Up Values				1st Inter		Length Factor	Speed over Section	Departure Speed	radius index
1	1000000	210	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	410	530	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8
3	1000000	400	3	-	-	-	8	10	114	120	114	120	115.8	115.8	0.26143791	115.8	106.3464052	-
4	2000	510	3	-	-	-	8	10	114	120	114	120	117.807843	117.807843	0.45132743	117.807843	111.5192666	-
5	1000000	120	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	550	170	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	750	230	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	1000000	100	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	510	90	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
10	360	250	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
11	1800	150	6	-	-	-	5	9	101	110	103	112	109.28	111.28	0.25862069	109.28	101.8068966	-
12	8300	430	6	-	-	-	4	10	109	117	110	118	110.445517	111.445517	1	110.445517	110.4455172	-
13	275	120	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
14	1000000	30	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	200	70	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
16	1000000	50	9	-	-	-	1	8	85	94	88	96	92.47	94.64	0.27777778	92.47	89.45833333	-
17	280	130	9	-	-	-	1	8	85	94	88	96	93.5125	95.5666667	1	93.5125	93.5125	-
18	1000000	40	10	-	-	-	2	9	96	106	99	108	99	101.7	0.13793103	99	93.82758621	-
19	540	100	10	-	-	-	2	9	96	106	99	108	99.8275862	102.444828	0.4	99.8275862	96.22758621	-
20	1000000	150	10	-	-	-	1	9	94	103	96	106	99.6048276	102.227586	1	99.6048276	99.60482759	-
21	420	70	11	-	-	-	1	9	94	103	96	106	102.644345	105.604828	0.4375	102.644345	100.9346164	-
22	1000000	90	11	-	-	-	1	10	103	112	106	114	103.841155	106.747693	1	103.841155	103.8411547	-
23	95	120	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
24	1000000	30	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	95	140	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	1400	170	13	0	2	91	-	-	-	-	-	-	-	-	-	-	-	-
27	1000000	140	13	-	-	-	3	9	99	108	100	109	99.9	100.9	0.41176471	99.9	94.66470588	-
28	570	100	13	-	-	-	1	9	94	103	96	106	98.1982353	100.664706	0.5	98.1982353	96.43147059	-
29	1000000	100	13	-	-	-	1	9	94	103	96	106	99.7883235	102.431471	1	99.7883235	99.78832353	-
30	190	135	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
31	1000000	140	15	-	-	-	3	8	90	99	91	100	98.775	99.775	0.44444444	98.775	93.76111111	-
32	360	110	15	-	-	-	1	9	94	103	96	106	97.385	99.7611111	0.62857143	97.385	96.03898413	-
33	1000000	65	15	-	-	-	1	9	94	103	96	106	99.4350857	102.038984	1	100.737035	100.7370349	-
34	140	65	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
35	1000000	200	17	-	-	-	1	8	85	94	88	96	92.74	94.88	1	92.74	92.74	-
36	265	90	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
37	1000000	150	19	-	-	-	2	8	88	96	90	99	95.04	97.92	0.6	95.04	92.544	-
38	470	100	19	-	-	-	1	9	94	103	96	106	96.2896	98.544	1	96.2896	96.2896	-
39	750	150	20	-	-	-	3	9	99	108	100	109	104.66064	105.66064	0.45454545	104.66064	100.0946182	-
40	1000000	180	20	-	-	-	1	10	103	112	106	114	103.085156	106.075695	1	103.085156	103.0851564	-
41	310	110	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
42	1000000	40	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Desired Speed	110			essment							
Element	Radius	Length	Section	speed index	look up values				1st Inter		Departure Speed
1	1000000	210	1	-	-	-	-	-	-	-	-
2	410	530	2	6	103	111	104	112	103	104	103
3	1000000	400	3	-	-	-	-	-	-	-	-
4	2000	510	3	-	-	-	-	-	-	-	-
5	1000000	120	3	-	-	-	-	-	-	-	-
6	550	170	3	-	-	-	-	-	-	-	-
7	750	230	3	-	-	-	-	-	-	-	-
8	1000000	100	3	-	-	-	-	-	-	-	-
9	510	90	4	6	104	113	105	114	109.4	110.4	109.4
10	360	250	5	5	95	102	96	103	99.2	100.2	99.2
11	1800	150	6	-	-	-	-	-	-	-	-
12	8300	430	6	-	-	-	-	-	-	-	-
13	275	120	7	6	100	107	102	109	102.1	104.1	102.1
14	1000000	30	7	-	-	-	-	-	-	-	-
15	200	70	8	4	82	89	84	92	88.3	91.2	88.3
16	1000000	50	9	-	-	-	-	-	-	-	-
17	280	130	9	-	-	-	-	-	-	-	-
18	1000000	40	10	-	-	-	-	-	-	-	-
19	540	100	10	-	-	-	-	-	-	-	-
20	1000000	150	10	-	-	-	-	-	-	-	-
21	420	70	11	-	-	-	-	-	-	-	-
22	1000000	90	11	-	-	-	-	-	-	-	-
23	95	120	12	5	78	82	84	92	80.4	88.8	80.4
24	1000000	30	12	-	-	-	-	-	-	-	-
25	95	140	12	-	-	-	-	-	-	-	-
26	1400	170	13	-	-	-	-	-	-	-	-
27	1000000	140	13	-	-	-	-	-	-	-	-
28	570	100	13	-	-	-	-	-	-	-	-
29	1000000	100	13	-	-	-	-	-	-	-	-
30	190	135	14	4	82	89	84	92	88.3	91.2	89.75
31	1000000	140	15	-	-	-	-	-	-	-	-
32	360	110	15	-	-	-	-	-	-	-	-
33	1000000	65	15	-	-	-	-	-	-	-	-
34	140	65	16	5	84	92	89	95	86.4	90.8	88.6
35	1000000	200	17	-	-	-	-	-	-	-	-
36	265	90	18	4	84	92	85	93	88.8	89.8	88.8
37	1000000	150	19	-	-	-	-	-	-	-	-
38	470	100	19	-	-	-	-	-	-	-	-
39	750	150	20	-	-	-	-	-	-	-	-
40	1000000	180	20	-	-	-	-	-	-	-	-
41	310	110	21	5	93	100	95	102	97.2	99.2	97.2
42	1000000	40	21	-	-	-	-	-	-	-	-

PARSONS BRINCKERHOFF

Section	Length	Section Length	Section Length Remaining	Section	Length
1	210	210	210	1	210
2	530	530	530	2	530
3	400	1530	1530	3	1530
3	510	1530	1130	4	90
3	120	1530	620	5	250
3	170	1530	500	6	580
3	230	1530	330	7	150
3	100	1530	100	8	70
4	90	90	90	9	180
5	250	250	250	10	290
6	150	580	580	11	160
6	430	580	430	12	290
7	120	150	150	13	510
7	30	150	30	14	135
8	70	70	70	15	315
9	50	180	180	16	65
9	130	180	130	17	200
10	40	290	290	18	90
10	100	290	250	19	250
10	150	290	150	20	330
11	70	160	160	21	150
11	90	160	90		
12	120	290	290		
12	30	290	170		
12	140	290	140		
13	170	510	510		
13	140	510	340		
13	100	510	200		
13	100	510	100		
14	135	135	135		
15	140	315	315		
15	110	315	175		
15	65	315	65		
16	65	65	65		
17	200	200	200		
18	90	90	90		
19	150	250	250		
19	100	250	100		
20	150	330	330		
20	180	330	180		
21	110	150	150		
21	40	150	40		

USQ Research Project

Case Study - Mt Nathan Road

Operating Speed Interactive Spreadsheet Tool (C Date: 29 Oct 2008

Element	Radius	Length	Section	Op. Speed (km/h)	Vehicle Speed	Side Friction Range		Side Friction Check	Side Friction Increase	Speed Reduction	Comments
1	inf	210	1	110	110	-0.060	0.030	Ok			
2	410	530	2	100	103	0.144	0.234	Unacceptable	Ok	7	
3	inf	400	3	110	106	-0.060	0.030	Ok	Ok	-3	
4	2000	510	3	110	110	-0.012	0.078	Ok	Ok	-4	
5	inf	120	3	110	110	-0.060	0.030	Ok	Ok	0	
6	550	170	3	110	110	0.113	0.203	Ok	Check!	0	
7	750	230	3	110	110	0.067	0.157	Ok	Ok	0	
8	inf	100	3	110	110	-0.060	0.030	Ok	Ok	0	
9	510	90	4	106	109	0.125	0.215	Unacceptable	Ok	1	
10	360	250	5	96	99	0.155	0.245	Undesirable	Ok	10	
11	1800	150	6	110	102	-0.015	0.075	Ok	Ok	-3	
12	8300	430	6	110	110	-0.049	0.041	Ok	Ok	-8	
13	**275**	**120**	**7**	**93**	**102**	**0.238**	**0.328**	**Unacceptable**	**Check!**	**8**	
14	inf	30	7	93	93	-0.060	0.030	Ok	Ok	9	
15	**200**	**70**	**8**	**79**	**88**	**0.247**	**0.337**	**Unacceptable**	**Ok**	**5**	
16	inf	50	9	93	89	-0.060	0.030	Ok	Ok	-1	
17	280	130	9	93	93	0.183	0.273	Unacceptable	Ok	-4	
18	inf	40	10	110	94	-0.060	0.030	Ok	Ok	-1	
19	540	100	10	110	96	0.075	0.165	Ok	Ok	-2	
20	inf	150	10	110	100	-0.060	0.030	Ok	Ok	-3	
21	420	70	11	105	101	0.131	0.221	Unacceptable	Ok	-1	
22	inf	90	11	105	104	-0.060	0.030	Ok	Ok	-3	
23	**95**	**120**	**12**	**66**	**80**	**0.476**	**0.566**	**Unacceptable**	**Check!**	**23**	
24	inf	30	12	66	66	-0.060	0.030	Ok	Ok	14	
25	95	140	12	66	66	0.301	0.391	Undesirable	Ok	0	
26	1400	170	13	110	91	-0.013	0.077	Ok	Ok	-25	
27	inf	140	13	110	95	-0.060	0.030	Ok	Ok	-4	
28	570	100	13	110	96	0.068	0.158	Ok	Check!	-2	
29	inf	100	13	110	100	-0.060	0.030	Ok	Ok	-3	
30	**190**	**135**	**14**	**79**	**90**	**0.274**	**0.364**	**Unacceptable**	**Check!**	**10**	
31	inf	140	15	100	94	-0.060	0.030	Ok	Ok	-4	
32	360	110	15	100	96	0.142	0.232	Undesirable	Ok	-2	
33	inf	65	15	100	100	-0.060	0.030	Ok	Ok	-4	
34	**140**	**65**	**16**	**73**	**89**	**0.382**	**0.472**	**Unacceptable**	**Check!**	**11**	
35	inf	200	17	110	93	-0.060	0.030	Ok	Ok	-4	
36	265	90	18	86	89	0.174	0.264	Undesirable	Ok	4	
37	inf	150	19	107	93	-0.060	0.030	Ok	Ok	-4	
38	470	100	19	107	96	0.095	0.185	Ok	Ok	-4	

PARSONS BRINCKERHOFF

Forward

Element	Radius	Length
1	inf	210
2	410	530
3	inf	400
4	2000	510
5	inf	120
6	550	170
7	750	230
8	inf	100
9	510	90
10	360	250
11	1800	150
12	8300	430
13	275	120
14	inf	30
15	200	70
16	inf	50
17	280	130
18	inf	40
19	540	100
20	inf	150
21	420	70
22	inf	90
23	95	120
24	inf	30
25	95	140
26	1400	170
27	inf	140
28	570	100
29	inf	100
30	190	135
31	inf	140
32	360	110
33	inf	65
34	140	65
35	inf	200
36	265	90
37	inf	150
38	470	100
39	750	150
40	inf	180
41	310	110
42	inf	40
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0
	0	0

Reverse

Element	Radius	Length
42	inf	40
41	310	110
40	inf	180
39	750	150
38	470	100
37	inf	150
36	265	90
35	inf	200
34	140	65
33	inf	65
32	360	110
31	inf	140
30	190	135
29	inf	100
28	570	100
27	inf	140
26	1400	170
25	95	140
24	inf	30
23	95	120
22	inf	90
21	420	70
20	inf	150
19	540	100
18	inf	40
17	280	130
16	inf	50
15	200	70
14	inf	30
13	275	120
12	8300	430
11	1800	150
10	360	250
9	510	90
8	inf	100
7	750	230
6	550	170
5	inf	120
4	2000	510
3	inf	400
2	410	530
1	inf	210

Appendix D

OSIST Formulae

PARSONS BRINCKERHOFF

Element	Radius	Length	Section	Op. Speed (km/h)	Vehicle Speed	Side Friction Range	
=IF(C6="","",1)	inf	210	=IF($B6="","",EG16)	=IF($B6="","",EH16)	=IF(C6="","",'Speed Analysis'!I7)	=IF(B6="","",IF(C6="inf",-0.06,((G6^2)/(127*C6))-0.06))	=IF(B6="","",IF(C6="inf",0.03,((G6^2)/(127*C6))+0.03))
=IF(C7="","",B6+1)	410	530	=IF($B7="","",EG17)	=IF($B7="","",EH17)	=IF(C7="","",'Speed Analysis'!I8)	=IF(B7="","",IF(C7="inf",-0.06,((G7^2)/(127*C7))-0.06))	=IF(B7="","",IF(C7="inf",0.03,((G7^2)/(127*C7))+0.03))
=IF(C8="","",B7+1)	inf	400	=IF($B8="","",EG18)	=IF($B8="","",EH18)	=IF(C8="","",'Speed Analysis'!I9)	=IF(B8="","",IF(C8="inf",-0.06,((G8^2)/(127*C8))-0.06))	=IF(B8="","",IF(C8="inf",0.03,((G8^2)/(127*C8))+0.03))
=IF(C9="","",B8+1)	2000	510	=IF($B9="","",EG19)	=IF($B9="","",EH19)	=IF(C9="","",'Speed Analysis'!I10)	=IF(B9="","",IF(C9="inf",-0.06,((G9^2)/(127*C9))-0.06))	=IF(B9="","",IF(C9="inf",0.03,((G9^2)/(127*C9))+0.03))
=IF(C10="","",B9+1)	inf	120	=IF($B10="","",EG20)	=IF($B10="","",EH20)	=IF(C10="","",'Speed Analysis'!I11)	=IF(B10="","",IF(C10="inf",-0.06,((G10^2)/(127*C10))-0.06))	=IF(B10="","",IF(C10="inf",0.03,((G10^2)/(127*C10))+0.03))
=IF(C11="","",B10+1)	550	170	=IF($B11="","",EG21)	=IF($B11="","",EH21)	=IF(C11="","",'Speed Analysis'!I12)	=IF(B11="","",IF(C11="inf",-0.06,((G11^2)/(127*C11))-0.06))	=IF(B11="","",IF(C11="inf",0.03,((G11^2)/(127*C11))+0.03))
=IF(C12="","",B11+1)	750	230	=IF($B12="","",EG22)	=IF($B12="","",EH22)	=IF(C12="","",'Speed Analysis'!I13)	=IF(B12="","",IF(C12="inf",-0.06,((G12^2)/(127*C12))-0.06))	=IF(B12="","",IF(C12="inf",0.03,((G12^2)/(127*C12))+0.03))
=IF(C13="","",B12+1)	inf	100	=IF($B13="","",EG23)	=IF($B13="","",EH23)	=IF(C13="","",'Speed Analysis'!I14)	=IF(B13="","",IF(C13="inf",-0.06,((G13^2)/(127*C13))-0.06))	=IF(B13="","",IF(C13="inf",0.03,((G13^2)/(127*C13))+0.03))
=IF(C14="","",B13+1)	510	90	=IF($B14="","",EG24)	=IF($B14="","",EH24)	=IF(C14="","",'Speed Analysis'!I15)	=IF(B14="","",IF(C14="inf",-0.06,((G14^2)/(127*C14))-0.06))	=IF(B14="","",IF(C14="inf",0.03,((G14^2)/(127*C14))+0.03))
=IF(C15="","",B14+1)	360	250	=IF($B15="","",EG25)	=IF($B15="","",EH25)	=IF(C15="","",'Speed Analysis'!I16)	=IF(B15="","",IF(C15="inf",-0.06,((G15^2)/(127*C15))-0.06))	=IF(B15="","",IF(C15="inf",0.03,((G15^2)/(127*C15))+0.03))
=IF(C16="","",B15+1)	1800	150	=IF($B16="","",EG26)	=IF($B16="","",EH26)	=IF(C16="","",'Speed Analysis'!I17)	=IF(B16="","",IF(C16="inf",-0.06,((G16^2)/(127*C16))-0.06))	=IF(B16="","",IF(C16="inf",0.03,((G16^2)/(127*C16))+0.03))
=IF(C17="","",B16+1)	8300	430	=IF($B17="","",EG27)	=IF($B17="","",EH27)	=IF(C17="","",'Speed Analysis'!I18)	=IF(B17="","",IF(C17="inf",-0.06,((G17^2)/(127*C17))-0.06))	=IF(B17="","",IF(C17="inf",0.03,((G17^2)/(127*C17))+0.03))
=IF(C18="","",B17+1)	**275**	**120**	**=IF($B18="","",EG28)**	**=IF($B18="","",EH28)**	**=IF(C18="","",'Speed Analysis'!I19)**	**=IF(B18="","",IF(C18="inf",-0.06,((G18^2)/(127*C18))-0.06))**	**=IF(B18="","",IF(C18="inf",0.03,((G18^2)/(127*C18))+0.03))**
=IF(C19="","",B18+1)	inf	30	=IF($B19="","",EG29)	=IF($B19="","",EH29)	=IF(C19="","",'Speed Analysis'!I20)	=IF(B19="","",IF(C19="inf",-0.06,((G19^2)/(127*C19))-0.06))	=IF(B19="","",IF(C19="inf",0.03,((G19^2)/(127*C19))+0.03))
=IF(C20="","",B19+1)	**200**	**70**	**=IF($B20="","",EG30)**	**=IF($B20="","",EH30)**	**=IF(C20="","",'Speed Analysis'!I21)**	**=IF(B20="","",IF(C20="inf",-0.06,((G20^2)/(127*C20))-0.06))**	**=IF(B20="","",IF(C20="inf",0.03,((G20^2)/(127*C20))+0.03))**
=IF(C21="","",B20+1)	inf	50	=IF($B21="","",EG31)	=IF($B21="","",EH31)	=IF(C21="","",'Speed Analysis'!I22)	=IF(B21="","",IF(C21="inf",-0.06,((G21^2)/(127*C21))-0.06))	=IF(B21="","",IF(C21="inf",0.03,((G21^2)/(127*C21))+0.03))
=IF(C22="","",B21+1)	280	130	=IF($B22="","",EG32)	=IF($B22="","",EH32)	=IF(C22="","",'Speed Analysis'!I23)	=IF(B22="","",IF(C22="inf",-0.06,((G22^2)/(127*C22))-0.06))	=IF(B22="","",IF(C22="inf",0.03,((G22^2)/(127*C22))+0.03))
=IF(C23="","",B22+1)	inf	40	=IF($B23="","",EG33)	=IF($B23="","",EH33)	=IF(C23="","",'Speed Analysis'!I24)	=IF(B23="","",IF(C23="inf",-0.06,((G23^2)/(127*C23))-0.06))	=IF(B23="","",IF(C23="inf",0.03,((G23^2)/(127*C23))+0.03))
=IF(C24="","",B23+1)	540	100	=IF($B24="","",EG34)	=IF($B24="","",EH34)	=IF(C24="","",'Speed Analysis'!I25)	=IF(B24="","",IF(C24="inf",-0.06,((G24^2)/(127*C24))-0.06))	=IF(B24="","",IF(C24="inf",0.03,((G24^2)/(127*C24))+0.03))
=IF(C25="","",B24+1)	inf	150	=IF($B25="","",EG35)	=IF($B25="","",EH35)	=IF(C25="","",'Speed Analysis'!I26)	=IF(B25="","",IF(C25="inf",-0.06,((G25^2)/(127*C25))-0.06))	=IF(B25="","",IF(C25="inf",0.03,((G25^2)/(127*C25))+0.03))
=IF(C26="","",B25+1)	420	70	=IF($B26="","",EG36)	=IF($B26="","",EH36)	=IF(C26="","",'Speed Analysis'!I27)	=IF(B26="","",IF(C26="inf",-0.06,((G26^2)/(127*C26))-0.06))	=IF(B26="","",IF(C26="inf",0.03,((G26^2)/(127*C26))+0.03))
=IF(C27="","",B26+1)	inf	90	=IF($B27="","",EG37)	=IF($B27="","",EH37)	=IF(C27="","",'Speed Analysis'!I28)	=IF(B27="","",IF(C27="inf",-0.06,((G27^2)/(127*C27))-0.06))	=IF(B27="","",IF(C27="inf",0.03,((G27^2)/(127*C27))+0.03))
=IF(C28="","",B27+1)	**95**	**120**	**=IF($B28="","",EG38)**	**=IF($B28="","",EH38)**	**=IF(C28="","",'Speed Analysis'!I29)**	**=IF(B28="","",IF(C28="inf",-0.06,((G28^2)/(127*C28))-0.06))**	**=IF(B28="","",IF(C28="inf",0.03,((G28^2)/(127*C28))+0.03))**
=IF(C29="","",B28+1)	inf	30	=IF($B29="","",EG39)	=IF($B29="","",EH39)	=IF(C29="","",'Speed Analysis'!I30)	=IF(B29="","",IF(C29="inf",-0.06,((G29^2)/(127*C29))-0.06))	=IF(B29="","",IF(C29="inf",0.03,((G29^2)/(127*C29))+0.03))
=IF(C30="","",B29+1)	95	140	=IF($B30="","",EG40)	=IF($B30="","",EH40)	=IF(C30="","",'Speed Analysis'!I31)	=IF(B30="","",IF(C30="inf",-0.06,((G30^2)/(127*C30))-0.06))	=IF(B30="","",IF(C30="inf",0.03,((G30^2)/(127*C30))+0.03))
=IF(C31="","",B30+1)	1400	170	=IF($B31="","",EG41)	=IF($B31="","",EH41)	=IF(C31="","",'Speed Analysis'!I32)	=IF(B31="","",IF(C31="inf",-0.06,((G31^2)/(127*C31))-0.06))	=IF(B31="","",IF(C31="inf",0.03,((G31^2)/(127*C31))+0.03))
=IF(C32="","",B31+1)	inf	140	=IF($B32="","",EG42)	=IF($B32="","",EH42)	=IF(C32="","",'Speed Analysis'!I33)	=IF(B32="","",IF(C32="inf",-0.06,((G32^2)/(127*C32))-0.06))	=IF(B32="","",IF(C32="inf",0.03,((G32^2)/(127*C32))+0.03))
=IF(C33="","",B32+1)	570	100	=IF($B33="","",EG43)	=IF($B33="","",EH43)	=IF(C33="","",'Speed Analysis'!I34)	=IF(B33="","",IF(C33="inf",-0.06,((G33^2)/(127*C33))-0.06))	=IF(B33="","",IF(C33="inf",0.03,((G33^2)/(127*C33))+0.03))
=IF(C34="","",B33+1)	inf	100	=IF($B34="","",EG44)	=IF($B34="","",EH44)	=IF(C34="","",'Speed Analysis'!I35)	=IF(B34="","",IF(C34="inf",-0.06,((G34^2)/(127*C34))-0.06))	=IF(B34="","",IF(C34="inf",0.03,((G34^2)/(127*C34))+0.03))
=IF(C35="","",B34+1)	**190**	**135**	**=IF($B35="","",EG45)**	**=IF($B35="","",EH45)**	**=IF(C35="","",'Speed Analysis'!I36)**	**=IF(B35="","",IF(C35="inf",-0.06,((G35^2)/(127*C35))-0.06))**	**=IF(B35="","",IF(C35="inf",0.03,((G35^2)/(127*C35))+0.03))**
=IF(C36="","",B35+1)	inf	140	=IF($B36="","",EG46)	=IF($B36="","",EH46)	=IF(C36="","",'Speed Analysis'!I37)	=IF(B36="","",IF(C36="inf",-0.06,((G36^2)/(127*C36))-0.06))	=IF(B36="","",IF(C36="inf",0.03,((G36^2)/(127*C36))+0.03))
=IF(C37="","",B36+1)	360	110	=IF($B37="","",EG47)	=IF($B37="","",EH47)	=IF(C37="","",'Speed Analysis'!I38)	=IF(B37="","",IF(C37="inf",-0.06,((G37^2)/(127*C37))-0.06))	=IF(B37="","",IF(C37="inf",0.03,((G37^2)/(127*C37))+0.03))
=IF(C38="","",B37+1)	inf	65	=IF($B38="","",EG48)	=IF($B38="","",EH48)	=IF(C38="","",'Speed Analysis'!I39)	=IF(B38="","",IF(C38="inf",-0.06,((G38^2)/(127*C38))-0.06))	=IF(B38="","",IF(C38="inf",0.03,((G38^2)/(127*C38))+0.03))
=IF(C39="","",B38+1)	**140**	**65**	**=IF($B39="","",EG49)**	**=IF($B39="","",EH49)**	**=IF(C39="","",'Speed Analysis'!I40)**	**=IF(B39="","",IF(C39="inf",-0.06,((G39^2)/(127*C39))-0.06))**	**=IF(B39="","",IF(C39="inf",0.03,((G39^2)/(127*C39))+0.03))**
=IF(C40="","",B39+1)	inf	200	=IF($B40="","",EG50)	=IF($B40="","",EH50)	=IF(C40="","",'Speed Analysis'!I41)	=IF(B40="","",IF(C40="inf",-0.06,((G40^2)/(127*C40))-0.06))	=IF(B40="","",IF(C40="inf",0.03,((G40^2)/(127*C40))+0.03))
=IF(C41="","",B40+1)	265	90	=IF($B41="","",EG51)	=IF($B41="","",EH51)	=IF(C41="","",'Speed Analysis'!I42)	=IF(B41="","",IF(C41="inf",-0.06,((G41^2)/(127*C41))-0.06))	=IF(B41="","",IF(C41="inf",0.03,((G41^2)/(127*C41))+0.03))
=IF(C42="","",B41+1)	inf	150	=IF($B42="","",EG52)	=IF($B42="","",EH52)	=IF(C42="","",'Speed Analysis'!I43)	=IF(B42="","",IF(C42="inf",-0.06,((G42^2)/(127*C42))-0.06))	=IF(B42="","",IF(C42="inf",0.03,((G42^2)/(127*C42))+0.03))
=IF(C43="","",B42+1)	470	100	=IF($B43="","",EG53)	=IF($B43="","",EH53)	=IF(C43="","",'Speed Analysis'!I44)	=IF(B43="","",IF(C43="inf",-0.06,((G43^2)/(127*C43))-0.06))	=IF(B43="","",IF(C43="inf",0.03,((G43^2)/(127*C43))+0.03))
=IF(C44="","",B43+1)	750	150	=IF($B44="","",EG54)	=IF($B44="","",EH54)	=IF(C44="","",'Speed Analysis'!I45)	=IF(B44="","",IF(C44="inf",-0.06,((G44^2)/(127*C44))-0.06))	=IF(B44="","",IF(C44="inf",0.03,((G44^2)/(127*C44))+0.03))
=IF(C45="","",B44+1)	inf	180	=IF($B45="","",EG55)	=IF($B45="","",EH55)	=IF(C45="","",'Speed Analysis'!I46)	=IF(B45="","",IF(C45="inf",-0.06,((G45^2)/(127*C45))-0.06))	=IF(B45="","",IF(C45="inf",0.03,((G45^2)/(127*C45))+0.03))
=IF(C46="","",B45+1)	310	110	=IF($B46="","",EG56)	=IF($B46="","",EH56)	=IF(C46="","",'Speed Analysis'!I47)	=IF(B46="","",IF(C46="inf",-0.06,((G46^2)/(127*C46))-0.06))	=IF(B46="","",IF(C46="inf",0.03,((G46^2)/(127*C46))+0.03))
=IF(C47="","",B46+1)	inf	40	=IF($B47="","",EG57)	=IF($B47="","",EH57)	=IF(C47="","",'Speed Analysis'!I48)	=IF(B47="","",IF(C47="inf",-0.06,((G47^2)/(127*C47))-0.06))	=IF(B47="","",IF(C47="inf",0.03,((G47^2)/(127*C47))+0.03))
=IF(C48="","",B47+1)			=IF($B48="","",EG58)	=IF($B48="","",EH58)	=IF(C48="","",'Speed Analysis'!I49)	=IF(B48="","",IF(C48="inf",-0.06,((G48^2)/(127*C48))-0.06))	=IF(B48="","",IF(C48="inf",0.03,((G48^2)/(127*C48))+0.03))
=IF(C49="","",B48+1)			=IF($B49="","",EG59)	=IF($B49="","",EH59)	=IF(C49="","",'Speed Analysis'!I50)	=IF(B49="","",IF(C49="inf",-0.06,((G49^2)/(127*C49))-0.06))	=IF(B49="","",IF(C49="inf",0.03,((G49^2)/(127*C49))+0.03))
=IF(C50="","",B49+1)			=IF($B50="","",EG60)	=IF($B50="","",EH60)	=IF(C50="","",'Speed Analysis'!I51)	=IF(B50="","",IF(C50="inf",-0.06,((G50^2)/(127*C50))-0.06))	=IF(B50="","",IF(C50="inf",0.03,((G50^2)/(127*C50))+0.03))
=IF(C51="","",B50+1)			=IF($B51="","",EG61)	=IF($B51="","",EH61)	=IF(C51="","",'Speed Analysis'!I52)	=IF(B51="","",IF(C51="inf",-0.06,((G51^2)/(127*C51))-0.06))	=IF(B51="","",IF(C51="inf",0.03,((G51^2)/(127*C51))+0.03))
=IF(C52="","",B51+1)			=IF($B52="","",EG62)	=IF($B52="","",EH62)	=IF(C52="","",'Speed Analysis'!I53)	=IF(B52="","",IF(C52="inf",-0.06,((G52^2)/(127*C52))-0.06))	=IF(B52="","",IF(C52="inf",0.03,((G52^2)/(127*C52))+0.03))
=IF(C53="","",B52+1)			=IF($B53="","",EG63)	=IF($B53="","",EH63)	=IF(C53="","",'Speed Analysis'!I54)	=IF(B53="","",IF(C53="inf",-0.06,((G53^2)/(127*C53))-0.06))	=IF(B53="","",IF(C53="inf",0.03,((G53^2)/(127*C53))+0.03))
=IF(C54="","",B53+1)			=IF($B54="","",EG64)	=IF($B54="","",EH64)	=IF(C54="","",'Speed Analysis'!I55)	=IF(B54="","",IF(C54="inf",-0.06,((G54^2)/(127*C54))-0.06))	=IF(B54="","",IF(C54="inf",0.03,((G54^2)/(127*C54))+0.03))
=IF(C55="","",B54+1)			=IF($B55="","",EG65)	=IF($B55="","",EH65)	=IF(C55="","",'Speed Analysis'!I56)	=IF(B55="","",IF(C55="inf",-0.06,((G55^2)/(127*C55))-0.06))	=IF(B55="","",IF(C55="inf",0.03,((G55^2)/(127*C55))+0.03))

Side Friction Check
=IF(B6="","",IF(MIN(H6:I6)<=VLOOKUP(ROUNDUP(G6/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H6:I6)<=VLOOKUP(ROUNDUP(G6/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B7="","",IF(MIN(H7:I7)<=VLOOKUP(ROUNDUP(G7/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H7:I7)<=VLOOKUP(ROUNDUP(G7/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B8="","",IF(MIN(H8:I8)<=VLOOKUP(ROUNDUP(G8/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H8:I8)<=VLOOKUP(ROUNDUP(G8/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B9="","",IF(MIN(H9:I9)<=VLOOKUP(ROUNDUP(G9/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H9:I9)<=VLOOKUP(ROUNDUP(G9/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B10="","",IF(MIN(H10:I10)<=VLOOKUP(ROUNDUP(G10/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H10:I10)<=VLOOKUP(ROUNDUP(G10/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B11="","",IF(MIN(H11:I11)<=VLOOKUP(ROUNDUP(G11/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H11:I11)<=VLOOKUP(ROUNDUP(G11/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B12="","",IF(MIN(H12:I12)<=VLOOKUP(ROUNDUP(G12/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H12:I12)<=VLOOKUP(ROUNDUP(G12/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B13="","",IF(MIN(H13:I13)<=VLOOKUP(ROUNDUP(G13/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H13:I13)<=VLOOKUP(ROUNDUP(G13/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B14="","",IF(MIN(H14:I14)<=VLOOKUP(ROUNDUP(G14/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H14:I14)<=VLOOKUP(ROUNDUP(G14/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B15="","",IF(MIN(H15:I15)<=VLOOKUP(ROUNDUP(G15/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H15:I15)<=VLOOKUP(ROUNDUP(G15/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B16="","",IF(MIN(H16:I16)<=VLOOKUP(ROUNDUP(G16/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H16:I16)<=VLOOKUP(ROUNDUP(G16/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B17="","",IF(MIN(H17:I17)<=VLOOKUP(ROUNDUP(G17/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H17:I17)<=VLOOKUP(ROUNDUP(G17/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B18="","",IF(MIN(H18:I18)<=VLOOKUP(ROUNDUP(G18/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H18:I18)<=VLOOKUP(ROUNDUP(G18/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B19="","",IF(MIN(H19:I19)<=VLOOKUP(ROUNDUP(G19/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H19:I19)<=VLOOKUP(ROUNDUP(G19/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B20="","",IF(MIN(H20:I20)<=VLOOKUP(ROUNDUP(G20/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H20:I20)<=VLOOKUP(ROUNDUP(G20/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B21="","",IF(MIN(H21:I21)<=VLOOKUP(ROUNDUP(G21/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H21:I21)<=VLOOKUP(ROUNDUP(G21/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B22="","",IF(MIN(H22:I22)<=VLOOKUP(ROUNDUP(G22/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H22:I22)<=VLOOKUP(ROUNDUP(G22/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B23="","",IF(MIN(H23:I23)<=VLOOKUP(ROUNDUP(G23/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H23:I23)<=VLOOKUP(ROUNDUP(G23/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B24="","",IF(MIN(H24:I24)<=VLOOKUP(ROUNDUP(G24/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H24:I24)<=VLOOKUP(ROUNDUP(G24/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B25="","",IF(MIN(H25:I25)<=VLOOKUP(ROUNDUP(G25/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H25:I25)<=VLOOKUP(ROUNDUP(G25/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B26="","",IF(MIN(H26:I26)<=VLOOKUP(ROUNDUP(G26/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H26:I26)<=VLOOKUP(ROUNDUP(G26/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B27="","",IF(MIN(H27:I27)<=VLOOKUP(ROUNDUP(G27/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H27:I27)<=VLOOKUP(ROUNDUP(G27/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B28="","",IF(MIN(H28:I28)<=VLOOKUP(ROUNDUP(G28/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H28:I28)<=VLOOKUP(ROUNDUP(G28/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B29="","",IF(MIN(H29:I29)<=VLOOKUP(ROUNDUP(G29/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H29:I29)<=VLOOKUP(ROUNDUP(G29/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B30="","",IF(MIN(H30:I30)<=VLOOKUP(ROUNDUP(G30/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H30:I30)<=VLOOKUP(ROUNDUP(G30/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B31="","",IF(MIN(H31:I31)<=VLOOKUP(ROUNDUP(G31/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H31:I31)<=VLOOKUP(ROUNDUP(G31/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B32="","",IF(MIN(H32:I32)<=VLOOKUP(ROUNDUP(G32/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H32:I32)<=VLOOKUP(ROUNDUP(G32/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B33="","",IF(MIN(H33:I33)<=VLOOKUP(ROUNDUP(G33/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H33:I33)<=VLOOKUP(ROUNDUP(G33/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B34="","",IF(MIN(H34:I34)<=VLOOKUP(ROUNDUP(G34/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H34:I34)<=VLOOKUP(ROUNDUP(G34/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B35="","",IF(MIN(H35:I35)<=VLOOKUP(ROUNDUP(G35/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H35:I35)<=VLOOKUP(ROUNDUP(G35/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B36="","",IF(MIN(H36:I36)<=VLOOKUP(ROUNDUP(G36/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H36:I36)<=VLOOKUP(ROUNDUP(G36/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B37="","",IF(MIN(H37:I37)<=VLOOKUP(ROUNDUP(G37/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H37:I37)<=VLOOKUP(ROUNDUP(G37/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B38="","",IF(MIN(H38:I38)<=VLOOKUP(ROUNDUP(G38/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H38:I38)<=VLOOKUP(ROUNDUP(G38/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B39="","",IF(MIN(H39:I39)<=VLOOKUP(ROUNDUP(G39/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H39:I39)<=VLOOKUP(ROUNDUP(G39/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B40="","",IF(MIN(H40:I40)<=VLOOKUP(ROUNDUP(G40/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H40:I40)<=VLOOKUP(ROUNDUP(G40/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B41="","",IF(MIN(H41:I41)<=VLOOKUP(ROUNDUP(G41/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H41:I41)<=VLOOKUP(ROUNDUP(G41/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B42="","",IF(MIN(H42:I42)<=VLOOKUP(ROUNDUP(G42/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H42:I42)<=VLOOKUP(ROUNDUP(G42/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B43="","",IF(MIN(H43:I43)<=VLOOKUP(ROUNDUP(G43/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H43:I43)<=VLOOKUP(ROUNDUP(G43/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B44="","",IF(MIN(H44:I44)<=VLOOKUP(ROUNDUP(G44/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H44:I44)<=VLOOKUP(ROUNDUP(G44/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B45="","",IF(MIN(H45:I45)<=VLOOKUP(ROUNDUP(G45/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H45:I45)<=VLOOKUP(ROUNDUP(G45/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B46="","",IF(MIN(H46:I46)<=VLOOKUP(ROUNDUP(G46/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H46:I46)<=VLOOKUP(ROUNDUP(G46/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B47="","",IF(MIN(H47:I47)<=VLOOKUP(ROUNDUP(G47/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H47:I47)<=VLOOKUP(ROUNDUP(G47/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B48="","",IF(MIN(H48:I48)<=VLOOKUP(ROUNDUP(G48/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H48:I48)<=VLOOKUP(ROUNDUP(G48/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B49="","",IF(MIN(H49:I49)<=VLOOKUP(ROUNDUP(G49/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H49:I49)<=VLOOKUP(ROUNDUP(G49/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B50="","",IF(MIN(H50:I50)<=VLOOKUP(ROUNDUP(G50/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H50:I50)<=VLOOKUP(ROUNDUP(G50/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B51="","",IF(MIN(H51:I51)<=VLOOKUP(ROUNDUP(G51/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H51:I51)<=VLOOKUP(ROUNDUP(G51/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B52="","",IF(MIN(H52:I52)<=VLOOKUP(ROUNDUP(G52/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H52:I52)<=VLOOKUP(ROUNDUP(G52/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B53="","",IF(MIN(H53:I53)<=VLOOKUP(ROUNDUP(G53/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H53:I53)<=VLOOKUP(ROUNDUP(G53/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B54="","",IF(MIN(H54:I54)<=VLOOKUP(ROUNDUP(G54/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H54:I54)<=VLOOKUP(ROUNDUP(G54/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))
=IF(B55="","",IF(MIN(H55:I55)<=VLOOKUP(ROUNDUP(G55/5,0)*5,R$49:T$66,3,TRUE),"Ok",IF(MIN(H55:I55)<=VLOOKUP(ROUNDUP(G55/5,0)*5,R$49:T$66,2,TRUE),"Undesirable","Unacceptable")))

Side Friction Increase	Speed Reduction
=IF(B7="","",IF(C6="inf","Ok",IF(C7="inf","Ok",IF(MAX(H6:I6)>(1.25*MIN(H7:I7)),"Ok","Check!"))))	=IF(B7="","",G6-G7)
=IF(B8="","",IF(C7="inf",IF(D7>(2*G8),"Ok",IF(MAX(H6:I6)>(1.25*MIN(H8:I8)),"Ok","Check!")),IF(C8="inf","Ok",IF(MAX(H7:I7)>(1.25*MIN(H8:I8)),"Ok","Check!"))))	=IF(B8="","",G7-G8)
=IF(B9="","",IF(C8="inf",IF(D8>(2*G9),"Ok",IF(MAX(H7:I7)>(1.25*MIN(H9:I9)),"Ok","Check!")),IF(C9="inf","Ok",IF(MAX(H8:I8)>(1.25*MIN(H9:I9)),"Ok","Check!"))))	=IF(B9="","",G8-G9)
=IF(B10="","",IF(C9="inf",IF(D9>(2*G10),"Ok",IF(MAX(H8:I8)>(1.25*MIN(H10:I10)),"Ok","Check!")),IF(C10="inf","Ok",IF(MAX(H9:I9)>(1.25*MIN(H10:I10)),"Ok","Check!"))))	=IF(B10="","",G9-G10)
=IF(B11="","",IF(C10="inf",IF(D10>(2*G11),"Ok",IF(MAX(H9:I9)>(1.25*MIN(H11:I11)),"Ok","Check!")),IF(C11="inf","Ok",IF(MAX(H10:I10)>(1.25*MIN(H11:I11)),"Ok","Check!"))))	=IF(B11="","",G10-G11)
=IF(B12="","",IF(C11="inf",IF(D11>(2*G12),"Ok",IF(MAX(H10:I10)>(1.25*MIN(H12:I12)),"Ok","Check!")),IF(C12="inf","Ok",IF(MAX(H11:I11)>(1.25*MIN(H12:I12)),"Ok","Check!"))))	=IF(B12="","",G11-G12)
=IF(B13="","",IF(C12="inf",IF(D12>(2*G13),"Ok",IF(MAX(H11:I11)>(1.25*MIN(H13:I13)),"Ok","Check!")),IF(C13="inf","Ok",IF(MAX(H12:I12)>(1.25*MIN(H13:I13)),"Ok","Check!"))))	=IF(B13="","",G12-G13)
=IF(B14="","",IF(C13="inf",IF(D13>(2*G14),"Ok",IF(MAX(H12:I12)>(1.25*MIN(H14:I14)),"Ok","Check!")),IF(C14="inf","Ok",IF(MAX(H13:I13)>(1.25*MIN(H14:I14)),"Ok","Check!"))))	=IF(B14="","",G13-G14)
=IF(B15="","",IF(C14="inf",IF(D14>(2*G15),"Ok",IF(MAX(H13:I13)>(1.25*MIN(H15:I15)),"Ok","Check!")),IF(C15="inf","Ok",IF(MAX(H14:I14)>(1.25*MIN(H15:I15)),"Ok","Check!"))))	**=IF(B15="","",G14-G15)**
=IF(B16="","",IF(C15="inf",IF(D15>(2*G16),"Ok",IF(MAX(H14:I14)>(1.25*MIN(H16:I16)),"Ok","Check!")),IF(C16="inf","Ok",IF(MAX(H15:I15)>(1.25*MIN(H16:I16)),"Ok","Check!"))))	=IF(B16="","",G15-G16)
=IF(B17="","",IF(C16="inf",IF(D16>(2*G17),"Ok",IF(MAX(H15:I15)>(1.25*MIN(H17:I17)),"Ok","Check!")),IF(C17="inf","Ok",IF(MAX(H16:I16)>(1.25*MIN(H17:I17)),"Ok","Check!"))))	=IF(B17="","",G16-G17)
=IF(B18="","",IF(C17="inf",IF(D17>(2*G18),"Ok",IF(MAX(H16:I16)>(1.25*MIN(H18:I18)),"Ok","Check!")),IF(C18="inf","Ok",IF(MAX(H17:I17)>(1.25*MIN(H18:I18)),"Ok","Check!"))))	**=IF(B18="","",G17-G18)**
=IF(B19="","",IF(C18="inf",IF(D18>(2*G19),"Ok",IF(MAX(H17:I17)>(1.25*MIN(H19:I19)),"Ok","Check!")),IF(C19="inf","Ok",IF(MAX(H18:I18)>(1.25*MIN(H19:I19)),"Ok","Check!"))))	=IF(B19="","",G18-G19)
=IF(B20="","",IF(C19="inf",IF(D19>(2*G20),"Ok",IF(MAX(H18:I18)>(1.25*MIN(H20:I20)),"Ok","Check!")),IF(C20="inf","Ok",IF(MAX(H19:I19)>(1.25*MIN(H20:I20)),"Ok","Check!"))))	**=IF(B20="","",G19-G20)**
=IF(B21="","",IF(C20="inf",IF(D20>(2*G21),"Ok",IF(MAX(H19:I19)>(1.25*MIN(H21:I21)),"Ok","Check!")),IF(C21="inf","Ok",IF(MAX(H20:I20)>(1.25*MIN(H21:I21)),"Ok","Check!"))))	=IF(B21="","",G20-G21)
=IF(B22="","",IF(C21="inf",IF(D21>(2*G22),"Ok",IF(MAX(H20:I20)>(1.25*MIN(H22:I22)),"Ok","Check!")),IF(C22="inf","Ok",IF(MAX(H21:I21)>(1.25*MIN(H22:I22)),"Ok","Check!"))))	=IF(B22="","",G21-G22)
=IF(B23="","",IF(C22="inf",IF(D22>(2*G23),"Ok",IF(MAX(H21:I21)>(1.25*MIN(H23:I23)),"Ok","Check!")),IF(C23="inf","Ok",IF(MAX(H22:I22)>(1.25*MIN(H23:I23)),"Ok","Check!"))))	=IF(B23="","",G22-G23)
=IF(B24="","",IF(C23="inf",IF(D23>(2*G24),"Ok",IF(MAX(H22:I22)>(1.25*MIN(H24:I24)),"Ok","Check!")),IF(C24="inf","Ok",IF(MAX(H23:I23)>(1.25*MIN(H24:I24)),"Ok","Check!"))))	=IF(B24="","",G23-G24)
=IF(B25="","",IF(C24="inf",IF(D24>(2*G25),"Ok",IF(MAX(H23:I23)>(1.25*MIN(H25:I25)),"Ok","Check!")),IF(C25="inf","Ok",IF(MAX(H24:I24)>(1.25*MIN(H25:I25)),"Ok","Check!"))))	=IF(B25="","",G24-G25)
=IF(B26="","",IF(C25="inf",IF(D25>(2*G26),"Ok",IF(MAX(H24:I24)>(1.25*MIN(H26:I26)),"Ok","Check!")),IF(C26="inf","Ok",IF(MAX(H25:I25)>(1.25*MIN(H26:I26)),"Ok","Check!"))))	=IF(B26="","",G25-G26)
=IF(B27="","",IF(C26="inf",IF(D26>(2*G27),"Ok",IF(MAX(H25:I25)>(1.25*MIN(H27:I27)),"Ok","Check!")),IF(C27="inf","Ok",IF(MAX(H26:I26)>(1.25*MIN(H27:I27)),"Ok","Check!"))))	=IF(B27="","",G26-G27)
=IF(B28="","",IF(C27="inf",IF(D27>(2*G28),"Ok",IF(MAX(H26:I26)>(1.25*MIN(H28:I28)),"Ok","Check!")),IF(C28="inf","Ok",IF(MAX(H27:I27)>(1.25*MIN(H28:I28)),"Ok","Check!"))))	**=IF(B28="","",G27-G28)**
=IF(B29="","",IF(C28="inf",IF(D28>(2*G29),"Ok",IF(MAX(H27:I27)>(1.25*MIN(H29:I29)),"Ok","Check!")),IF(C29="inf","Ok",IF(MAX(H28:I28)>(1.25*MIN(H29:I29)),"Ok","Check!"))))	**=IF(B29="","",G28-G29)**
=IF(B30="","",IF(C29="inf",IF(D29>(2*G30),"Ok",IF(MAX(H28:I28)>(1.25*MIN(H30:I30)),"Ok","Check!")),IF(C30="inf","Ok",IF(MAX(H29:I29)>(1.25*MIN(H30:I30)),"Ok","Check!"))))	=IF(B30="","",G29-G30)
=IF(B31="","",IF(C30="inf",IF(D30>(2*G31),"Ok",IF(MAX(H29:I29)>(1.25*MIN(H31:I31)),"Ok","Check!")),IF(C31="inf","Ok",IF(MAX(H30:I30)>(1.25*MIN(H31:I31)),"Ok","Check!"))))	=IF(B31="","",G30-G31)
=IF(B32="","",IF(C31="inf",IF(D31>(2*G32),"Ok",IF(MAX(H30:I30)>(1.25*MIN(H32:I32)),"Ok","Check!")),IF(C32="inf","Ok",IF(MAX(H31:I31)>(1.25*MIN(H32:I32)),"Ok","Check!"))))	=IF(B32="","",G31-G32)
=IF(B33="","",IF(C32="inf",IF(D32>(2*G33),"Ok",IF(MAX(H31:I31)>(1.25*MIN(H33:I33)),"Ok","Check!")),IF(C33="inf","Ok",IF(MAX(H32:I32)>(1.25*MIN(H33:I33)),"Ok","Check!"))))	=IF(B33="","",G32-G33)
=IF(B34="","",IF(C33="inf",IF(D33>(2*G34),"Ok",IF(MAX(H32:I32)>(1.25*MIN(H34:I34)),"Ok","Check!")),IF(C34="inf","Ok",IF(MAX(H33:I33)>(1.25*MIN(H34:I34)),"Ok","Check!"))))	=IF(B34="","",G33-G34)
=IF(B35="","",IF(C34="inf",IF(D34>(2*G35),"Ok",IF(MAX(H33:I33)>(1.25*MIN(H35:I35)),"Ok","Check!")),IF(C35="inf","Ok",IF(MAX(H34:I34)>(1.25*MIN(H35:I35)),"Ok","Check!"))))	**=IF(B35="","",G34-G35)**
=IF(B36="","",IF(C35="inf",IF(D35>(2*G36),"Ok",IF(MAX(H34:I34)>(1.25*MIN(H36:I36)),"Ok","Check!")),IF(C36="inf","Ok",IF(MAX(H35:I35)>(1.25*MIN(H36:I36)),"Ok","Check!"))))	=IF(B36="","",G35-G36)
=IF(B37="","",IF(C36="inf",IF(D36>(2*G37),"Ok",IF(MAX(H35:I35)>(1.25*MIN(H37:I37)),"Ok","Check!")),IF(C37="inf","Ok",IF(MAX(H36:I36)>(1.25*MIN(H37:I37)),"Ok","Check!"))))	=IF(B37="","",G36-G37)
=IF(B38="","",IF(C37="inf",IF(D37>(2*G38),"Ok",IF(MAX(H36:I36)>(1.25*MIN(H38:I38)),"Ok","Check!")),IF(C38="inf","Ok",IF(MAX(H37:I37)>(1.25*MIN(H38:I38)),"Ok","Check!"))))	=IF(B38="","",G37-G38)
=IF(B39="","",IF(C38="inf",IF(D38>(2*G39),"Ok",IF(MAX(H37:I37)>(1.25*MIN(H39:I39)),"Ok","Check!")),IF(C39="inf","Ok",IF(MAX(H38:I38)>(1.25*MIN(H39:I39)),"Ok","Check!"))))	**=IF(B39="","",G38-G39)**
=IF(B40="","",IF(C39="inf",IF(D39>(2*G40),"Ok",IF(MAX(H38:I38)>(1.25*MIN(H40:I40)),"Ok","Check!")),IF(C40="inf","Ok",IF(MAX(H39:I39)>(1.25*MIN(H40:I40)),"Ok","Check!"))))	=IF(B40="","",G39-G40)
=IF(B41="","",IF(C40="inf",IF(D40>(2*G41),"Ok",IF(MAX(H39:I39)>(1.25*MIN(H41:I41)),"Ok","Check!")),IF(C41="inf","Ok",IF(MAX(H40:I40)>(1.25*MIN(H41:I41)),"Ok","Check!"))))	=IF(B41="","",G40-G41)
=IF(B42="","",IF(C41="inf",IF(D41>(2*G42),"Ok",IF(MAX(H40:I40)>(1.25*MIN(H42:I42)),"Ok","Check!")),IF(C42="inf","Ok",IF(MAX(H41:I41)>(1.25*MIN(H42:I42)),"Ok","Check!"))))	=IF(B42="","",G41-G42)
=IF(B43="","",IF(C42="inf",IF(D42>(2*G43),"Ok",IF(MAX(H41:I41)>(1.25*MIN(H43:I43)),"Ok","Check!")),IF(C43="inf","Ok",IF(MAX(H42:I42)>(1.25*MIN(H43:I43)),"Ok","Check!"))))	=IF(B43="","",G42-G43)
=IF(B44="","",IF(C43="inf",IF(D43>(2*G44),"Ok",IF(MAX(H42:I42)>(1.25*MIN(H44:I44)),"Ok","Check!")),IF(C44="inf","Ok",IF(MAX(H43:I43)>(1.25*MIN(H44:I44)),"Ok","Check!"))))	=IF(B44="","",G43-G44)
=IF(B45="","",IF(C44="inf",IF(D44>(2*G45),"Ok",IF(MAX(H43:I43)>(1.25*MIN(H45:I45)),"Ok","Check!")),IF(C45="inf","Ok",IF(MAX(H44:I44)>(1.25*MIN(H45:I45)),"Ok","Check!"))))	=IF(B45="","",G44-G45)
=IF(B46="","",IF(C45="inf",IF(D45>(2*G46),"Ok",IF(MAX(H44:I44)>(1.25*MIN(H46:I46)),"Ok","Check!")),IF(C46="inf","Ok",IF(MAX(H45:I45)>(1.25*MIN(H46:I46)),"Ok","Check!"))))	=IF(B46="","",G45-G46)
=IF(B47="","",IF(C46="inf",IF(D46>(2*G47),"Ok",IF(MAX(H45:I45)>(1.25*MIN(H47:I47)),"Ok","Check!")),IF(C47="inf","Ok",IF(MAX(H46:I46)>(1.25*MIN(H47:I47)),"Ok","Check!"))))	=IF(B47="","",G46-G47)
=IF(B48="","",IF(C47="inf",IF(D47>(2*G48),"Ok",IF(MAX(H46:I46)>(1.25*MIN(H48:I48)),"Ok","Check!")),IF(C48="inf","Ok",IF(MAX(H47:I47)>(1.25*MIN(H48:I48)),"Ok","Check!"))))	**=IF(B48="","",G47-G48)**
=IF(B49="","",IF(C48="inf",IF(D48>(2*G49),"Ok",IF(MAX(H47:I47)>(1.25*MIN(H49:I49)),"Ok","Check!")),IF(C49="inf","Ok",IF(MAX(H48:I48)>(1.25*MIN(H49:I49)),"Ok","Check!"))))	**=IF(B49="","",G48-G49)**
=IF(B50="","",IF(C49="inf",IF(D49>(2*G50),"Ok",IF(MAX(H48:I48)>(1.25*MIN(H50:I50)),"Ok","Check!")),IF(C50="inf","Ok",IF(MAX(H49:I49)>(1.25*MIN(H50:I50)),"Ok","Check!"))))	**=IF(B50="","",G49-G50)**
=IF(B51="","",IF(C50="inf",IF(D50>(2*G51),"Ok",IF(MAX(H49:I49)>(1.25*MIN(H51:I51)),"Ok","Check!")),IF(C51="inf","Ok",IF(MAX(H50:I50)>(1.25*MIN(H51:I51)),"Ok","Check!"))))	**=IF(B51="","",G50-G51)**
=IF(B52="","",IF(C51="inf",IF(D51>(2*G52),"Ok",IF(MAX(H50:I50)>(1.25*MIN(H52:I52)),"Ok","Check!")),IF(C52="inf","Ok",IF(MAX(H51:I51)>(1.25*MIN(H52:I52)),"Ok","Check!"))))	**=IF(B52="","",G51-G52)**
=IF(B53="","",IF(C52="inf",IF(D52>(2*G53),"Ok",IF(MAX(H51:I51)>(1.25*MIN(H53:I53)),"Ok","Check!")),IF(C53="inf","Ok",IF(MAX(H52:I52)>(1.25*MIN(H53:I53)),"Ok","Check!"))))	**=IF(B53="","",G52-G53)**
=IF(B54="","",IF(C53="inf",IF(D53>(2*G54),"Ok",IF(MAX(H52:I52)>(1.25*MIN(H54:I54)),"Ok","Check!")),IF(C54="inf","Ok",IF(MAX(H53:I53)>(1.25*MIN(H54:I54)),"Ok","Check!"))))	**=IF(B54="","",G53-G54)**
=IF(B55="","",IF(C54="inf",IF(D54>(2*G55),"Ok",IF(MAX(H53:I53)>(1.25*MIN(H55:I55)),"Ok","Check!")),IF(C55="inf","Ok",IF(MAX(H54:I54)>(1.25*MIN(H55:I55)),"Ok","Check!"))))	**=IF(B55="","",G54-G55)**

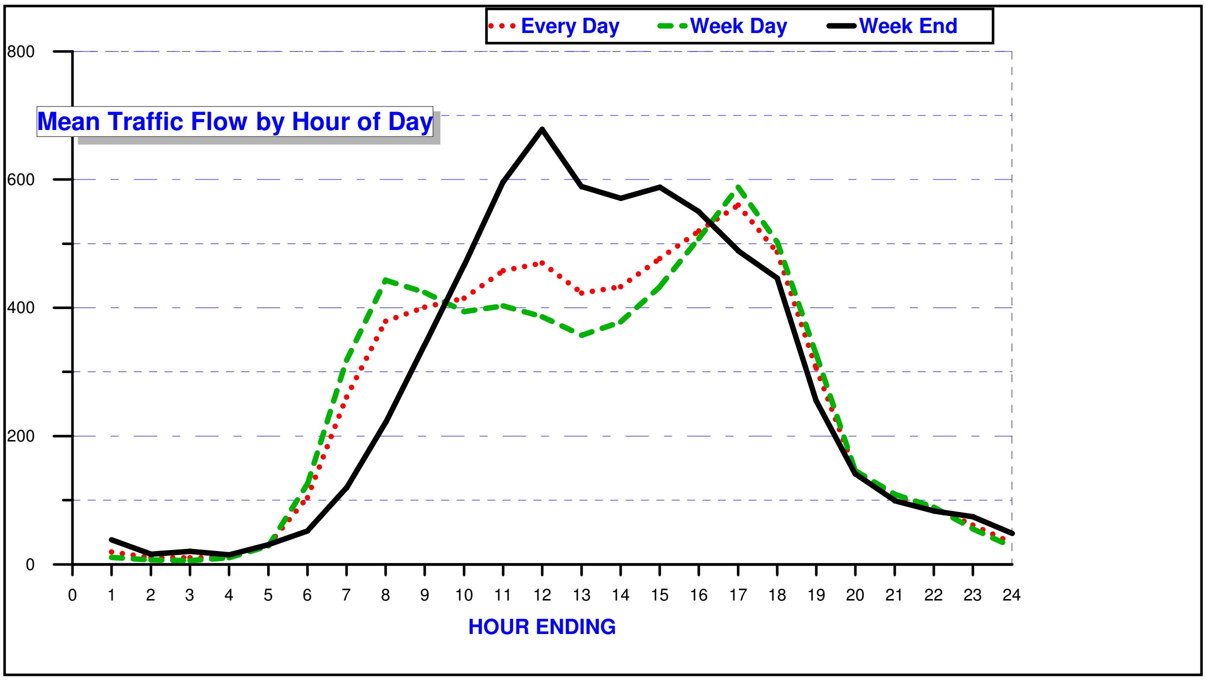
Appendix E

Mt Nathan Road Traffic Counts

Traffic Analysis and Reporting System
WEEKLY SUMMARY REPORT

District	1 SOUTH COAST HINTERLAND DISTRICT		Mean Counts for
Road Section	202 BEAUDESERT - NERANG ROAD		06-AUG-2007
Site	11431 150 metres south of Crystal Springs Ct		12-AUG-2007
Type	COVERAGE	TDist 43.3	
Site Stream	All Site Streams		
Traffic Class	00 All Vehicles		
Data Class	0 Volume	Range 0	

Hour	Monday	%	Tuesday	%	Wednesday	%	Thursday	%	Friday	%	Saturday	%	Sunday	%	Average Week Day	%	Average Week End	%	Average Day	%
00- 01	10	.2	9	.2	15	.3	12	.2	9	.1	42	.7	33	.5	11	.2	38	.6	19	.3
01- 02	11	.2	9	.2	4	.1	5	.1	6	.1	17	.3	15	.2	7	.1	16	.2	10	.2
02- 03	2	.0	8	.1	7	.1	5	.1	9	.1	16	.3	23	.3	6	.1	20	.3	10	.2
03- 04	9	.2	6	.1	11	.2	13	.2	9	.1	14	.2	16	.2	10	.2	15	.2	11	.2
04- 05	29	.5	33	.6	27	.5	24	.4	32	.5	35	.6	27	.4	29	.5	31	.5	30	.5
05- 06	134	2.2	143	2.4	117	2.0	113	1.9	120	1.8	62	1.0	42	.6	125	2.1	52	.8	104	1.7
06- 07	334	5.6	304	5.1	333	5.6	318	5.3	303	4.6	136	2.2	102	1.5	318	5.2	119	1.8	261	4.2
07- 08	445	7.4	448	7.6	435	7.4	447	7.4	438	6.7	230	3.7	211	3.1	443	7.3	221	3.4	379	6.1
08- 09	430	7.2	401	6.8	429	7.3	428	7.1	433	6.6	362	5.8	322	4.7	424	7.0	342	5.2	401	6.5
09- 10	397	6.6	386	6.5	412	7.0	372	6.2	404	6.2	464	7.4	468	6.9	394	6.5	466	7.1	415	6.7
10- 11	411	6.9	374	6.3	411	6.9	405	6.7	415	6.3	552	8.9	639	9.4	403	6.6	596	9.1	458	7.4
11- 12	380	6.4	355	6.0	401	6.8	374	6.2	421	6.4	623	10.0	733	10.8	386	6.4	678	10.4	470	7.6
12- 13	353	5.9	355	6.0	342	5.8	320	5.3	413	6.3	542	8.7	636	9.3	357	5.9	589	9.0	423	6.8
13- 14	410	6.9	356	6.0	358	6.1	375	6.2	392	6.0	534	8.6	608	8.9	378	6.2	571	8.8	433	7.0
14- 15	414	6.9	412	7.0	397	6.7	396	6.6	545	8.3	515	8.3	660	9.7	433	7.1	588	9.0	477	7.7
15- 16	508	8.5	490	8.3	493	8.3	501	8.3	550	8.4	470	7.5	629	9.2	508	8.4	550	8.4	520	8.4
16- 17	568	9.5	583	9.9	566	9.6	571	9.5	654	10.0	435	7.0	543	8.0	588	9.7	489	7.5	560	9.0
17- 18	514	8.6	506	8.6	467	7.9	506	8.4	523	8.0	441	7.1	450	6.6	503	8.3	446	6.8	487	7.8
18- 19	271	4.5	324	5.5	313	5.3	355	5.9	373	5.7	256	4.1	253	3.7	327	5.4	255	3.9	306	4.9
19- 20	122	2.0	144	2.4	137	2.3	165	2.7	162	2.5	141	2.3	141	2.1	146	2.4	141	2.2	145	2.3
20- 21	106	1.8	103	1.7	105	1.8	120	2.0	113	1.7	99	1.6	99	1.5	109	1.8	99	1.5	106	1.7
21- 22	63	1.1	82	1.4	77	1.3	111	1.8	110	1.7	90	1.4	75	1.1	89	1.5	83	1.3	87	1.4
22- 23	47	.8	57	1.0	39	.7	59	1.0	75	1.1	92	1.5	55	.8	55	.9	74	1.1	61	1.0
23- 24	16	.3	26	.4	21	.4	19	.3	55	.8	64	1.0	32	.5	27	.5	48	.7	33	.5
Peaks	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value
AM	8:00	445	8:00	448	8:00	435	8:00	447	8:00	438	12:00	623	12:00	733	8:00	443	12:00	678	12:00	470
PM	17:00	568	17:00	583	17:00	566	17:00	571	17:00	654	13:00	542	15:00	660	17:00	588	13:00	589	17:00	560
12 Hour	5,101	85.2	4,990	84.4	5,024	84.9	5,050	84.0	5,561	84.7	5,424	87.0	6,152	90.3	5,145	84.6	5,788	88.7	5,329	85.9
16 Hour	5,726	95.7	5,623	95.1	5,676	95.9	5,764	95.8	6,249	95.2	5,890	94.5	6,569	96.4	5,808	95.5	6,230	95.5	5,928	95.5
18 Hour	5,789	96.7	5,706	96.5	5,736	96.9	5,842	97.1	6,379	97.2	6,046	97.0	6,656	97.7	5,890	96.9	6,351	97.4	6,022	97.0
24 Hour	5,984	100.0	5,914	100.0	5,917	100.0	6,014	100.0	6,564	100.0	6,232	100.0	6,812	100.0	6,079	100.0	6,522	100.0	6,205	100.0
AVG Week Day		98.4%		97.3%		97.3%		98.9%		108.0%						100.0%		107.3%		102.1%
AVG Week End												95.6%		104.4%		93.2%		100.0%		95.1%
AVG Day		96.4%		95.3%		95.4%		96.9%		105.8%		100.4%		109.8%		98.0%		105.1%		100.0%



Traffic Analysis and Reporting System
WEEKLY SUMMARY REPORT

District	1 SOUTH COAST HINTERLAND DISTRICT
Road Section	202 BEAUDESERT - NERANG ROAD
Site	11431 150 metres south of Crystal Springs Ct
Type	COVERAGE
TDist	43.3
Site Stream	Gazettal Direction
Traffic Class	00 All Vehicles
Data Class	0 Volume
Range	0

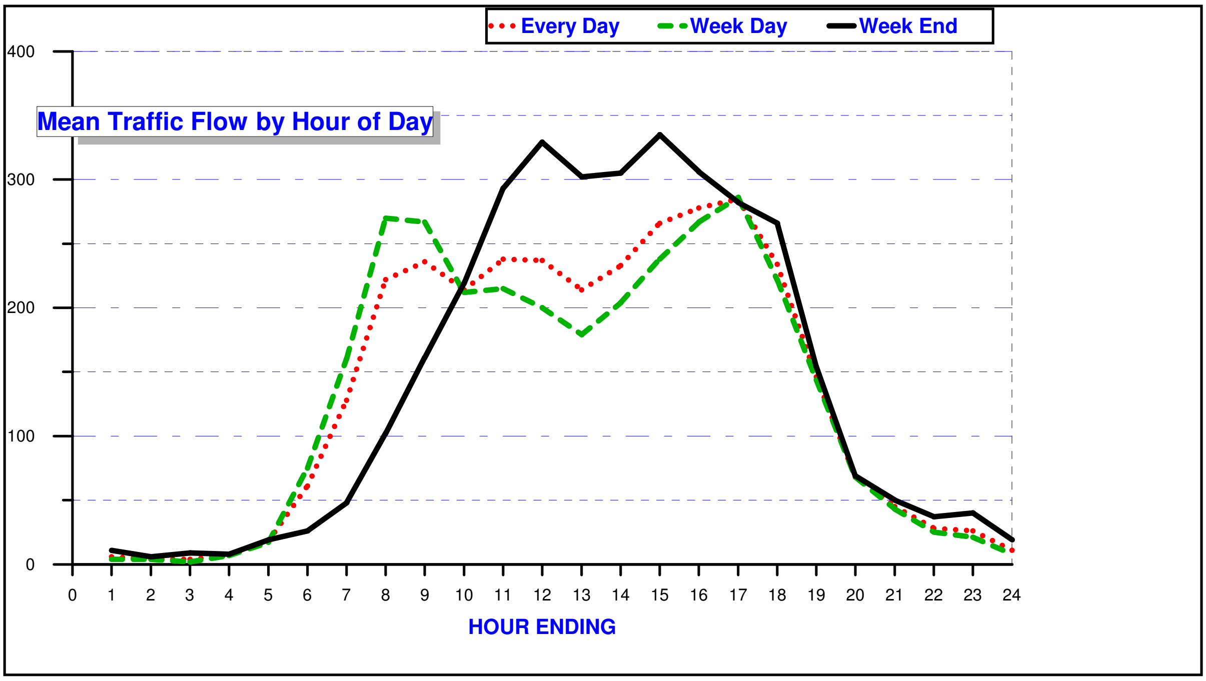
Mean Counts for
06-AUG-2007
12-AUG-2007

Hour	Monday	%	Tuesday	%	Wednesday	%	Thursday	%	Friday	%	Saturday	%	Sunday	%	Average Week Day	%	Average Week End	%	Average Day	%
00- 01	2	.1	2	.1	8	.3	4	.1	4	.1	9	.3	13	.4	4	.1	11	.3	6	.2
01- 02	5	.2	5	.2	4	.1	2	.1	2	.1	9	.3	2	.1	4	.1	6	.2	4	.1
02- 03	1	.0	4	.1	1	.0	2	.1	4	.1	7	.2	10	.3	2	.1	9	.3	4	.1
03- 04	8	.3	4	.1	8	.3	9	.3	5	.1	6	.2	9	.3	7	.2	8	.2	7	.2
04- 05	21	.7	19	.6	13	.4	13	.4	21	.6	19	.6	18	.5	17	.6	19	.5	18	.6
05- 06	75	2.4	82	2.7	64	2.1	78	2.5	74	2.2	34	1.1	18	.5	75	2.4	26	.8	61	1.9
06- 07	168	5.4	154	5.1	177	5.8	153	4.9	150	4.4	56	1.7	40	1.1	160	5.1	48	1.4	128	4.0
07- 08	271	8.8	278	9.2	267	8.8	275	8.8	257	7.5	118	3.7	86	2.4	270	8.6	102	3.0	222	6.9
08- 09	270	8.7	272	9.0	251	8.3	265	8.5	275	8.1	193	6.0	128	3.6	267	8.5	161	4.7	236	7.4
09- 10	220	7.1	224	7.4	219	7.2	184	5.9	212	6.2	228	7.1	209	5.8	212	6.8	219	6.4	214	6.7
10- 11	227	7.3	189	6.2	221	7.3	220	7.1	220	6.5	285	8.9	301	8.4	215	6.9	293	8.6	238	7.4
11- 12	185	6.0	172	5.7	212	7.0	207	6.6	224	6.6	321	10.0	337	9.4	200	6.4	329	9.7	237	7.4
12- 13	184	6.0	164	5.4	171	5.6	165	5.3	211	6.2	258	8.0	345	9.7	179	5.7	302	8.9	214	6.7
13- 14	213	6.9	203	6.7	191	6.3	208	6.7	203	6.0	290	9.0	320	9.0	204	6.5	305	9.0	233	7.2
14- 15	228	7.4	221	7.3	220	7.2	222	7.1	300	8.8	270	8.4	400	11.2	238	7.6	335	9.9	266	8.3
15- 16	270	8.7	241	8.0	249	8.2	282	9.0	292	8.6	246	7.7	365	10.2	267	8.5	306	9.0	278	8.7
16- 17	263	8.5	280	9.3	284	9.3	276	8.8	327	9.6	232	7.2	331	9.3	286	9.1	282	8.3	285	8.9
17- 18	224	7.2	224	7.4	212	7.0	225	7.2	225	6.6	246	7.7	285	8.0	222	7.1	266	7.8	234	7.3
18- 19	118	3.8	144	4.8	141	4.6	145	4.6	170	5.0	146	4.6	161	4.5	144	4.6	154	4.5	146	4.6
19- 20	54	1.7	67	2.2	57	1.9	79	2.5	82	2.4	67	2.1	70	2.0	68	2.2	69	2.0	68	2.1
20- 21	42	1.4	27	.9	36	1.2	51	1.6	59	1.7	48	1.5	51	1.4	43	1.4	50	1.5	45	1.4
21- 22	19	.6	23	.8	16	.5	31	1.0	34	1.0	40	1.2	34	1.0	25	.8	37	1.1	28	.9
22- 23	16	.5	23	.8	12	.4	18	.6	37	1.1	49	1.5	30	.8	21	.7	40	1.2	26	.8
23- 24	8	.3	4	.1	4	.1	5	.2	21	.6	28	.9	10	.3	8	.3	19	.6	11	.4

Peaks	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value
AM	8:00	271	8:00	278	8:00	267	8:00	275	9:00	275	12:00	321	12:00	337	8:00	270	12:00	329	11:00	238
PM	16:00	270	17:00	280	17:00	284	16:00	282	17:00	327	14:00	290	15:00	400	17:00	286	15:00	335	17:00	285

12 Hour	2,673	86.4	2,612	86.3	2,638	86.8	2,674	85.7	2,916	85.5	2,833	88.4	3,268	91.5	2,703	86.2	3,051	90.0	2,802	87.3
16 Hour	2,956	95.6	2,883	95.3	2,924	96.2	2,988	95.8	3,241	95.1	3,044	95.0	3,463	96.9	2,998	95.6	3,254	96.0	3,071	95.7
18 Hour	2,980	96.4	2,910	96.2	2,940	96.8	3,011	96.5	3,299	96.8	3,121	97.4	3,503	98.0	3,028	96.5	3,312	97.7	3,109	96.9
24 Hour	3,092	100.0	3,026	100.0	3,038	100.0	3,119	100.0	3,409	100.0	3,205	100.0	3,573	100.0	3,137	100.0	3,389	100.0	3,209	100.0

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Average Week Day	Average Week End	Average Day
AVG Week Day	98.6%	96.5%	96.9%	99.4%	108.7%			100.0%	108.0%	102.3%
AVG Week End						94.6%	105.4%	92.6%	100.0%	94.7%
AVG Day	96.4%	94.3%	94.7%	97.2%	106.2%	99.9%	111.3%	97.8%	105.6%	100.0%



Traffic Analysis and Reporting System
WEEKLY SUMMARY REPORT

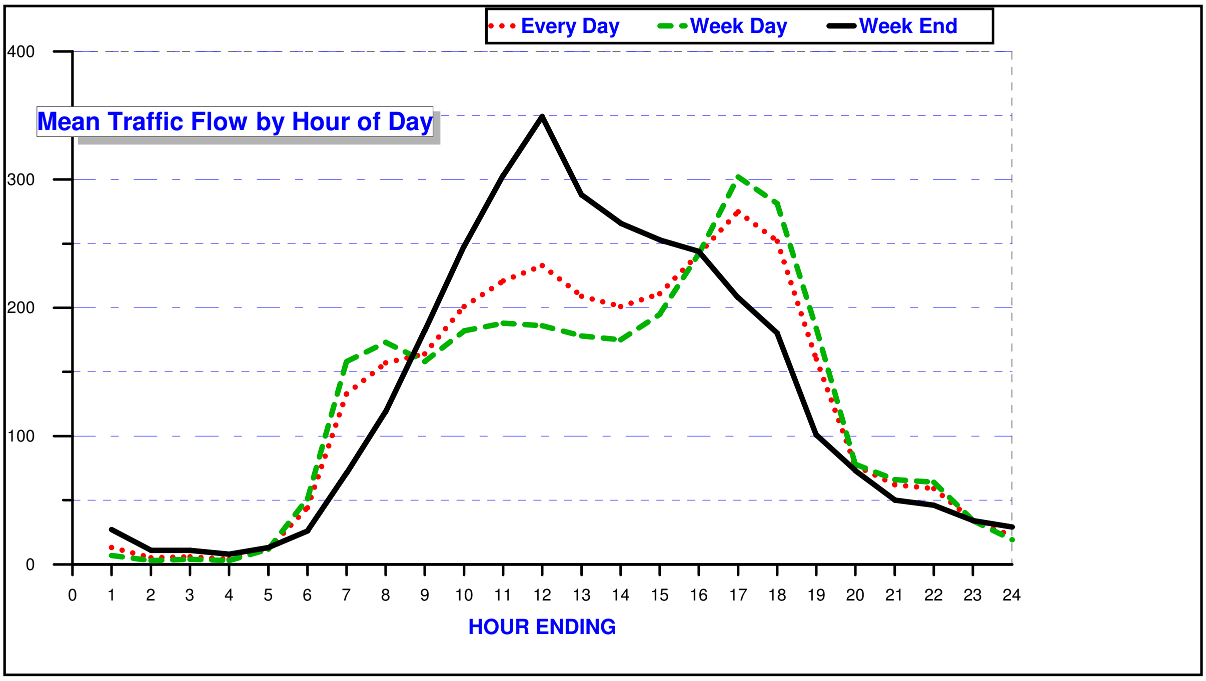
District	1 SOUTH COAST HINTERLAND DISTRICT		Mean Counts for
Road Section	202 BEAUDESERT - NERANG ROAD		06-AUG-2007
Site	11431 150 metres south of Crystal Springs Ct		12-AUG-2007
Type	COVERAGE	TDist	43.3
Site Stream	Against Gazettal		
Traffic Class	00 All Vehicles		
Data Class	0 Volume	Range	0

Hour	Monday	%	Tuesday	%	Wednesday	%	Thursday	%	Friday	%	Saturday	%	Sunday	%	Average Week Day	%	Average Week End	%	Average Day	%
00- 01	8	.3	7	.2	7	.2	8	.3	5	.2	33	1.1	20	.6	7	.2	27	.8	13	.4
01- 02	6	.2	4	.1	0	.0	3	.1	4	.1	8	.3	13	.4	3	.1	11	.3	5	.2
02- 03	1	.0	4	.1	6	.2	3	.1	5	.2	9	.3	13	.4	4	.1	11	.4	6	.2
03- 04	1	.0	2	.1	3	.1	4	.1	4	.1	8	.3	7	.2	3	.1	8	.2	4	.1
04- 05	8	.3	14	.5	14	.5	11	.4	11	.3	16	.5	9	.3	12	.4	13	.4	12	.4
05- 06	59	2.0	61	2.1	53	1.8	35	1.2	46	1.5	28	.9	24	.7	51	1.7	26	.8	44	1.5
06- 07	166	5.7	150	5.2	156	5.4	165	5.7	153	4.8	80	2.6	62	1.9	158	5.4	71	2.3	133	4.4
07- 08	174	6.0	170	5.9	168	5.8	172	5.9	181	5.7	112	3.7	125	3.9	173	5.9	119	3.8	157	5.3
08- 09	160	5.5	129	4.5	178	6.2	163	5.6	158	5.0	169	5.6	194	6.0	158	5.4	182	5.8	164	5.5
09- 10	177	6.1	162	5.6	193	6.7	188	6.5	192	6.1	236	7.8	259	8.0	182	6.2	248	7.9	201	6.7
10- 11	184	6.4	185	6.4	190	6.6	185	6.4	195	6.2	267	8.8	338	10.4	188	6.4	303	9.7	221	7.4
11- 12	195	6.7	183	6.3	189	6.6	167	5.8	197	6.2	302	10.0	396	12.2	186	6.3	349	11.1	233	7.8
12- 13	169	5.8	191	6.6	171	5.9	155	5.4	202	6.4	284	9.4	291	9.0	178	6.0	288	9.2	209	7.0
13- 14	197	6.8	153	5.3	167	5.8	167	5.8	189	6.0	244	8.1	288	8.9	175	5.9	266	8.5	201	6.7
14- 15	186	6.4	191	6.6	177	6.1	174	6.0	245	7.8	245	8.1	260	8.0	195	6.6	253	8.1	211	7.0
15- 16	238	8.2	249	8.6	244	8.5	219	7.6	258	8.2	224	7.4	264	8.2	242	8.2	244	7.8	242	8.1
16- 17	305	10.5	303	10.5	282	9.8	295	10.2	327	10.4	203	6.7	212	6.5	302	10.3	208	6.6	275	9.2
17- 18	290	10.0	282	9.8	255	8.9	281	9.7	298	9.4	195	6.4	165	5.1	281	9.6	180	5.7	252	8.4
18- 19	153	5.3	180	6.2	172	6.0	210	7.3	203	6.4	110	3.6	92	2.8	184	6.2	101	3.2	160	5.3
19- 20	68	2.4	77	2.7	80	2.8	86	3.0	80	2.5	74	2.4	71	2.2	78	2.7	73	2.3	77	2.6
20- 21	64	2.2	76	2.6	69	2.4	69	2.4	54	1.7	51	1.7	48	1.5	66	2.3	50	1.6	62	2.1
21- 22	44	1.5	59	2.0	61	2.1	80	2.8	76	2.4	50	1.7	41	1.3	64	2.2	46	1.5	59	2.0
22- 23	31	1.1	34	1.2	27	.9	41	1.4	38	1.2	43	1.4	25	.8	34	1.2	34	1.1	34	1.1
23- 24	8	.3	22	.8	17	.6	14	.5	34	1.1	36	1.2	22	.7	19	.6	29	.9	22	.7

Peaks	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value
AM	12:00	195	11:00	185	10:00	193	10:00	188	12:00	197	12:00	302	12:00	396	11:00	188	12:00	349	12:00	233
PM	17:00	305	17:00	303	17:00	282	17:00	295	17:00	327	13:00	284	13:00	291	17:00	302	13:00	288	17:00	275

12 Hour	2,428	84.0	2,378	82.3	2,386	82.9	2,376	82.1	2,645	83.8	2,591	85.6	2,884	89.0	2,443	83.0	2,738	87.4	2,527	84.3
16 Hour	2,770	95.8	2,740	94.9	2,752	95.6	2,776	95.9	3,008	95.3	2,846	94.0	3,106	95.9	2,809	95.5	2,976	95.0	2,857	95.3
18 Hour	2,809	97.1	2,796	96.8	2,796	97.1	2,831	97.8	3,080	97.6	2,925	96.6	3,153	97.3	2,862	97.3	3,039	97.0	2,913	97.2
24 Hour	2,892	100.0	2,888	100.0	2,879	100.0	2,895	100.0	3,155	100.0	3,027	100.0	3,239	100.0	2,942	100.0	3,133	100.0	2,996	100.0

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Average Week Day	Average Week End	Average Day
AVG Week Day	98.3%	98.2%	97.9%	98.4%	107.2%			100.0%	106.5%	101.9%
AVG Week End						96.6%	103.4%	93.9%	100.0%	95.6%
AVG Day	96.5%	96.4%	96.1%	96.6%	105.3%	101.0%	108.1%	98.2%	104.6%	100.0%

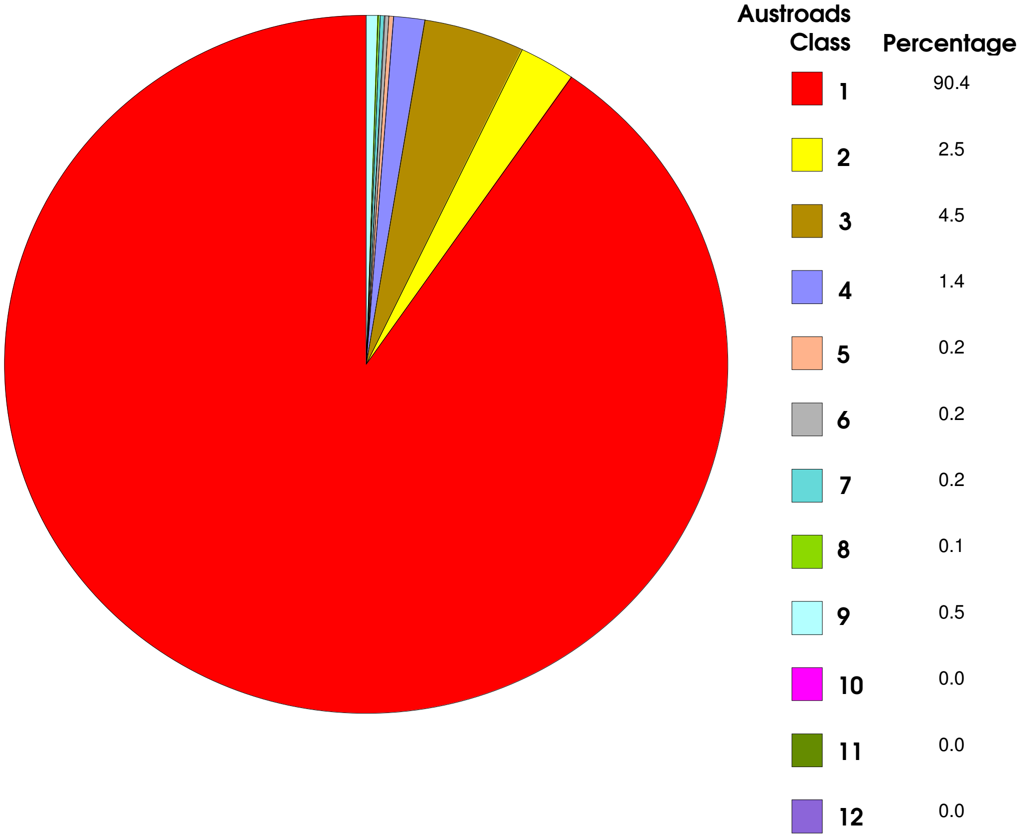


Traffic Analysis and Reporting System
CLASSIFIED VEHICLE REPORT

District	1 SOUTH COAST HINTERLAND DISTRICT
Road Section	202 BEAUDESERT - NERANG ROAD
Site	11431 150 metres south of Crystal Springs Ct
Tdist	43.3
Site Stream	All Site Streams
From	06-AUG-2007 To 12-AUG-2007

	Austroads Class												
Hour	1	2	3	4	5	6	7	8	9	10	11	12	Total
00-01	18	0	0	0	0	0	0	0	0	0	0	0	18
01-02	9	0	0	0	0	0	0	0	0	0	0	0	9
02-03	8	0	2	0	0	0	0	0	0	0	0	0	10
03-04	9	1	1	0	0	0	0	0	0	0	0	0	11
04-05	26	1	2	1	0	0	0	0	0	0	0	0	30
05-06	92	2	7	2	0	0	0	0	1	0	0	0	104
06-07	224	11	16	5	0	0	1	0	3	0	0	0	260
07-08	335	11	24	6	1	1	1	1	1	0	0	0	381
08-09	356	9	23	8	1	1	1	0	1	0	0	0	400
09-10	364	12	21	10	1	1	1	1	3	0	0	0	414
10-11	410	15	20	9	0	1	1	0	2	1	0	0	459
11-12	421	13	20	9	1	1	1	0	4	0	0	0	470
12-13	376	13	22	6	2	1	1	0	2	0	0	0	423
13-14	390	11	21	7	1	1	1	0	2	0	0	0	434
14-15	429	12	22	6	1	1	1	1	2	1	0	0	476
15-16	475	12	22	5	1	1	1	0	3	0	0	0	520
16-17	515	13	21	4	0	2	1	0	2	0	0	0	558
17-18	457	8	16	3	1	0	1	0	1	0	0	0	487
18-19	288	5	10	2	0	0	1	0	1	0	0	0	307
19-20	136	2	4	1	0	0	1	0	2	0	0	0	146
20-21	99	3	2	1	0	0	0	1	0	0	0	0	106
21-22	83	1	2	0	0	0	0	0	0	0	0	0	86
22-23	58	0	2	0	0	0	0	0	0	0	0	0	60
23-24	31	0	2	0	0	0	0	0	0	0	0	0	33
Total	**5609**	**155**	**282**	**85**	**10**	**11**	**14**	**4**	**30**	**2**	**0**	**0**	**6202**
Class%	**90.4**	**2.5**	**4.5**	**1.4**	**0.2**	**0.2**	**0.2**	**0.1**	**0.5**	**0.0**	**0.0**	**0.0**	

Light %	92.9
Heavy %	7.1
Short %	92.9
Truck or Bus %	6.1
Art. Veh. %	1.0
Rd. Train	0.0


Austroads Class
Percentage
1
90.4
2
2.5
3
4.5
4
1.4
5
0.2
6
0.2
7
0.2
8
0.1
9
0.5
10
0.0
11
0.0
12
0.0

Traffic Analysis and Reporting System
CLASSIFIED VEHICLE REPORT

District: 1 SOUTH COAST HINTERLAND DISTRICT

Road Section: 202 BEAUDESERT - NERANG ROAD

Site: 11431 150 metres south of Crystal Springs Ct

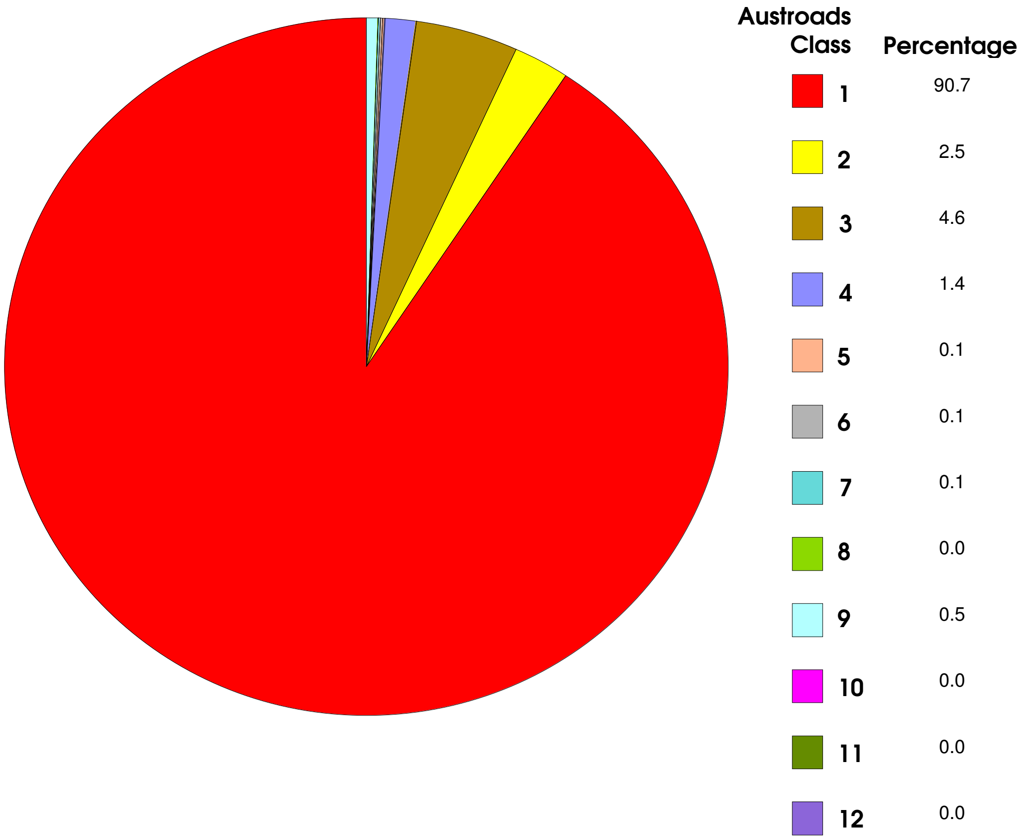
Tdist: 43.3

Site Stream: Gazettal Direction

From: 06-AUG-2007 To: 12-AUG-2007

	Austroads Class												
Hour	1	2	3	4	5	6	7	8	9	10	11	12	Total
00-01	6	0	0	0	0	0	0	0	0	0	0	0	6
01-02	4	0	0	0	0	0	0	0	0	0	0	0	4
02-03	3	0	0	0	0	0	0	0	0	0	0	0	3
03-04	5	0	1	0	0	0	0	0	0	0	0	0	6
04-05	15	1	1	0	0	0	0	0	0	0	0	0	17
05-06	54	1	4	1	0	0	0	0	0	0	0	0	60
06-07	111	5	9	1	0	0	0	0	2	0	0	0	128
07-08	200	5	12	3	0	0	0	0	1	0	0	0	221
08-09	214	5	12	4	1	0	0	0	1	0	0	0	237
09-10	190	6	10	5	0	0	0	0	1	0	0	0	212
10-11	211	8	11	5	0	0	0	0	1	0	0	0	236
11-12	212	8	10	5	0	0	0	0	1	0	0	0	236
12-13	188	7	13	3	1	0	0	0	1	0	0	0	213
13-14	210	5	10	4	0	1	1	0	1	0	0	0	232
14-15	238	6	12	4	1	1	0	1	2	1	0	0	266
15-16	254	6	11	3	0	1	1	0	1	0	0	0	277
16-17	258	8	11	4	0	1	1	0	1	0	0	0	284
17-18	220	3	8	2	0	0	0	0	1	0	0	0	234
18-19	135	2	7	1	0	0	0	0	0	0	0	0	145
19-20	62	1	2	1	0	0	0	0	2	0	0	0	68
20-21	41	2	1	0	0	0	0	0	0	0	0	0	44
21-22	27	0	1	0	0	0	0	0	0	0	0	0	28
22-23	25	0	1	0	0	0	0	0	0	0	0	0	26
23-24	11	0	1	0	0	0	0	0	0	0	0	0	12
Total	**2894**	**79**	**148**	**46**	**3**	**4**	**3**	**1**	**16**	**1**	**0**	**0**	**3195**
Class%	**90.7**	**2.5**	**4.6**	**1.4**	**0.1**	**0.1**	**0.1**	**0.0**	**0.5**	**0.0**	**0.0**	**0.0**	

Light %	93.2
Heavy %	6.8
Short %	93.2
Truck or Bus %	6.1
Art. Veh. %	0.7
Rd. Train	0.0


Austroads Class
Percentage
1 90.7
2 2.5
3 4.6
4 1.4
5 0.1
6 0.1
7 0.1
8 0.0
9 0.5
10 0.0
11 0.0
12 0.0

Traffic Analysis and Reporting System
CLASSIFIED VEHICLE REPORT

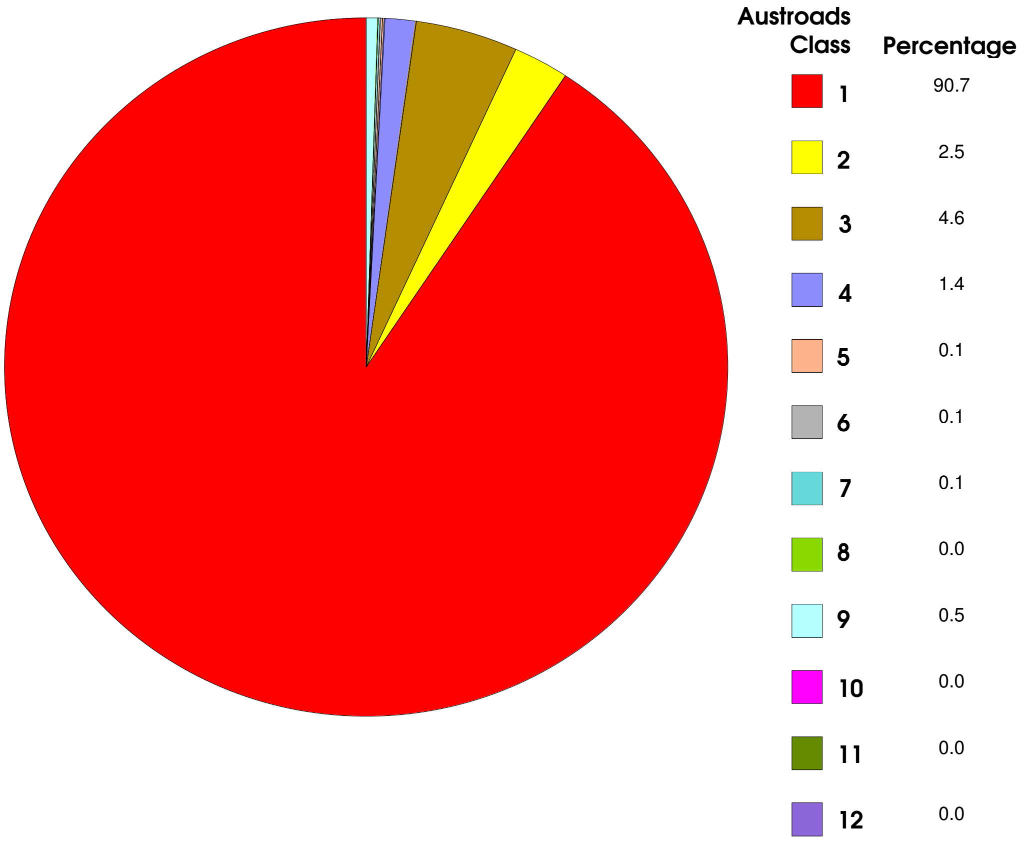
District	1 SOUTH COAST HINTERLAND DISTRICT
Road Section	202 BEAUDESERT - NERANG ROAD
Site	11431 150 metres south of Crystal Springs Ct
Tdist	43.3
Site Stream	Gazettal Direction
From	06-AUG-2007
To	12-AUG-2007

	Austroads Class												
Hour	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
00-01	6	0	0	0	0	0	0	0	0	0	0	0	6
01-02	4	0	0	0	0	0	0	0	0	0	0	0	4
02-03	3	0	0	0	0	0	0	0	0	0	0	0	3
03-04	5	0	1	0	0	0	0	0	0	0	0	0	6
04-05	15	1	1	0	0	0	0	0	0	0	0	0	17
05-06	54	1	4	1	0	0	0	0	0	0	0	0	60
06-07	111	5	9	1	0	0	0	0	2	0	0	0	128
07-08	200	5	12	3	0	0	0	0	1	0	0	0	221
08-09	214	5	12	4	1	0	0	0	1	0	0	0	237
09-10	190	6	10	5	0	0	0	0	1	0	0	0	212
10-11	211	8	11	5	0	0	0	0	1	0	0	0	236
11-12	212	8	10	5	0	0	0	0	1	0	0	0	236
12-13	188	7	13	3	1	0	0	0	1	0	0	0	213
13-14	210	5	10	4	0	1	1	0	1	0	0	0	232
14-15	238	6	12	4	1	1	0	1	2	1	0	0	266
15-16	254	6	11	3	0	1	1	0	1	0	0	0	277
16-17	258	8	11	4	0	1	1	0	1	0	0	0	284
17-18	220	3	8	2	0	0	0	0	1	0	0	0	234
18-19	135	2	7	1	0	0	0	0	0	0	0	0	145
19-20	62	1	2	1	0	0	0	0	2	0	0	0	68
20-21	41	2	1	0	0	0	0	0	0	0	0	0	44
21-22	27	0	1	0	0	0	0	0	0	0	0	0	28
22-23	25	0	1	0	0	0	0	0	0	0	0	0	26
23-24	11	0	1	0	0	0	0	0	0	0	0	0	12
Total	**2894**	**79**	**148**	**46**	**3**	**4**	**3**	**1**	**16**	**1**	**0**	**0**	**3195**
Class%	**90.7**	**2.5**	**4.6**	**1.4**	**0.1**	**0.1**	**0.1**	**0.0**	**0.5**	**0.0**	**0.0**	**0.0**	

Light %	93.2
Heavy %	6.8
Short %	93.2
Truck or Bus %	6.1
Art. Veh. %	0.7
Rd. Train	0.0

Queensland Government
Department of Main Roads

Traffic Analysis and Reporting System
CLASSIFIED VEHICLE REPORT



Queensland Government
Department of Main Roads

2001 Vehicle Classification Counts

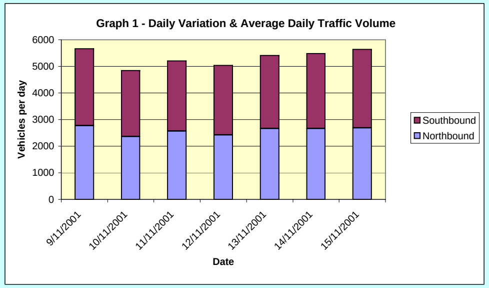
South Coast Hinterland District
Traffic Census

Location: Beaudesert - Nerang Road, Mt Nathan, between Oxenford - Coomera Gorge Road and Nerang - Murwillumbah Road

Site No. 32 **Site ID** 11431 **Survey Dates** Friday,9 November 2001 to Thursday,15 November 2001

	Northbound	Southbound	Total
Average Daily Traffic	2590	2734	5324
Average Weekday Traffic	2642	2802	5444
Percentage Heavy Vehicles	4.7%	4.1%	4.4%

	Northbound	Southbound
Mean Speed	92	89
85%ile Speed	102	98



Vehicle Distribution by AUSTROADS Classification

Direction 1 Northbound

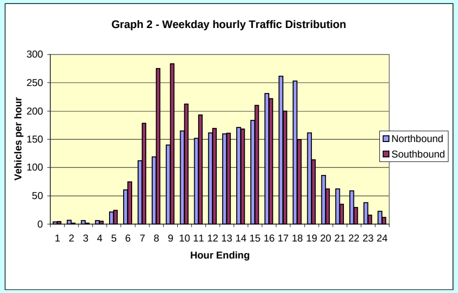
Date	Day	Volume	Class 1	Cl 2	Cl 3	Cl 4	Cl 5	Cl 6	Cl 7	Cl 8	Cl 9	Cl 10	Cl 11	Cl 12	Cl 13
9-Nov-01	6	2767	2558	60	101	13	3	3	9	8	9	1	0	0	2
10-Nov-01	7	2359	2255	46	36	12	3	0	4	0	3	0	0	0	0
11-Nov-01	1	2561	2432	74	36	5	0	3	8	1	1	0	0	0	1
12-Nov-01	2	2421	2238	53	85	12	3	1	10	5	14	0	0	0	0
13-Nov-01	3	2663	2457	58	94	24	5	1	11	4	7	1	0	0	1
14-Nov-01	4	2667	2460	51	99	26	8	1	5	5	9	3	0	0	0
15-Nov-01	5	2692	2463	72	95	28	6	7	5	4	7	1	1	0	3
	Average	**2590**	**2409**	**59**	**78**	**17**	**4**	**2**	**7**	**4**	**7**	**1**	**0**	**0**	**1**
	Percent	100.0%	93.0%	2.3%	3.0%	0.7%	0.2%	0.1%	0.3%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%

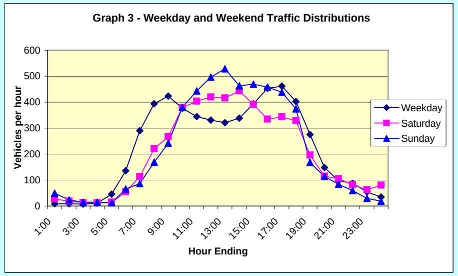
Direction 2 Southbound

Date	Day	Volume	Class 1	Cl 2	Cl 3	Cl 4	Cl 5	Cl 6	Cl 7	Cl 8	Cl 9	Cl 10	Cl 11	Cl 12	Cl 13
9-Nov-01	6	2892	2678	70	95	16	2	2	5	3	17	3	0	0	1
10-Nov-01	7	2484	2376	49	41	5	2	1	7	2	0	0	0	0	1
11-Nov-01	1	2640	2545	63	25	2	0	3	2	0	0	0	0	0	0
12-Nov-01	2	2611	2437	49	78	13	2	1	6	4	16	0	0	1	4
13-Nov-01	3	2743	2542	65	82	26	5	1	8	3	9	0	0	0	2
14-Nov-01	4	2820	2620	53	94	22	5	2	5	2	14	3	0	0	0
15-Nov-01	5	2945	2735	72	82	31	2	6	2	3	10	0	0	0	2
	Average	**2734**	**2562**	**60**	**71**	**16**	**3**	**2**	**5**	**2**	**9**	**1**	**0**	**0**	**1**
	Percent	100.0%	93.7%	2.2%	2.6%	0.6%	0.1%	0.1%	0.2%	0.1%	0.3%	0.0%	0.0%	0.0%	0.1%

Combined Average Daily Volumes

	Volume	Class 1	Cl 2	Cl 3	Cl 4	Cl 5	Cl 6	Cl 7	Cl 8	Cl 9	Cl 10	Cl 11	Cl 12	Cl 13
Total	**5324**	**4971**	**119**	**149**	**34**	**7**	**5**	**12**	**6**	**17**	**2**	**0**	**0**	**2**
Percent	100.0%	93.4%	2.2%	2.8%	0.6%	0.1%	0.1%	0.2%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%





Speed Distribution

Hour Ending	Direction 1 Northbound		Direction 2 Southbound	
	Ave Speed	85% Speed	Ave Speed	85% Speed
1:00	87	103	83	93
2:00	91	100	87	96
3:00	94	103	95	99
4:00	92	102	91	94
5:00	95	105	94	105
6:00	97	108	94	104
7:00	93	102	92	103
8:00	92	103	91	100
9:00	92	101	89	99
10:00	89	99	85	95
11:00	88	97	84	93
12:00	87	97	85	96
13:00	91	100	86	96
14:00	90	99	86	95
15:00	91	101	85	94
16:00	91	101	86	96
17:00	92	101	88	97
18:00	93	102	88	98
19:00	91	102	88	98
20:00	91	102	89	98
21:00	92	104	89	99
22:00	93	105	89	99
23:00	92	103	90	99
0:00	94	105	94	101

Appendix F

Mt Nathan Road Accident Data

DEFINITIONS FOR CODING ACCIDENTS

NOTE:- 1 = Key vehicle direction. ie; The direction in which the key vehicle was travelling as it approached the crash location.

	00	10	20	30	40	50	60	70	80	90
	PEDESTRIAN on foot or in toy/pram	**INTERSECTION** vehicles from adjacent approaches	**VEHICLES** from opposing directions	**VEHICLES** from one direction	**MANOEUVRING**	**OVERTAKING**	**ON PATH**	**OFF PATH ON STRAIGHT**	**OFF PATH ON CURVE**	**PASSENGERS & MISCELLANEOUS**
	OTHER 000	OTHER 100	OTHER 200	OTHER 300	OTHER 400	OTHER 500	OTHER 600	OTHER 700	OTHER 800	OTHER 900
1	NEAR SIDE 001	THRU - THRU 101	HEAD - ON 201	VEHICLES IN THE SAME LANE REAR END 301	LEAVING PARKING 401	HEAD - ON 501	PARKED 601	OFF CARRIAGEWAY TO LEFT 701	OFF CARRIAGEWAY RIGHT BEND 801	FELL IN/ FROM VEHICLE 901
2	EMERGING 002	RIGHT - THRU 102	THRU - RIGHT 202	LEFT REAR 302	PARKING 402	OUT OF CONTROL 502	DOUBLE PARKED 602	OFF CARRIAGEWAY TO RIGHT 702	OFF CARRIAGEWAY LEFT BEND 802	
3	FAR SIDE 003	LEFT - THRU 103	RIGHT - LEFT 203	RIGHT REAR 303	PARKING VEHICLES ONLY 403	PULLING OUT 503		LEFT OFF CARRIAGEWAY INTO OBJECT 703	OFF RIGHT BEND INTO OBJECT 803	HIT TRAIN 903
4	PLAYING, WORKING, LYING, STANDING ON CARRIAGEWAY 004	THRU - RIGHT 104	RIGHT 204	U TURN 304	REVERSING IN TRAFFIC 404	CUTTING IN 504	CAR DOOR 604	RIGHT OFF CARRIAGEWAY INTO OBJECT 704	OFF LEFT BEND INTO OBJECT 804	HIT RAILWAY X-ING FURNITURE 904
5	WALKING WITH TRAFFIC 005	RIGHT - RIGHT 105	THRU - LEFT 205	VEHICLES IN PARALLEL LANES LANE SIDE SWIPE 305	REVERSING INTO FIXED OBJECT 405	PULLING OUT REAR END 505	HIT PERMANENT OBSTRUCTION 605	OUT OF CONTROL ON CARRIAGEWAY 705	OUT OF CONTROL ON CARRIAGEWAY 805	HIT ANIMAL OFF CARRIAGEWAY 905
6	FACING TRAFFIC 006	LEFT - RIGHT 106	LEFT - LEFT 206	LANE CHANGE RIGHT 306	LEAVING DRIVEWAY 406	OVERTAKING RIGHT TURN 506	HIT TEMPORARY ROADWORK 606	LEFT TURN 706	LEFT TURN 806	PARKED VEHICLE RAN AWAY 906
7	DRIVEWAY 007	THRU - LEFT 107	U TURN 207	LANE CHANGE LEFT 307	FROM LOADING BAY 407		HIT TEMPORARY OBJECT ON CARRIAGEWAY 607	RIGHT TURN 707	RIGHT TURN 807	VEHICLE MOVEMENTS NOT KNOWN 907
8	ON FOOTWAY 008	RIGHT - LEFT 108		RIGHT TURN SIDE SWIPE 308	FROM FOOTWAY 408		ACCIDENT OR BROKEN DOWN 608	MOUNTS TRAFFIC ISLAND 708	MOUNTS TRAFFIC ISLAND 808	
9	STRUCK WHILE BOARDING OR ALIGHTING 009	LEFT - LEFT 109		LEFT TURN SIDE SWIPE 309			ANIMAL 609			
0				PULLING OUT 310			LOAD HITS VEHICLE 610			

Queensland Government
Department of Main Roads

Road Crash 2
CRASH LISTING REPORT

Crash Types

Crash Dates: 01-JAN-1992 - 29-OCT-2008

Owner: MR DEPARTMENT OF MAIN ROADS

DCA Cod:

Group:

Fatalities: =

Severity:

Nature:

Alignment: Vertical:

Horizontal:

Feature:

Traffic Ctrl:

Speed Limit:

Contrib Circ.:

Unit Type:

Risk Factor:

Area

LGA: | SLA: | Police Division:

Road Sections

All Road Sections ☐ Include Crashes or ☑ Thru road Mid-block ☑ Thru roads at Intersections ☑ Intersecting roads at Intersection

Road Section	Cway	Start RPC	Start Dist	End RPC	End Dist	Tdist Start	Tdist End	Fatal	Hosp.	Injury	PDO	Total
202 BEAUDESERT - NERANG ROAD		8	3.915	10	0.090	41.800	48.100	2	38	28	28	96

Intersections

All Intersections ☐

Road Section 202 Beaudesert - Nerang Road Cway Tdist 41.800 - 48.100

Road Section 201 Nerang - Murwillumbah Road

Crash No.	Date	Day	Hour	Dca	Key	Seve	Fatal	Feature	Vehicle 1	Vehicle 2	Inter	Cway	RPC	Dist	Tdist	Street 1	Street 2
920015652	13-JUL-1992	Mon	07	104	N	Hosp	0	11	Utility, Panel	Utility, Panel	83	1	1	0.000	0.000	Beaudesert - Nerang	Beechmont Rd
20040011796	10-MAY-2004	Mon	16	302	E	Treat	0	11	Car, Station \	Car, Station \	83	1	1	0.000	0.000	Beaudesert - Nerang	Nerang - Murwillumb
20050007222	24-MAR-2005	Thu	15	104	N	Inj	0	11	Car, Station \	Car, Station \	83	1	1	0.000	0.000	Beaudesert - Nerang	Nerang - Murwillumb
20050022549	08-SEP-2005	Thu	16	104	N	Inj	0	11	4-Wheel Driv	Car, Station \	83	1	1	0.000	0.000	Beaudesert - Nerang	Nerang - Murwillumb

Road Section 202 Beaudesert - Nerang Road

Crash No.	Date	Day	Hour	Dca	Key	Seve	Fatal	Feature	Vehicle 1	Vehicle 2	Inter	Cway	RPC	Dist	Tdist	Street 1	Street 2
980018812	28-AUG-1998	Fri	23	701	E	Prop	0	99	Car, Station \			1	8	3.935	41.820	Beaudesert - Nerang	
20600072039	27-SEP-2006	Wed	15	201	N	Treat	0	99	Car, Station \	Car, Station \		1	8	4.335	42.220	Beaudesert - Nerang	
940028987	15-DEC-1994	Thu	20	104	E	Hosp	0	11	Car, Station \	Motor Cycle	150	1	9	0.000	42.320	Beaudesert - Nerang	Oxenford - Coomera
940029000	15-DEC-1994	Thu	20	400	E	Treat	0	11	Car, Station \	Utility, Panel	150	1	9	0.000	42.320	Beaudesert - Nerang	Oxenford - Coomera
950008994	23-APR-1995	Sun	14	304	N	Prop	0	11	Car, Station \	Car, Station \	150	1	9	0.000	42.320	Beaudesert - Nerang	Oxenford - Coomera
960010845	11-MAY-1996	Sat	07	307	W	Prop	0	12	Car, Station \	Utility, Panel		1	9	0.000	42.320	Beaudesert - Nerang	Oxenford - Coomera
960014049	17-JUN-1996	Mon	09	307	W	Prop	0	11	Car, Station \	Car, Station \		1	9	0.000	42.320	Beaudesert - Nerang	Oxenford - Coomera
960028577	20-NOV-1996	Wed	05	202	N	Inj	0	11	Car, Station \	Car, Station \	150	1	9	0.000	42.320	Beaudesert - Nerang	Oxenford - Coomera
20600058321	02-SEP-2006	Sat	13	303	N	Prop	0	11	Car, Station \	Car, Station \	150	1	9	0.000	42.320	Beaudesert - Nerang	Oxenford - Coomera
20700255404	27-AUG-2007	Mon	22	408	S	Hosp	0	99	Car, Station \	Car, Station \		1	9	0.050	42.370	Beaudesert - Nerang	
20040027877	30-OCT-2004	Sat	08	301	S	Inj	0	99	4-Wheel Driv	Car, Station \		1	9	0.080	42.400	Beaudesert - Nerang	
20000026043	02-DEC-2000	Sat	17	705	N	Hosp	0	99	Car, Station \			1	9	0.250	42.570	Beaudesert - Nerang	
20600107304	29-NOV-2006	Wed	17	201	S	Hosp	0	99	Utility, Panel	Car, Station \		1	9	0.380	42.700	Beaudesert - Nerang	
20600067501	19-SEP-2006	Tue	19	104	W	Hosp	0	10	Car, Station \	Car, Station \	604	1	9	0.400	42.720	Beaudesert - Nerang	Crystal Springs Ct
20050000228	04-JAN-2005	Tue	21	308	N	Treat	0	99	Car, Station \	4-Wheel Driv		1	9	0.415	42.735	Beaudesert - Nerang	
980016630	02-AUG-1998	Sun	18	201	N	Hosp	0	99	Motor Cycle	Car, Station \		1	9	0.690	43.010	Beaudesert - Nerang	
20030009049	16-APR-2003	Wed	14	701	E	Treat	0	99	Car, Station \			1	9	0.690	43.010	Beaudesert - Nerang	

Road Crash 2
CRASH LISTING REPORT

Road Section 202 Beaudesert - Nerang Road Cway Tdist 41.800 - 48.100

Road Section 202 Beaudesert - Nerang Road

Crash No.	Date	Day	Hour	Dca	Key	Seve	Fatal	Feature	Vehicle 1	Vehicle 2	Inter	Cway	RPC	Dist	Tdist	Street 1	Street 2
980025757	03-NOV-1998	Tue	07	805	W	Prop	0	99	Utility, Panel			1	9	0.735	43.055	Beaudesert - Nerang	
20700131745	26-JUN-2007	Tue	16	704	W	Prop	0	99	Car, Station \			1	9	1.022	43.342	Beaudesert - Nerang	
20010009361	27-APR-2001	Fri	16	201	N	Fatal	1	99	Car, Station \	Truck		1	9	1.154	43.474	Beaudesert - Nerang	
940002698	06-FEB-1994	Sun	12	207	W	Hosp	0	99	Utility, Panel	Utility, Panel		1	9	1.454	43.774	Beaudesert - Nerang	
990004714	07-MAR-1999	Sun	11	801	S	Hosp	0	99	Utility, Panel			1	9	1.750	44.070	Beaudesert - Nerang	
20700002346	04-JAN-2007	Thu	22	800	N	Treat	0	99	Car, Station \			1	9	2.000	44.320	Beaudesert - Nerang	
20050027563	03-NOV-2005	Thu	01	609	N	Prop	0	99	Car, Station \	Animal - Othe		1	9	2.020	44.340	Beaudesert - Nerang	
970022037	06-OCT-1997	Mon	08	502	N	Hosp	0	99	Car, Station \			1	9	2.120	44.440	Beaudesert - Nerang	
960028971	08-DEC-1996	Sun	15	201	S	Treat	0	99	Utility, Panel	Car, Station \		1	9	2.190	44.510	Beaudesert - Nerang	
20000004962	08-MAR-2000	Wed	14	301	S	Hosp	0	99	4-Wheel Driv	Car, Station \		1	9	2.220	44.540	Beaudesert - Nerang	
20030005149	04-MAR-2003	Tue	06	705	W	Prop	0	99	Car, Station \			1	9	2.220	44.540	Beaudesert - Nerang	
20040014373	08-JUN-2004	Tue	19	703	N	Prop	0	99	Truck			1	9	2.220	44.540	Beaudesert - Nerang	
940002453	02-FEB-1994	Wed	23	803	N	Prop	0	99	Car, Station \			1	9	2.690	45.010	Beaudesert - Nerang	
20030008844	14-APR-2003	Mon	12	805	N	Prop	0	99	Truck			1	9	2.690	45.010	Beaudesert - Nerang	
20040005657	05-MAR-2004	Fri	13	400	N	Prop	0	99	Car, Station \			1	9	2.690	45.010	Beaudesert - Nerang	
950003579	16-FEB-1995	Thu	08	303	N	Prop	0	11	Car, Station \	Utility, Panel	607	1	9	2.944	45.264	Beaudesert - Nerang	Nathan Homestead F
20020000053	01-JAN-2002	Tue	05	700	N	Hosp	0	99	Car, Station \			1	9	2.994	45.314	Beaudesert - Nerang	
20020003816	18-FEB-2002	Mon	09	805	N	Hosp	0	99	Motor Cycle			1	9	3.074	45.394	Beaudesert - Nerang	
20020023904	24-SEP-2002	Tue	16	805	W	Inj	0	99	Articulated V			1	9	3.174	45.494	Beaudesert - Nerang	
980000781	28-DEC-1997	Sun	15	201	S	Treat	0	99	Car, Station \	Car, Station \		1	9	3.212	45.532	Beaudesert - Nerang	
930009589	10-MAY-1993	Mon	16	003	S	Hosp	0	99	Pedestrian	Car, Station \		1	9	3.274	45.594	Beaudesert - Nerang	
940003079	11-FEB-1994	Fri	11	201	W	Hosp	0	99	Car, Station \	Utility, Panel		1	9	3.324	45.644	Beaudesert - Nerang	
990004115	27-FEB-1999	Sat	12	201	S	Prop	0	99	Car, Station \	Car, Station \		1	9	3.324	45.644	Beaudesert - Nerang	

Road Crash 2
CRASH LISTING REPORT

Road Section 202 Beaudesert - Nerang Road Cway Tdist 41.800 - 48.100

Road Section 202 Beaudesert - Nerang Road

Crash No.	Date	Day	Hour	Dca	Key	Seve	Fatal	Feature	Vehicle 1	Vehicle 2	Inter	Cway	RPC	Dist	Tdist	Street 1	Street 2
20010024487	17-OCT-2001	Wed	10	803	E	Hosp	0	99	4-Wheel Driv			1	9	3.374	45.694	Beaudesert - Nerang	
20700115037	16-JUN-2007	Sat	16	805	N	Hosp	0	99	Motor Cycle			1	9	3.474	45.794	Beaudesert - Nerang	
970008338	14-APR-1997	Mon	07	201	N	Hosp	0	99	Car, Station \	Utility, Panel		1	9	3.524	45.844	Beaudesert - Nerang	
960024538	16-OCT-1996	Wed	21	801	N	Inj	0	99	Car, Station \			1	9	3.554	45.874	Beaudesert - Nerang	
20600010654	01-JUN-2006	Thu	06	104	E	Hosp	0	11	Car, Station \	Car, Station \	608	1	9	3.574	45.894	Arunta Dr	Beaudesert - Nerang
970010074	08-MAY-1997	Thu	07	804	E	Inj	0	99	Car, Station \			1	9	3.624	45.944	Beaudesert - Nerang	
950026977	19-NOV-1995	Sun	15	800	S	Prop	0	99	Car, Station \			1	9	3.674	45.994	Beaudesert - Nerang	
980004192	28-FEB-1998	Sat	18	805	E	Prop	0	99	Car, Station \			1	9	3.690	46.010	Beaudesert - Nerang	
20700268027	02-SEP-2007	Sun	20	803	N	Hosp	0	99	Utility, Panel			1	9	3.980	46.300	Beaudesert - Nerang	
20000012036	06-JUN-2000	Tue	15	201	E	Hosp	0	99	Car, Station \	4-Wheel Driv		1	9	4.274	46.594	Beaudesert - Nerang	
20030022912	16-SEP-2003	Tue	08	804	E	Prop	0	99	Car, Station \			1	9	4.304	46.624	Beaudesert - Nerang	
20020022163	05-SEP-2002	Thu	16	802	E	Hosp	0	99	Car, Station \			1	9	4.334	46.654	Beaudesert - Nerang	
20040014415	09-JUN-2004	Wed	12	804	E	Hosp	0	99	Motor Cycle			1	9	4.334	46.654	Beaudesert - Nerang	
20040008859	07-APR-2004	Wed	08	104	N	Treat	0	11	Car, Station \	Car, Station \	609	1	9	4.354	46.674	Beaudesert - Nerang	Potoroo Dr
20030015461	26-JUN-2003	Thu	17	803	E	Prop	0	99	Car, Station \			1	9	4.372	46.692	Beaudesert - Nerang	
970027618	17-DEC-1997	Wed	19	608	W	Hosp	0	11	Car, Station \	Special Purp		1	9	4.594	46.914	Beaudesert - Nerang	Paddemellon Way
940007173	01-APR-1994	Fri	19	805	S	Hosp	0	99	Utility, Panel			1	9	4.690	47.010	Beaudesert - Nerang	
950025177	27-OCT-1995	Fri	17	201	W	Prop	0	99	Car, Station \	Car, Station \		1	9	4.690	47.010	Beaudesert - Nerang	
990014809	15-JUL-1999	Thu	02	805	S	Inj	0	99	Car, Station \			1	9	4.690	47.010	Beaudesert - Nerang	
960010514	07-MAY-1996	Tue	11	803	E	Inj	0	99	Car, Station \			1	9	4.827	47.147	Beaudesert - Nerang	
20000017551	14-AUG-2000	Mon	07	000	N	Hosp	0	99	Car, Station \	Pedestrian		1	9	5.480	47.800	Beaudesert - Nerang	
950030361	30-DEC-1995	Sat	22	201	N	Hosp	0	99	Car, Station \	Car, Station \		1	9	5.600	47.920	Beaudesert - Nerang	
950018870	08-JUN-1994	Wed	08	201	N	Treat	0	12	Car, Station \	Articulated V	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb

Road Section 202 Beaudesert - Nerang Road Cway Tdist 41.800 - 48.100

Road Section 202 Beaudesert - Nerang Road

Crash No.	Date	Day	Hour	Dca	Key	Seve	Fatal	Feature	Vehicle 1	Vehicle 2	Inter	Cway	RPC	Dist	Tdist	Street 1	Street 2
960001817	24-JAN-1996	Wed	23	201	E	Prop	0	99	Car, Station \	Car, Station \		2	10	0.000	48.010	Beaudesert - Nerang	
960014544	23-JUN-1996	Sun	15	202	S	Hosp	0	11	Car, Station \	Utility, Panel	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
970004259	26-FEB-1997	Wed	09	104	S	Treat	0	11	Car, Station \	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
970019803	08-SEP-1997	Mon	16	202	W	Prop	0	11	Car, Station \	Car, Station \	83	3	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
990005804	20-MAR-1999	Sat	17	104	E	Prop	0	11	Car, Station \	Utility, Panel	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
990026246	02-DEC-1999	Thu	16	202	W	Treat	0	11	Special Purp	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20010010699	15-MAY-2001	Tue	07	202	S	Prop	0	11	Utility, Panel	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20010018699	13-AUG-2001	Mon	10	202	S	Hosp	0	11	Car, Station \	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20010028265	24-NOV-2001	Sat	21	301	N	Inj	0	11	Car, Station \	Car, Station \		2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20030012575	27-MAY-2003	Tue	13	202	S	Hosp	0	11	Car, Station \	Car, Station \		2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20030016988	13-JUL-2003	Sun	11	202	S	Hosp	0	11	Omnibus	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20040003274	08-FEB-2004	Sun	09	202	S	Hosp	0	11	4-Wheel Driv	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20040009096	09-APR-2004	Fri	15	202	S	Hosp	0	11	Car, Station \	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20040012706	20-MAY-2004	Thu	14	104	E	Fatal	1	11	Car, Station \	Utility, Panel	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20040013611	31-MAY-2004	Mon	09	202	S	Hosp	0	11	Utility, Panel	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20050010754	02-MAY-2005	Mon	19	202	S	Prop	0	11	Car, Station \	Utility, Panel	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20050011207	07-MAY-2005	Sat	15	202	S	Hosp	0	11	4-Wheel Driv	Motor Cycle	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20050011778	14-MAY-2005	Sat	08	202	W	Inj	0	11	Car, Station \	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20050012495	22-MAY-2005	Sun	12	202	W	Hosp	0	11	Car, Station \	Motor Cycle	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20060012956	27-MAY-2006	Sat	10	202	S	Prop	0	11	Car, Station \	Car, Station \	83	2	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20600075805	04-OCT-2006	Wed	16	202	N	Treat	0	11	Car, Station \	Car, Station \	83	3	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20700112139	12-JUN-2007	Tue	13	202	S	Treat	0	11	Utility, Panel	Car, Station \	83	3	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb
20700267328	02-SEP-2007	Sun	14	201	W	Inj	0	99	Utility, Panel	Utility, Panel		3	10	0.000	48.010	Beaudesert - Nerang	

Road Crash 2
CRASH LISTING REPORT

Road Section 202 Beaudesert - Nerang Road Cway Tdist 41.800 - 48.100

Road Section 202 Beaudesert - Nerang Road

Crash No.	Date	Day	Hour	Dca	Key	Seve	Fatal	Feature	Vehicle 1	Vehicle 2	Inter	Cway	RPC	Dist	Tdist	Street 1	Street 2
20700420159	11-NOV-2007	Sun	11	202	S	Prop	0	11	Car, Station \	Car, Station \	83	3	10	0.000	48.010	Beaudesert - Nerang	Nerang - Murwillumb

Road Section 2029 Oxenford - Coomera Gorge Road

Crash No.	Date	Day	Hour	Dca	Key	Seve	Fatal	Feature	Vehicle 1	Vehicle 2	Inter	Cway	RPC	Dist	Tdist	Street 1	Street 2
940000588	06-JAN-1994	Thu	07	102	W	Prop	0	11	Car, Station \	Car, Station \	150	1	2	0.000	7.600	Beaudesert - Nerang	Oxenford - Coomera
970008854	25-APR-1997	Fri	11	104	S	Treat	0	11	Car, Station \	Car, Station \	150	1	2	0.000	7.600	Beaudesert - Nerang	Oxenford - Coomera
20000013984	29-JUN-2000	Thu	23	803	S	Hosp	0	11	Car, Station \		150	1	2	0.000	7.600	Beaudesert - Nerang	Oxenford - Coomera
20010026749	09-NOV-2001	Fri	22	801	S	Hosp	0	11	Truck		150	1	2	0.000	7.600	Beaudesert - Nerang	Maudsland Rd
20020010137	28-APR-2002	Sun	10	107	S	Treat	0	11	Car, Station \	Car, Station \	150	1	2	0.000	7.600	Beaudesert - Nerang	Maudsland Rd

Appendix G

Mt Nathan Road OSIST Output

PARSONS BRINCKERHOFF

USQ Research Project

Case Study - Mt Nathan Road

Operating Speed Interactive Spreadsheet Tool (C Date: 29 Oct 2008

Element	Radius	Length	Section	Op. Speed (km/h)	Vehicle Speed	Side Friction Range		Side Friction Check	Side Friction Increase	Speed Reduction	Comments
1	inf	210	1	110	110	-0.060	0.030	Ok			
2	410	530	2	100	103	0.144	0.234	Unacceptable	Ok	7	
3	inf	400	3	110	106	-0.060	0.030	Ok	Ok	-3	
4	2000	510	3	110	110	-0.012	0.078	Ok	Ok	-4	
5	inf	120	3	110	110	-0.060	0.030	Ok	Ok	0	
6	550	170	3	110	110	0.113	0.203	Ok	Check!	0	
7	750	230	3	110	110	0.067	0.157	Ok	Ok	0	
8	inf	100	3	110	110	-0.060	0.030	Ok	Ok	0	
9	510	90	4	106	109	0.125	0.215	Unacceptable	Ok	1	
10	360	250	5	96	99	0.155	0.245	Undesirable	Ok	10	
11	1800	150	6	110	102	-0.015	0.075	Ok	Ok	-3	
12	8300	430	6	110	110	-0.049	0.041	Ok	Ok	-8	
13	**275**	**120**	**7**	**93**	**102**	**0.238**	**0.328**	**Unacceptable**	**Check!**	**8**	
14	inf	30	7	93	93	-0.060	0.030	Ok	Ok	9	
15	**200**	**70**	**8**	**79**	**88**	**0.247**	**0.337**	**Unacceptable**	**Ok**	**5**	
16	inf	50	9	93	89	-0.060	0.030	Ok	Ok	-1	
17	280	130	9	93	93	0.183	0.273	Unacceptable	Ok	-4	
18	inf	40	10	110	94	-0.060	0.030	Ok	Ok	-1	
19	540	100	10	110	96	0.075	0.165	Ok	Ok	-2	
20	inf	150	10	110	100	-0.060	0.030	Ok	Ok	-3	
21	420	70	11	105	101	0.131	0.221	Unacceptable	Ok	-1	
22	inf	90	11	105	104	-0.060	0.030	Ok	Ok	-3	
23	**95**	**120**	**12**	**66**	**80**	**0.476**	**0.566**	**Unacceptable**	**Check!**	**23**	
24	inf	30	12	66	66	-0.060	0.030	Ok	Ok	14	
25	95	140	12	66	66	0.301	0.391	Undesirable	Ok	0	
26	1400	170	13	110	91	-0.013	0.077	Ok	Ok	-25	
27	inf	140	13	110	95	-0.060	0.030	Ok	Ok	-4	
28	570	100	13	110	96	0.068	0.158	Ok	Check!	-2	
29	inf	100	13	110	100	-0.060	0.030	Ok	Ok	-3	
30	**190**	**135**	**14**	**79**	**90**	**0.274**	**0.364**	**Unacceptable**	**Check!**	**10**	
31	inf	140	15	100	94	-0.060	0.030	Ok	Ok	-4	
32	360	110	15	100	96	0.142	0.232	Undesirable	Ok	-2	
33	inf	65	15	100	100	-0.060	0.030	Ok	Ok	-4	
34	**140**	**65**	**16**	**73**	**89**	**0.382**	**0.472**	**Unacceptable**	**Check!**	**11**	
35	inf	200	17	110	93	-0.060	0.030	Ok	Ok	-4	
36	265	90	18	86	89	0.174	0.264	Undesirable	Ok	4	
37	inf	150	19	107	93	-0.060	0.030	Ok	Ok	-4	
38	470	100	19	107	96	0.095	0.185	Ok	Ok	-4	

PARSONS BRINCKERHOFF

39	750	150	20	110	100	0.045	0.135	Ok	Ok	-4	
40	inf	180	20	110	103	-0.060	0.030	Ok	Ok	-3	
41	310	110	21	96	97	0.180	0.270	Unacceptable	Check!	6	
42	inf	40	21	96	96	-0.060	0.030	Ok	Ok	1	