OPUS

Te Rimu Trust

Te Araroa Port Feasibility Study

Revision 2

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1 Executive Summary

Te Rimu Trust has engaged Opus International Consultants to asses any potential cost savings to be made if the future log harvest from the East Cape North Island were to be transported to the port at Gisborne by barge via a new terminal at the mouth of the Karakatuwhero River rather than by road.

There is a large area of forest coming on-stream for logging in the East Cape region in future years. If the full amount is trucked to current ports there will be significant costs over and above the actual transport costs. An assessment has been undertaken of net transport benefits assuming it is proposed that forest related traffic and harvested wood is diverted from SH35 to travel by barge from a new facility at Te Araroa.

The total amount that can be logged in the catchment of a barge terminal at Te Araroa is summarised below.

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Log Volumes (tonnes/yr)	972,900	639,400	1,013,000	1,122,900	382,400

Road wear costs vary between $0.50 and $3.00 per return trip made on every kilometre of highway the range depending on road foundation circumstances).

Accident costs in total over the route are estimated to be approximately two-thirds higher again than road wear costs.

The cost of the emission of CO_2 amounts to approximately a quarter of the cost of road wear.

This report sets out an evaluation of these costs, using the procedures of the New Zealand Transport Agency Economic Evaluation Manual (EEM).

Log volumes and their outlet points onto SH35 have been provided by Scion.

There are three forests on the western side of the Cape that would likely connect with Tauranga rather than Gisborne if there was no barge terminal. There is also the potential for some forests close to Gisborne to be instead transported to Tauranga Port. Rather than carry out a detailed analysis of road wear and accidents on the Tauranga route, the simplifying assumption that the output would travel to Gisborne has been made. This is considered sufficient to give a reasonable estimate of savings.

Road wear has been determined by summing recorded highway maintenance costs over a period of years, and dividing this by the number of heavy vehicle axles (expressed in numbers of an equivalent standard axle) passing over the highway (obtained from traffic counts) in that time, to obtain a wear cost per equivalent standard axle (ESA). The ESA total for each log truck is known, allowing wear costs to be determined for future log truck movements.

Accident costs have been determined by using the EEM procedures.

The costs of CO_2 emissions have been similarly determined from the EEM. These would be saved by barging to Gisborne, but at the same time there would be emission costs from the tugs used. The costs of tug & barge travel have been deducted from the truck savings to give a net emission saving.

The savings made by providing a tug & barge service from Te Araroa have been evaluated for the years from 2017 to 2040. The yearly amounts have been discounted at a discount rate of 6% to give a present day total amount. These are:

Savings in Road Wear:	$58.2 million.
Savings in Accident Costs:	$98.8 million
Savings in CO_2 Emissions:	$8.4 million
Total	$165.4 million

Note that this evaluation assumes that all available forestry will be harvested, and at the appropriate time. This will depend on the decisions of numerous forest owners, and on the costs faced by each. It is probable that the full amount will not be harvested and the above savings need to be adjusted accordingly.

In doing so, a reduction in the savings total in the same ratio as the reduction in output would give an indicative estimate of savings. This would not be a precise estimate, as the results depend on the forest locations, volumes, and SH35 outlet points concerned.

Note, however, that the volumes of harvested logs assumed in this report relate solely to the existing forests. No account has been taken of any proposed replanting after harvesting. Replanting, if carried out, would bring more logging beyond the end year, 2040, of this analysis. This can be included in the discounting, with a meaningful contribution, for a total of 40 years (current NZTA policy), i.e. to 2055.

Also, the quantified benefits are conservative as there would likely be net travel cost benefits as well. Quantification of truck operating cost savings and travel-time savings should be included within the detailed business model, alongside the barge terminal and operating costs.

Finally, no assessment has been undertaken as to the market that may be captured by a new port. Again, the figures in this report need to be scaled based on an assessment of likely market capture. They do however, represent a conservative upper limit to the transport benefit associated with wood being transported via a new barge facility at Te Araroa.

Following the initial draft of the report Opus was asked to provide analysis on further scenarios involving 350,000m^3, 500,000m^3 and 700,000 m^3 per year of wood carried by barge as well as present the data in terms of the truck kilometres saved and the number of deaths/serious injuries represented by the accident savings. The following table summarises this analysis.

SAVINGS	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3
Outlet 11	**350000 m^3 yr 1**	**500,000 m^3 yr 1**	**700,000 m^3 yr 1**
Road Wear ($m)	29.2	41.7	58.4
Accident Costs ($m)	63.0	86.4	117.6
CO_2 Emissions ($m)	4.4	6.3	8.8
TOTAL ($m)	**96.6**	**134.4**	**184.8**
Truck-km 24yr total	101.75 million	145.34 million	203.45 million
Deaths 24yr total	16	22	15
Serious Injury 24yr total	93	126	171

Table 1: Analysis of Savings

2 Introduction

This report, prepared for Te Rimu Trust, sets out a rough order evaluation of the potential cost savings to be made if the future log harvest from the East Cape North Island were to be transported to the port of Gisborne by barge via a new barge terminal at the mouth of the Karakatuwhero River rather than by road.

The evaluation has been made in accordance with the procedures of the New Zealand Transport Authority (NZTA) guideline Economic Evaluation Manual (EEM). The national point of view (savings to the country) has been taken.

The result obtained of $165.4 million as a discounted total over 24 years is explained in detail in the following sections.

3 Background

Logs harvested in the northeast and east of the East Cape are currently transported to the Port of Gisborne by truck. These travel over State Highway 35 (SH35).

In the future the amount of log output is expected to grow significantly. The graph below shows the total amount of wood in the East Cape that will be available for harvesting in the East Cape in future years.

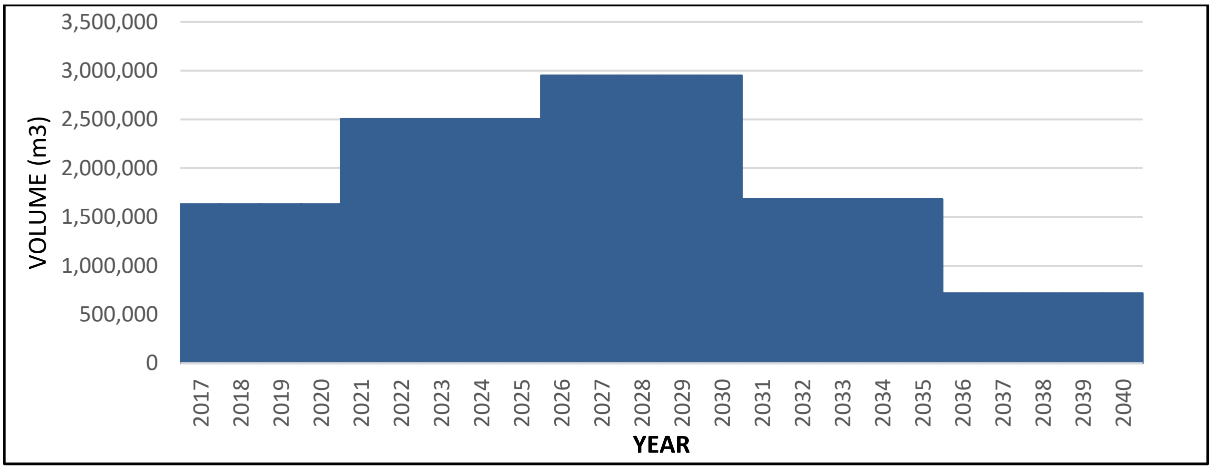


Figure 1: East Cape Forestry Available for Harvesting

As there is multi-ownership It is not known what percentage of these volumes will be harvested, nor how they will be processed before export. However the figures do show that there could be significant additional truck numbers on SH35 and, under the present situation, entering Gisborne to the port, at any time soon.

Heavy traffic produces road wear. This process may not be evident by casual observation, but it is a fact that the country spends in the order of $1.5 billion each year on road maintenance, of which some $600 million per year is spent on pavement repair and resealing to make up for annual wear and damage to the road surface. An increase in log traffic on SH35 will increase road wear.

As well, traffic accidents are related to numbers of vehicles on the roads. An increase in heavy traffic will bring about an increase in accidents. Each accident causes some hardship for those involved, and in some circumstances for the wider family. From a national point of view each accident also produces a cost, including that associated with damage repairs, and future losses experienced as the impact of harm to those involved. The NZTA EEM sets out the values established for these losses.

4 Proposal

Consideration is being given to the location of a barge terminal at either Hicks Bay or Te Araroa, which would remove much of the future heavy traffic from SH35 and provide savings in road wear, accident numbers, and impacts on the environment.

5 Forestry

An assessment of the wood available for harvesting in the catchment area of a port at Te Araroa has been provided by Scion, as an adjunct to their report 'Assessment of the Potential Wood Availability in the East Coast Region' of February 2016.

It is only log traffic on SH35 that will change with a barge option as traffic between the forest and SH35 will remain the same in either alternative. The road segments on SH35 between Te Araroa and Gisborne, along with the forest outlets onto SH35 are shown in Figures 2 (a) to (c). Road segments are identified by their start Reference Point number (large numbers 159 to 327) and forest outlets by marker triangles and smaller numbers (1 to 33).

Te Araroa is at the forest outlet 11. In either case of timber going to Gisborne or of timber going to a new terminal in Te Araroa, the flow of log trucks from point 1 up to point 11 will be the same. There are no changes on the road and therefore no savings on the road between points 1 and 11.

In the present (Gisborne) case the log trucks reaching point 11 will carry on south on SH35 to Gisborne. In the Te Araroa case this traffic will stop at point 11, giving savings from there to Gisborne.

Figure 2 (a): Road Segments and Forest Outlets

Figure 3 (b): Road Segments and Forest Outlets

Figure 4 (c): Road Segments and Forest Outlets

Forest output at outlets 1 to 32 will, without a barge terminal and based on travel distance above, travel to Gisborne rather than Tauranga simply because of a distance advantage. Part of this output can be diverted to a barge terminal at Te Araroa, and part that is closer to Gisborne will remain with Gisborne.

Near Te Kaha on the western side of the Cape there are three forests from which the output would more likely, without the barge terminal, travel to Tauranga. These are:

- Te Kaha – distance to Gisborne 217km, distance to Tauranga 208km
- Omaio – distance to Gisborne 199km, distance to Tauranga 190km
- Hawai - distance to Gisborne 173km, distance to Tauranga 164km

In addition, some forest that are closer to Gisborne than Tauranga may be directed to Tauranga due to factors such as port capacity and costs.

Separate analysis of these wood flows diverting from Tauranga to Te Araroa would entail a detailed study of road wear, accidents and emission volumes on the Tauranga route, equivalent to that which follows for the route to Gisborne. Instead it has been decided to simplify the analysis to give an indicative cost saving for these three forests (and any other traffic that travels further to Tauranga) by assuming that they would normally travel to Gisborne. In this case the evaluation is made of savings on travel from Te Araroa to Gisborne, a distance of 167km. The saving is approximately equal to that which in fact would be saved from the forest outlets to Tauranga as the 167km Gisborne distances are only slighter longer than the distances to Tauranga. Overall it is considered that unduly basing an assessment on assuming all traffic will go to Gisborne will give a reasonable rough order cost similar to any analysis that splits the traffic between Gisborne and Tauranga. The road wear costs would be less to Tauranga because of the better condition and standard of the road. However, accident costs would likely be higher on the route to Tauranga as these are proportional to the numbers and growth of all other traffic as well as log truck traffic, and annual average daily traffic is much higher on SH2.

Details of the road segments are set out below.

Road Segment			Distance (km)	Average Daily Traffic	Percent Heavy Traffic	Numbers of Heavy Traffic/day	Distance from Gisborne (km)	Distance from Te Araroa (km)
ID or Outlet Point		End Point						
159	11	12	5.3	381	20.0	76	167.7	0.0
	12	13	2.2	381	20.0	76	162.4	5.3
	13	172	5.3	381	20.0	76	160.2	7.5
172		14	3.6	381	20.0	76	154.9	12.8
	14	15	0.9	381	20.0	76	151.3	16.4
	15	180	3.9	381	20.0	76	150.4	17.3
180		190	9.5	480	16.0	77	146.5	21.2
190		17	4.6	533	16.0	85	137.0	30.7
17		200	4.3	533	16.0	85	132.4	35.3
200		19	2.8	586	16.0	94	128.1	39.6
19		20	4.2	870	16.0	139	125.3	42.4
20		21	4.6	870	16.0	139	121.1	46.6
21		213	3.1	870	16.0	139	116.5	51.2
213		22	1.8	879	16.0	141	113.4	54.3
22		23	4.3	879	16.0	141	111.6	56.1

Road Segment			Distance (km)	Average Daily Traffic	Percent Heavy Traffic	Numbers of Heavy Traffic/day	Distance from Gisborne (km)	Distance from Te Araroa (km)
ID or Outlet Point		End Point						
23		24	1.8	879	16.0	141	107.3	60.4
24		225	3.9	879	16.0	141	105.5	62.2
225		25	1.0	879	16.0	141	101.6	66.1
25		26	1.1	879	16.0	141	100.6	67.1
26		27	1.3	879	16.0	141	99.5	68.2
27		28	5.5	888	16.0	142	98.2	69.5
28		238	3.1	888	16.0	142	92.7	75.0
238		29	5.4	1088	19.0	207	89.6	78.1
29		250	7.4	1088	19.0	207	84.2	83.5
250		263	12.2	1133	19.0	215	76.8	90.9
263		274	11.2	1223	19.0	232	64.6	103.1
274		289	15.4	2133	22.0	469	53.4	114.3
289		300	11.0	1739	24.0	417	38.0	129.7
300		308	8.0	2038	24.0	489	27.0	140.7
308		321	13.0	2439	21.0	512	19.0	148.7
321		327	6.0	9953	7.0	697	6.0	161.7
327		end	0.9	19599	3.0	588	0.0	167.7

Table 2: Characteristics of SH35 Road Segments

5.1 Forest Output

From table 1 of the Scion report there is a total of 10,526 ha in the Opotiki district that can be harvested over the years of this study. From the age grouping in the table it is further possible to apportion this total to the five-year periods of this study. The area of the three forests noted above is approximately 2600 ha, or 25% of the total. Scion has used a figure of 519 m^3/ha of harvest wood, and this then gives the following volumes of logs per five-year period:

2017-2020	150,000 m^3/year
2021-2025	30,000 m^3/yr
2021-2025	28,000 m^3/yr
2021-2025	41,000 m^3/yr
2021-2025	25,000 m^3/yr

The forest output at the SH35 outlet points, including the above in outlet 1, is given below.

Forest Outlet	YEARS				
	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
1	562,600	111,000	97,400	183,200	123,500
2	3,900	800	400	-	-
3	5,800	1,200	2,900	3,400	-
4	11,800	2,000	9,100	10,900	-
5	8,900	1,800	6,400	15,300	-
6	38,300	7,300	1,600	700	1,200

Forest Outlet	YEARS				
	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
7	93,900	32,800	24,700	7,100	4,600
8	73,500	46,700	43,300	14,200	4,900
9	3,200	8,000	14,400	3,400	100
10	13,700	30,700	21,600	8,000	100
11	61,100	142,300	306,500	397,900	77,700
12	7,400	14,900	4,800	-	-
13	16,600	35,200	85,500	130,500	39,500
14	15,000	31,300	27,500	26,400	17,900
15	28,800	95,600	162,800	130,500	51,400
16	11,800	42,600	118,600	60,900	22,000
17	35,300	98,200	208,300	190,000	24,200
18	17,900	49,800	158,400	92,800	12,400
19	44,200	96,000	81,500	18,200	3,100
20	23,700	54,500	44,400	9,600	1,600
21	113,300	319,700	409,100	152,500	78,100
22	1,200	19,400	59,100	1,300	-
23	54,900	149,000	216,400	76,400	40,600
24	3,800	17,000	32,800	3,100	1,300
25	6,800	17,700	29,300	1,600	-
26	13,000	31,100	31,000	4,800	2,900
27	2,600	5,500	3,300	7,500	6,900
28	213,400	465,800	355,900	56,400	102,100
29	63,100	128,800	64,900	5,400	21,400
30	224,200	475,800	350,600	111,400	102,300

Table 3: Log Output at Each SH35 Outlet Point

Wood originating close to Gisborne will continue by road freight to there. However at some point north of Gisborne it will become more economic to take the output further north to Te Araroa and barge to Gisborne rather than truck to the south. It is therefore necessary at each point south of Te Araroa to determine the cost of trucking to Gisborne and compare it with the barging cost The barging cost comprises:

1. Cost by road to Te Araroa;
2. Additional cost of loading at Te Araroa;
3. Cost per m^3 of wood to cover the cost of providing the terminal, and for its operation;
4. Barging cost to Gisborne;
5. Additional cost of unloading the barge at Gisborne.

A preliminary evaluation of these costs has been made – sufficient to approximate the point where wood flows will alter to travel north to the new terminal. This is based on a wood flow through the terminal of 700,000 m^3/year, and would alter slightly for flows different from this value.
The cost of transport by log truck has been taken from Scion[1] as being equal to -0.0254 x Ln (x) + 0.3038 ($/t/km) in 2010, where x is the distance in km to be trucked. This has been increased by 17%, using the Statistics NZ road freight transport index, to give present-day costs.

Additional load and unload costs have been assumed to be $2 per tonne in both cases. This is derived from the number of loaders equipped with a log grapple required to be present all year to meet the flow of timber.

The capital cost is taken to be $1.00 (per tonne), based on a capital requirement of $5.5 million, and an interest rate requirement of 8% over 15 years.

Tug and barge operating cost has been derived from a review of online charter rates, and is set at $14.

Personal costs for the terminal operations have been assumed to equal 25% of the tug and barge operating cost.

Capital	1.50
Tug and barge operation	14.00
Personnel cost	3.50
Maintenance	0.50
Loading/unloading	4.00
TOTAL	23.50

Table 4: Costs in dollars per tonne

The following Table 5 shows the costs from each outlet point to either (a) Gisborne directly by road, or (b) Gisborne via Te Araroa by road, then Gisborne by barge. Outlet point 16 is the closest to Gisborne at which it is less costly to travel via Te Araroa.

Forest Outlet Point	Distance from Gisborne (km)	Cost ($/t/km)	Distance to Te Araroa (km)	Cost ($/t/km)	(a) Cost by Road to Gisborne ($/t)	Cost by Road to Te Araroa ($/t)	(b) Cost to Gisborne by Road and Barge ($/t)
11	167.7	0.20	0	0.00	**34.08**	0.00	**23.50**
12	162.4	0.20	5.3	0.31	**33.16**	1.62	**25.12**
13	160.2	0.20	7.5	0.30	**32.77**	2.22	**25.72**
14	154.9	0.21	12.8	0.28	**31.85**	3.58	**27.08**
15	151.3	0.21	16.4	0.27	**31.21**	4.47	**27.97**
16	150.4	0.21	17.3	0.27	**31.05**	4.68	**28.18**
17	136.3	0.21	31.4	0.25	28.54	7.94	31.44

[1] Scion, Volume and cost analysis of large scale woody biomass study, Report for the Parliamentary Commission for the Environment, 2010

Forest Outlet Point	Distance from Gisborne (km)	Cost ($/t/km)	Distance to Te Araroa (km)	Cost ($/t/km)	(a) Cost by Road to Gisborne ($/t)	Cost by Road to Te Araroa ($/t)	(b) Cost to Gisborne by Road and Barge ($/t)
18	132	0.21	35.7	0.25	27.76	8.90	32.40
19	129.2	0.21	38.5	0.25	27.26	9.51	33.01
20	125	0.21	42.7	0.24	26.49	10.41	33.91
21	120.4	0.21	47.3	0.24	25.65	11.39	34.89
22	115.5	0.21	52.2	0.24	24.75	12.42	35.92
23	111.2	0.22	56.5	0.24	23.96	13.31	36.81
24	109.4	0.22	58.3	0.23	23.62	13.68	37.18
25	104.5	0.22	63.2	0.23	22.71	14.68	38.18
26	103.4	0.22	64.3	0.23	22.50	14.90	38.40
27	102.1	0.22	65.6	0.23	22.25	15.16	38.66
28	96.6	0.22	71.1	0.23	21.22	16.26	39.76
29	88.1	0.22	79.6	0.23	19.59	17.94	41.44
30	80.7	0.22	87	0.22	18.15	19.38	42.88

Table 5: Costs to Transport to Gisborne by Road or by Barge

The timber volumes travelling via Te Araroa are therefore those arising from outlet points 1 to 16. Those arising from 1 to 11 will be removed from SH35 from point 11 to Gisborne – a distance of 167.7km. The saving from points 12 to 16 will in each case be the distance from the point to Gisborne, less the distance from that point to point 11.

Outlet Point	Road Traffic Saving (km)			Wood Volume (m³/yr)				
	Distance to Gisborne (km)	Distance to Te Araroa (km)	Saving (km)	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
11	167.7	0	167.7	876,700	384,600	528,300	644,100	212,100
12	162.4	5.3	157.1	7,400	14,900	4,800	-	-
13	160.2	7.5	152.7	16,600	35,200	85,500	130,500	39,500
14	154.9	12.8	142.1	15,000	31,300	27,500	26,400	17,900
15	151.3	16.4	134.9	28,800	95,600	162,800	130,500	51,400
16	150.4	17.3	133.1	11,800	42,600	118,600	60,900	22,000
		Total Volume (t/yr)		956,300	604,200	927,500	992,400	342,900

Table 6: Distance Saving by Using Barge, and Corresponding Log Volumes

6 Increase in Heavy Vehicles

The yearly increase in numbers of log trucks from points 11 to 16 has been determined from the Table 6 volumes and is based on a log-truck load of 28 tonnes. In the following table this number has been further divided by 300 (assumed working days) to give a daily number of road trips. The decimal fraction does not mean a portion of a load travelling each day, instead meaning a full trip at intervals greater than one day.

Outlet Point	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
11	104.4	45.8	62.9	76.7	25.3
12	0.9	1.8	0.6	-	-
13	2.0	4.2	10.2	15.5	4.7
14	1.8	3.7	3.3	3.1	2.1
15	3.4	11.4	19.4	15.5	6.1
16	1.4	5.1	14.1	7.3	2.6

Table 7: Increase in Future Log Truck Trips from Outlets 11 to 16

7 Costs of Road Wear

7.1 Road Design

For many reasons (standardisation, economy, predictable performance, material availability and certification), there is a standard design for the typical countrywide tar-seal road pavement. The design involves the type and number of layers and the make-up of the sealing on top. It is possible to use the design guidelines to produce a road surface that would last for a very long time, but this would involve an excess of construction materials, and would be uneconomic. Instead New Zealand road paving is designed to give an optimal balance between initial construction cost and ongoing maintenance. This is possible because there is known to be a relationship between traffic levels and rate of road wear. In fact, each wheeled axle passing over a road has an instant effect of wearing a minute amount from the surface seal, and a longer-term effect of degrading the underlayers, depending on the type of ground underneath, drainage conditions, and cracking in the seal that allows water ingression. The effect of heavy traffic placing stress on the pavement can be appreciated when the passage of a heavily loaded truck can be felt at a distance from the road. The outcome of the surface wear is the need for resealing at intervals, and the longer-term damage leads to the pavement eventually having to be removed and replaced.

Experience, analysis, and laboratory testing have led to a formulation of the link between axle passage and road wear. Primarily, road damage is proportional to the fourth power of the axle load. This says, ignoring units for simplicity, that an axle with a load of 10 will have an impact that is 10^4 or 10,000 times greater than an axle with a load of 1. A car has a negligible impact, whereas a heavy vehicle has a measurable impact on the road design and life.

7.2 Equivalent Standard Axle

The units were left out of the above comparison because the effects of different vehicles are complicated, depending not only on the vehicle load but also on how this is distributed to the road surface by way of numbers of axles and tyres. There are many different configurations. The design approach taken has been to set up a 'standard axle' (known as the equivalent standard axle or ESA), with a specified configuration and known impact. This is a single axle with dual wheels applying an axle load of 8.2 tonnes to the pavement.

For all other axle groups and loads the damage caused is expressed as the number of standard axles that produce the same damage as the axle group. The procedure uses studies that have determined the number of ESA that cause the same damage as the different axle/wheel group. For example, the load on a single axle with single wheels that produces the same wear as the ESA is 5.4 tonnes. A load of 8 tonnes on this axle is equivalent to $(8/5.4)^4$ ESA, i.e. 4.8 ESA.

The design of a new pavement takes account of the desired economical life and the load in total ESA expected over the life.

7.3 Log Trucks

While there are many variations of axle and tyre configurations the type used for log trucks is fairly similar within a small range of ESA impact from the loaded vehicles, having been optimised for purpose. We assume the vehicle is represented by a truck and trailer rig with a single-axle single-wheel steering axle, and 3 dual-axle dual-wheel configurations. This is PAT Class 751.

TERNZ report[2] gives results from measurements made on-road, taking account of the way in which the load is distributed. Table 10 of the report notes an average ESA value for a loaded truck of 3.88.

Table 11 of the report gives the measured empty truck ESA for the class, but this does not correspond to the values used in other studies for log truck-trailer combinations. Values of 1.12 and 1.33 have been used, and we have chosen a value of 1.22.

The average away and return ESA value is then 2.55.

7.4 Historical Road Wear

Road wear on any section is related to the number of ESA passing over the section. It can be assumed that there is a direct proportionality. However, the ESA impact is also related to local conditions, particularly the strength of the ground underneath, local drainage, and surrounding geology. Therefore each section of road is divided into smaller lengths for data collection on road repair costs. Historical costs have been taken from the RAMM (Road Assessment and Maintenance Management) records belonging to SH35. A sample of surfacing, pavement and reseal costs for section 159 are given in Table 44 to Table 46 of Appendix A.

At the same time data is collected on traffic use. This includes a breakdown of the types of traffic into car, light commercial vehicle, medium commercial vehicle, heavy commercial vehicle I, heavy commercial vehicle II, and bus. Knowledge of the type and number of vehicles travelling allows a calculation of ESA-km over each stretch of road to be made. A sample of the vehicle count data, also for section 159, is given in Table 47 of Appendix A.

[2] TERNZ Lower Bound HPMVs – Vehicle Configurations, Prepared for: NZTA, November 2012.

7.5 Historical Cost per ESA-km

The cost per ESA-km for each section over the financial years 2001/02 to 2016/2017 has been determined by summing the total cost of road pavement works on the section, and then dividing by the summed ESA-km over the same period.

The final column of the table below gives the cost (or damage) by each standard axle travelling over one kilometre of the section.

Note the high figures for sections 159 and 172, which, as noted above, are likely due to the terrain.

Road Section	Surface Cost	Pavement Cost	Sealing	TOTAL	ESA-km	$/ESA-km
159	226,846	919,300	3,484,774	4,630,920	3,706,679	1.249
172	394,248	1,162,959	1,775,750	3,332,957	2,438,911	1.367
180	100,947	430,446	821,971	1,353,363	4,883,156	0.277
190	131,192	673,239	1,103,200	1,907,632	6,610,509	0.289
200	170,922	696,427	1,474,909	2,342,258	9,983,227	0.235
213	533,503	1,848,575	1,886,983	4,269,061	9746365.00	0.438
225	548,998	1,587,168	2,931,949	5,068,115	10,372,962	0.489
238	331,050	1,264,932	1,385,378	2,981,359	12,171,520	0.245
250	217,183	1,132,697	2,057,572	3,407,452	11,250,358	0.303
263	146,931	736,890	4,304,885	5,188,706	11,626,680	0.446
274	652,628	1,602,347	3,972,258	6,227,233	30,211,856	0.206
289	300,328	1,405,961	9,640,308	11,346,596	18,425,521	0.616
300	190,096	1,269,106	2,929,147	4,388,348	18,185,164	0.241
308	216,874	1,167,796	4,678,885	6,063,555	19,922,452	0.304

Table 8: Road Wear Cost by ESA-km Travelled, for Each Section

7.6 Savings in Road Costs

The analysis gives savings that will be made in the costs of road wear by removing a substantial portion of predicted future log-truck traffic from the route to Gisborne. Part of this arises north of Te Araroa, and this will be removed from the Te Araroa-Gisborne section of SH35. Part arises just south of Te Araroa and will travel on SH35 to the terminal. The additional road wear costs associated with this traffic have been deducted from the savings.

The spreadsheet analysis is set out in full in Appendix A. Annual savings have been discounted at a rate of 6% to give a total savings. Results are given below.

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	6561608	3784009	5715817	6360374	2170382
Additional Cost ($/yr)	156635	443564	793267	615591	252550
Net Saving ($/yr)	**6,404,974**	**3,340,445**	**4,922,550**	**5,744,783**	**1,917,832**

Table 9: Net Road Wear Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	6404974	6042428
2018	6404974	5700404
2019	6404974	5377739
2020	6404974	5073339
2021	3340445	2496175
2022	3340445	2354882
2023	3340445	2221587
2024	3340445	2095837
2025	3340445	1977204
2026	4922550	2748726
2027	4922550	2593138
2028	4922550	2446356
2029	4922550	2307883
2030	4922550	2177248
2031	5305954	2213989
2032	5305954	2088669
2033	5305954	1970443
2034	5305954	1858908
2035	5305954	1753687
2036	1917832	597989
2037	1917832	564141
2038	1917832	532208
2039	1917832	502083
2040	1917832	473663
	TOTAL	**$58,168,800**

Table 10: Discounted Total Road Wear Cost Savings

8 Saving in Accident Costs

Accidents involving trucks are proportional to the number of trucks on the road. The doubling of truck numbers, for example, doubles the exposure of the annual traffic to truck-related accidents, given that all other traffic remains constant. At the same time if the other traffic grows as well, the exposure of the annual traffic is increased in proportion to this growth rate.

This requires an evaluation of the expected growth in car, LCV, and MCV numbers. AADT figures for these vehicles over the periods 2001/02 to 2015/16 have been graphed, as presented in Appendix D. These show the historical growth rates, base numbers at year zero, and the incremental number each year assuming arithmetic growth (as required by the NZTA EEM). Many of the road sections furthest north from Gisborne have a negative growth rate, i.e. numbers are declining. It has been assumed in this study, however, that numbers in these sections would not decline when a significant growth in forest output takes place, and that future car, LCV, and MCV traffic will continue at the existing level.

It is difficult to determine how the existing log-related heavy vehicle numbers on SH35 would change in the barge terminal option. When evaluating the damage to the road pavement it is assumed that any change from the existing pattern will have similar impacts in either the Do Minimum or Barge alternative, and the focus is only on new traffic generated by the future output from the study forests. The same could be assumed in the determination of accident numbers. However in the crash rate analysis the increase in accidents is not proportional just to the increase in heavy traffic from the study forests, but depends as much on car numbers as it does on truck numbers, i.e. it is proportional to the changes in total AADT on each section of the highway. Therefore existing heavy vehicle traffic is included in AADT at a constant level in future years.

The assumptions made for growth in each section (from Appendix D) are given in the following table.

Road Section	Growth Rate (% arithmetic)	Year 1 AADT (Car, LCV,MCV)	Incremental Number (per year)	Year 1 Existing HCV AADT
159	Nil	350	0	38
172	Nil	350	0	38
180	Nil	427	0	48
190	Nil	500	0	68
200	Nil	700	0	85
213	1.1	885	9	97
225	1.0	882	9	105
238	Nil	990	0	100
250	0.4	1008	4	102
263	0.7	1077	7	137
274	3.4	1985	65	311
289	2.4	1549	36	287
300	0.7	1546	10	305
308	0.5	1688	8	225
321	0.5	9265	46	585

Table 11: Traffic Growth Rates

8.1 Crash Rates

The Sections of SH35 involved in the crash analysis have low traffic and therefore a low rate of crashes. The record of crashes is not sufficient to give a good statistical rate of accidents, even over a period of ten years. Therefore method C of the EEM (A6.3) has been used in determining future accident costs. This method uses standard predictions of crash rates determined from countrywide records and adapted for particular road circumstances, weighted also by the actual record of accidents along the SH35 sections.
The analysis gives savings that will be made in the costs of accidents by removing a substantial portion of predicted future log-truck traffic from the route to Gisborne. Part of this arises north of Te Araroa, and this will be removed from the Te Araroa-Gisborne section of SH35. Part arises just south of Te Araroa and will travel on SH35 to the terminal. The additional accident costs associated with this traffic have been deducted from the savings.

The spreadsheet analysis is set out in full in Appendix B. Annual savings have been discounted at a rate of 6% to give a total savings. Results are given below.

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	11,577,502	6,641,376	8,601,197	8,745,790	3,698,495
Additional Cost ($/yr)	180,840	513,146	914,968	712,869	292,575
Net Saving ($/yr)	11,396,662	6,128,230	7,686,228	8,032,921	3,405,919

Table 12: Net Accident Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	11,396,662	10,751,568
2018	11,396,662	10,142,989
2019	11,396,662	9,568,857
2020	11,396,662	9,027,224
2021	6,128,230	4,579,370
2022	6,128,230	4,320,160
2023	6,128,230	4,075,623
2024	6,128,230	3,844,927
2025	6,128,230	3,627,290
2026	7,686,228	4,291,950
2027	7,686,228	4,049,009
2028	7,686,228	3,819,820
2029	7,686,228	3,603,604
2030	7,686,228	3,399,626
2031	8,032,921	3,351,857
2032	8,032,921	3,162,129

Year	Annual Saving ($)	Discounted Annual Saving ($)
2033	8,032,921	2,983,141
2034	8,032,921	2,814,284
2035	8,032,921	2,654,985
2036	3,405,919	1,061,982
2037	3,405,919	1,001,870
2038	3,405,919	945,160
2039	3,405,919	891,660
2040	3,405,919	841,189
	TOTAL	**$98,810,300**

Table 13: Discounted Total Accident Cost Savings

The total of savings in accident costs over 24 years is $98,810,300 as a discounted sum.

9 Savings in Emissions of CO_2

9.1 Savings in CO2 Emissions From Truck Transport

NZTA EEM Section A9.2 states that pollutants include:

- carbon dioxide (CO2)
- carbon monoxide (CO)
- oxides of nitrogen (NOx)
- unburnt hydrocarbons
- lead compounds
- particles such as smoke, tyre and brake wear products.

As the emissions leading to air pollution take place for the most part in rural areas, and would not be a significant health problem, they have not been evaluated in this study. However the emission of CO2 does have a further impact in that it is a greenhouse gas. The evaluation of this impact is covered by section A9.7 of the NZTA EEM. The process relates CO_2 emissions to vehicle operating costs (VOC), using Table A 5.5 to determine these by road terrain and gradient. Assumptions have been made as to these characteristics for each road segment, as shown in the table below. The relationship between VOC and carbon cost is given by the formula for heavy vehicles is CO_2 (in tonnes) = VOC ($) x 0.0016. This is valued at $40 per tonne.

Ref	Length (km)	Terrain	Gradient	Speed (kph)	VOC (c/km)	Adjustment (to Jul 16)	Total ($)	CO2 tonnes	$/vehicle	$/tonne Per rtn. trip
159	12.80	hilly	5.0%	75	215.5	211.19	54.05	0.086	3.46	0.124
172	8.41	hilly	5.0%	75	215.5	211.19	35.52	0.057	2.27	0.081
180	9.47	rolling	3.5%	80	197.0	193.06	36.57	0.059	2.34	0.084
190	10.40	flat	2.0%	85	181.6	177.97	37.03	0.059	2.37	0.085
200	13.21	flat	2.0%	85	181.6	177.97	47.01	0.075	3.01	0.107
213	11.74	rolling	3.5%	80	197.0	193.06	45.33	0.073	2.90	0.104
225	12.39	rolling	3.5%	80	197.0	193.06	47.83	0.077	3.06	0.109
238	12.65	rolling	3.5%	80	197.0	193.06	48.82	0.078	3.12	0.112
250	12.22	flat	2.0%	85	181.6	177.97	43.49	0.070	2.78	0.099
263	11.16	flat	2.0%	85	181.6	177.97	39.74	0.064	2.54	0.091
274	15.36	flat	2.0%	85	181.6	177.97	54.67	0.087	3.50	0.125
289	10.62	flat	2.0%	85	181.6	177.97	37.79	0.060	2.42	0.086
300	8.00	flat	2.0%	85	181.6	177.97	28.47	0.046	1.82	0.065
308	11.17	flat	2.0%	85	181.6	177.97	39.76	0.064	2.54	0.091
321	6.17	flat	2.0%	85	181.6	177.97	21.95	0.035	1.41	0.050

Table 14: Cost of CO2 Emissions per Vehicle Return Trip ($)

Net emission cost savings (saving in CO2 emissions from trucks reaching Te Araroa no longer travelling to Gisborne, plus savings in trucks originating from Te Araroa to Tikitiki no longer travelling to Gisborne, minus the additional cost of the latter trucks diverting to Te Araroa) are set out in Appendix C, and are summarised below.

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	1339475	819604	1245668	1,351,559	464,820
Additional Cost ($/yr)	13,234	37,301	72,827	64,014	23,661
Net Saving ($/yr)	1326241	782303	1172840	1,287,545	441,159

Table 15: Cost of CO2 Emissions per Vehicle Return Trip ($)

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	1,326,241	1,251,171
2018	1,326,241	1,180,350
2019	1,326,241	1,113,538
2020	1,326,241	1,050,507
2021	782,303	584,582
2022	782,303	551,492
2023	782,303	520,276
2024	782,303	490,826
2025	782,303	463,044
2026	1,172,840	654,908
2027	1,172,840	617,838
2028	1,172,840	582,866
2029	1,172,840	549,873
2030	1,172,840	518,748
2031	1,287,545	537,248
2032	1,287,545	506,837
2033	1,287,545	478,148
2034	1,287,545	451,083
2035	1,287,545	425,550
2036	441,159	137,556
2037	441,159	129,769
2038	441,159	122,424
2039	441,159	115,494
2040	441,159	108,957
	TOTAL	**$13,143,100**

Table 16: Discounted Total Truck Emission Cost Savings

9.2 Additional CO2 Emissions from the Tug and Barge Operation

The assumed tug size is a vessel with a bollard pull of 30t, a loaded speed of 7 knots, an unloaded speed of 12 knots, and an engine size of 2 x 1000 kW. Fuel use is 500 litres per hour in total.

The barge would have a capacity of 1500t.

CO_2 emissions are proportional to fuel use. A common figure used is the production of 3.2 tonnes of CO_2 from each 1 tonne of fuel. At a value of $40 per tonne, the cost is $128 per tonne of fuel used.

The distance between Te Araroa and Gisborne by tug and barge is 88 Nautical Miles. The return time is therefore 18.5 hrs. Fuel used is noted as 210gm per kW-hr, i.e. 157gm per HP-hr. This equates to 4.5 tonnes of oil including auxiliary engines, giving a cost of $538 per voyage, or $0.36 per tonne of logs.

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Log Volumes (tonnes/yr)	956300	604200	927500	992400	342900
CO_2 Cost ($/yr)	$344,268.00	$217,512.00	$333,900.00	$357,264.00	$123,444.00

Table 17: Annual Cost of CO_2 Emissions

	Saved from Truck Travel		Additional Tug/Barge Cost		Net Emission Cost Saving	
Year	Annual Saving ($)	Discounted Annual Saving ($)	Annual Cost ($)	Discounted Annual Cost ($)	Annual Saving ($)	Discounted Annual Saving ($)
2017	1,114,285	1,051,213	344,268	324,781	770,017	726,432
2018	1,114,285	991,710	344,268	306,397	770,017	685,313
2019	1,114,285	935,576	344,268	289,054	770,017	646,521
2020	1,114,285	882,618	344,268	272,693	770,017	609,926
2021	739,922	552,913	217,512	162,538	522,410	390,375
2022	739,922	521,616	217,512	153,337	522,410	368,279
2023	739,922	492,091	217,512	144,658	522,410	347,433
2024	739,922	464,236	217,512	136,470	522,410	327,767
2025	739,922	437,959	217,512	128,745	522,410	309,214
2026	1,133,286	632,821	333,900	186,448	799,386	446,373
2027	1,133,286	597,001	333,900	175,894	799,386	421,106
2028	1,133,286	563,208	333,900	165,938	799,386	397,270
2029	1,133,286	531,329	333,900	156,545	799,386	374,783
2030	1,133,286	501,253	333,900	147,684	799,386	353,569
2031	1,229,625	513,080	357,264	149,074	872,361	364,006
2032	1,229,625	484,037	357,264	140,636	872,361	343,402
2033	1,229,625	456,639	357,264	132,675	872,361	323,964
2034	1,229,625	430,792	357,264	125,165	872,361	305,626

	Saved from Truck Travel		Additional Tug/Barge Cost		Net Emission Cost Saving	
Year	Annual Saving ($)	Discounted Annual Saving ($)	Annual Cost ($)	Discounted Annual Cost ($)	Annual Saving ($)	Discounted Annual Saving ($)
2035	1,229,625	406,407	357,264	118,080	872,361	288,327
2036	405,843	126,544	123,444	38,490	282,399	88,053
2037	405,843	119,381	123,444	36,312	282,399	83,069
2038	405,843	112,623	123,444	34,256	282,399	78,367
2039	405,843	106,248	123,444	32,317	282,399	73,931
2040	405,843	100,234	123,444	30,488	282,399	69,746
TOTALS		**$12,011,529**		**$3,588,677**		**$8,422,852**

Table 18: Discounted Total Emission Cost Savings

10 Cost Summary

The savings made by diverting part of the future possible log output of the East Cape through a barge terminal at Te Araroa for tug & barge transport to Gisborne are summarised below.

Savings in Road Wear:	$58.2 million.
Savings in Accident Costs:	$98.8 million
Savings in CO_2 Emissions:	$8.4 million
Total	**$165.4 million**

The savings above are a present value total of annual savings, discounted at a rate of 6%.

The savings arise from the full possible amount of available logs being harvested, which in practice may not be the outcome. A lesser amount would in fact be more manageable through a tug & barge operation. In that case the savings should be reduced accordingly, but would still leave a significant figure.

11 Additional Analysis Sensitivity Tests

Following the above analysis Te Rimu Trust representatives requested that some sensitivity testing occur based on the following scenarios.

Scenario 1: The wood volume arriving from the west at Te Araroa is 350,000 m^3/year.

Scenario 2: The wood volume arriving from the west at Te Araroa is 500,000 m^3/year.

Scenario 3: The total wood volume arriving at Te Araroa is 700,000 m^3/year.

11.1 Scenario 1: (350,000 m^3/yr)

11.1.1 Road Wear Saved

Table 19: Distance Saving by Using Barge, and Corresponding Log Volumes

Outlet Point	Road Traffic Saving (km)			Wood Volume (m^3/yr)				
	Distance to Gisborne (km)	Distance to Te Araroa (km)	Saving (km)	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
11	167.7	0	167.7	320,900	320,900	320,900	320,900	320,900
12	162.4	5.3	157.1	2,700	2,700	2,700	2,700	2,700
13	160.2	7.5	152.7	6,100	6,100	6,100	6,100	6,100
14	154.9	12.8	142.1	5,500	5,500	5,500	5,500	5,500
15	151.3	16.4	134.9	10,500	10,500	10,500	10,500	10,500
16	150.4	17.3	133.1	4,300	4,300	4,300	4,300	4,300
		Total Volume (t/yr)		**350,000**	**350,000**	**350,000**	**350,000**	**350,000**

Table 20: Net Road Wear Cost Savings

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	2383273	2383273	2383273	2383273	2383273
Additional Cost ($/yr)	57248	57248	57248	57248	57248
Net Saving ($/yr)	**2326024**	**2326024**	**2326024**	**2326024**	**2326024**

Table 21: Discounted Total Road Wear Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	2326024	2194363
2018	2326024	2070154
2019	2326024	1952975
2020	2326024	1842429
2021	2326024	1738141
2022	2326024	1639755
2023	2326024	1546939
2024	2326024	1459377
2025	2326024	1376770

Year	Annual Saving ($)	Discounted Annual Saving ($)
2026	2326024	1298840
2027	2326024	1225321
2028	2326024	1155963
2029	2326024	1090531
2030	2326024	1028803
2031	2326024	970569
2032	2326024	915631
2033	2326024	863803
2034	2326024	814908
2035	2326024	768781
2036	2326024	725265
2037	2326024	684213
2038	2326024	645484
2039	2326024	608947
2040	2326024	574478
	TOTAL	**$29,192,500**

11.1.2 Accident Cost Savings

Table 22: Net Accident Cost Savings

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	4,401,963	4,788,703	5,272,129	5,755,555	6,238,981
Additional Cost ($/yr)	66,394	66,394	66,394	66,394	66,394
Net Saving ($/yr)	**4,335,569**	**4,722,309**	**5,205,735**	**5,689,161**	**6,172,587**

Table 23: Discounted Total Accident Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	4,335,569	4,090,159
2018	4,335,569	3,858,641
2019	4,335,569	3,640,227
2020	4,335,569	3,434,176
2021	4,722,309	3,528,784
2022	4,722,309	3,329,042
2023	4,722,309	3,140,605
2024	4,722,309	2,962,835
2025	4,722,309	2,795,128
2026	5,205,735	2,906,855
2027	5,205,735	2,742,316
2028	5,205,735	2,587,091
2029	5,205,735	2,440,652
2030	5,205,735	2,302,502
2031	5,689,161	2,373,888

Year	Annual Saving ($)	Discounted Annual Saving ($)
2032	5,689,161	2,239,517
2033	5,689,161	2,112,752
2034	5,689,161	1,993,162
2035	5,689,161	1,880,342
2036	6,172,587	1,924,642
2037	6,172,587	1,815,700
2038	6,172,587	1,712,924
2039	6,172,587	1,615,966
2040	6,172,587	1,524,497
	TOTAL	**$62,952,500**

11.1.3 Savings in CO2 Emissions

Table 24: Cost of CO2 Emissions per Vehicle Return Trip ($)

	Saved from Truck Travel		Additional Tug/Barge Cost			
Year	**Annual Saving ($)**	**Discounted Annual Saving ($)**	**Annual Cost ($)**	**Discounted Annual Cost ($)**	**Annual Saving ($)**	**Discounted Annual Saving ($)**
2017	475,717	448,789	126,000	118,868	349,717	329,921
2018	475,717	423,386	126,000	112,140	349,717	311,247
2019	475,717	399,421	126,000	105,792	349,717	293,629
2020	475,717	376,812	126,000	99,804	349,717	277,008
2021	475,717	355,483	126,000	94,155	349,717	261,329
2022	475,717	335,361	126,000	88,825	349,717	246,536
2023	475,717	316,379	126,000	83,797	349,717	232,582
2024	475,717	298,471	126,000	79,054	349,717	219,417
2025	475,717	281,576	126,000	74,579	349,717	206,997
2026	475,717	265,638	126,000	70,358	349,717	195,280
2027	475,717	250,602	126,000	66,375	349,717	184,226
2028	475,717	236,417	126,000	62,618	349,717	173,798
2029	475,717	223,035	126,000	59,074	349,717	163,961
2030	475,717	210,410	126,000	55,730	349,717	154,680
2031	475,717	198,500	126,000	52,575	349,717	145,925
2032	475,717	187,264	126,000	49,599	349,717	137,665
2033	475,717	176,664	126,000	46,792	349,717	129,872
2034	475,717	166,664	126,000	44,143	349,717	122,521
2035	475,717	157,231	126,000	41,645	349,717	115,586
2036	475,717	148,331	126,000	39,287	349,717	109,043
2037	475,717	139,935	126,000	37,064	349,717	102,871
2038	475,717	132,014	126,000	34,966	349,717	97,048
2039	475,717	124,541	126,000	32,986	349,717	91,555
2040	475,717	117,492	126,000	31,119	349,717	86,373
TOTALS		**$5,970,414**		**$1,581,345**		**$4,389,069**

11.2 Scenario 2: (500,000 m³/yr)

11.2.1 Road Wear Saved

Table 25: Distance Saving by Using Barge, and Corresponding Log Volumes

Outlet Point	Road Traffic Saving (km)							
	Distance to Gisborne (km)	Distance to Te Araroa (km)	Saving (km)	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
11	167.7	0	167.7	167.7	458,300	458,300	458,300	458,300
12	162.4	5.3	157.1	157.1	3,900	3,900	3,900	3,900
13	160.2	7.5	152.7	152.7	8,700	8,700	8,700	8,700
14	154.9	12.8	142.1	142.1	7,800	7,800	7,800	7,800
15	151.3	16.4	134.9	134.9	15,100	15,100	15,100	15,100
16	150.4	17.3	133.1	133.1	6,200	6,200	6,200	6,200
		Total Volume (t/yr)		**500,000**	**500,000**	**500,000**	**500,000**	**500,000**

Table 26: Net Road Wear Cost Savings

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	3404169	3404169	3404169	3404169	3404169
Additional Cost ($/yr)	81950	81950	81950	81950	81950
Net Saving ($/yr)	**3,322,219**	**3,322,219**	**3,322,219**	**3,322,219**	**3,322,219**

Table 27: Discounted Total Road Wear Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	3322219	3134169
2018	3322219	2956763
2019	3322219	2789399
2020	3322219	2631509
2021	3322219	2482555
2022	3322219	2342033
2023	3322219	2209465
2024	3322219	2084401
2025	3322219	1966416
2026	3322219	1855110
2027	3322219	1750104
2028	3322219	1651041
2029	3322219	1557586
2030	3322219	1469421
2031	3322219	1386246
2032	3322219	1307779
2033	3322219	1233754
2034	3322219	1163919
2035	3322219	1098037

Year	Annual Saving ($)	Discounted Annual Saving ($)
2036	3322219	1035884
2037	3322219	977249
2038	3322219	921933
2039	3322219	869748
2040	3322219	820517
	TOTAL	**$41,695,100**

11.2.2 Accident Cost Savings

Table 28: Net Accident Cost Savings

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	6,225,592	6,652,797	7,186,804	7,720,810	8,254,817
Additional Cost ($/yr)	95,036	95,036	95,036	95,036	95,036
Net Saving ($/yr)	**6,130,556**	**6,557,761**	**7,091,768**	**7,625,774**	**8,159,781**

Table 29: Discounted Total Accident Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	6,130,556	5,783,543
2018	6,130,556	5,456,173
2019	6,130,556	5,147,333
2020	6,130,556	4,855,974
2021	6,557,761	4,900,341
2022	6,557,761	4,622,963
2023	6,557,761	4,361,286
2024	6,557,761	4,114,420
2025	6,557,761	3,881,529
2026	7,091,768	3,960,006
2027	7,091,768	3,735,855
2028	7,091,768	3,524,391
2029	7,091,768	3,324,897
2030	7,091,768	3,136,696
2031	7,625,774	3,181,969
2032	7,625,774	3,001,858
2033	7,625,774	2,831,941
2034	7,625,774	2,671,643
2035	7,625,774	2,520,418
2036	8,159,781	2,544,258
2037	8,159,781	2,400,244
2038	8,159,781	2,264,381
2039	8,159,781	2,136,208
2040	8,159,781	2,015,291
	TOTAL	**$86,373,700**

11.2.3 Savings in CO2 Emissions

Table 30: Cost of CO2 Emissions per Vehicle Return Trip ($)

	Saved from Truck Travel		Additional Tug/Barge Cost			
Year	**Annual Saving ($)**	**Discounted Annual Saving ($)**	**Annual Cost ($)**	**Discounted Annual Cost ($)**	**Annual Saving ($)**	**Discounted Annual Saving ($)**
2017	679,485	641,024	180,000	169,811	499,485	471,213
2018	679,485	604,740	180,000	160,199	499,485	444,540
2019	679,485	570,509	180,000	151,131	499,485	419,378
2020	679,485	538,216	180,000	142,577	499,485	395,639
2021	679,485	507,751	180,000	134,506	499,485	373,245
2022	679,485	479,010	180,000	126,893	499,485	352,118
2023	679,485	451,897	180,000	119,710	499,485	332,186
2024	679,485	426,318	180,000	112,934	499,485	313,383
2025	679,485	402,186	180,000	106,542	499,485	295,645
2026	679,485	379,421	180,000	100,511	499,485	278,910
2027	679,485	357,944	180,000	94,822	499,485	263,123
2028	679,485	337,683	180,000	89,454	499,485	248,229
2029	679,485	318,569	180,000	84,391	499,485	234,178
2030	679,485	300,537	180,000	79,614	499,485	220,923
2031	679,485	283,526	180,000	75,108	499,485	208,418
2032	679,485	267,477	180,000	70,856	499,485	196,621
2033	679,485	252,337	180,000	66,846	499,485	185,491
2034	679,485	238,054	180,000	63,062	499,485	174,992
2035	679,485	224,579	180,000	59,492	499,485	165,086
2036	679,485	211,867	180,000	56,125	499,485	155,742
2037	679,485	199,874	180,000	52,948	499,485	146,926
2038	679,485	188,561	180,000	49,951	499,485	138,610
2039	679,485	177,887	180,000	47,124	499,485	130,764
2040	679,485	167,818	180,000	44,456	499,485	123,362
TOTALS		**$8,527,785**		**$2,259,064**		**$6,268,721**

11.3 Scenario 3 (700,000 m³/yr)

11.3.1 Road Wear Saved

Table 31: Distance Saving by Using Barge, and Corresponding Log Volumes

Outlet Point	Road Traffic Saving (km)			Wood Volume (m³/yr)				
	Distance to Gisborne (km)	Distance to Te Araroa (km)	Saving (km)	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
11	167.7	0	167.7	641,700	641,700	641,700	641,700	641,700
12	162.4	5.3	157.1	5,400	5,400	5,400	5,400	5,400
13	160.2	7.5	152.7	12,200	12,200	12,200	12,200	12,200
14	154.9	12.8	142.1	11,000	11,000	11,000	11,000	11,000
15	151.3	16.4	134.9	21,100	21,100	21,100	21,100	21,100
16	150.4	17.3	133.1	8,600	8,600	8,600	8,600	8,600
		Total Volume (t/yr)		**700,000**	**700,000**	**700,000**	**700,000**	**700,000**

Table 32: Net Road Wear Cost Savings

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	4766344	4766344	4766344	4766344	4766344
Additional Cost ($/yr)	114698	114698	114698	114698	114698
Net Saving ($/yr)	**4,651,646**	**4,651,646**	**4,651,646**	**4,651,646**	**4,651,646**

Table 33: Discounted Total Road Wear Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	4651646	4388345
2018	4651646	4139948
2019	4651646	3905611
2020	4651646	3684539
2021	4651646	3475980
2022	4651646	3279227
2023	4651646	3093610
2024	4651646	2918500
2025	4651646	2753302
2026	4651646	2597455
2027	4651646	2450429
2028	4651646	2311725
2029	4651646	2180873
2030	4651646	2057427
2031	4651646	1940969
2032	4651646	1831103
2033	4651646	1727456
2034	4651646	1629675
2035	4651646	1537429
2036	4651646	1450405

Year	Annual Saving ($)	Discounted Annual Saving ($)
2037	4651646	1368307
2038	4651646	1290855
2039	4651646	1217788
2040	4651646	1148857
	TOTAL	**$58,379,900**

11.3.2 Accident Cost Savings

Table 34: Net Accident Cost Savings

Period	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Cost Saving ($/yr)	8,657,531	9,138,689	9,740,137	10,341,585	10,943,033
Additional Cost ($/yr)	133,021	133,021	133,021	133,021	133,021
Net Saving ($/yr)	**8,524,510**	**9,005,669**	**9,607,116**	**10,208,564**	**10,810,012**

Table 35: Discounted Total Accident Cost Savings

Year	Annual Saving ($)	Discounted Annual Saving ($)
2017	8,524,510	8,041,991
2018	8,524,510	7,586,784
2019	8,524,510	7,157,343
2020	8,524,510	6,752,211
2021	9,005,669	6,729,559
2022	9,005,669	6,348,641
2023	9,005,669	5,989,284
2024	9,005,669	5,650,268
2025	9,005,669	5,330,441
2026	9,607,116	5,364,564
2027	9,607,116	5,060,909
2028	9,607,116	4,774,443
2029	9,607,116	4,504,191
2030	9,607,116	4,249,237
2031	10,208,564	4,259,677
2032	10,208,564	4,018,563
2033	10,208,564	3,791,098
2034	10,208,564	3,576,507
2035	10,208,564	3,374,063
2036	10,810,012	3,370,613
2037	10,810,012	3,179,824
2038	10,810,012	2,999,833
2039	10,810,012	2,830,032
2040	10,810,012	2,669,841
	TOTAL	**117,610,000**

11.3.3 Savings in CO2 Emissions

Table 36: Cost of CO2 Emissions per Vehicle Return Trip ($)

	Saved from Truck Travel		Additional Tug/Barge Cost			
Year	Annual Saving ($)	Discounted Annual Saving ($)	Annual Cost ($)	Discounted Annual Cost ($)	Annual Saving ($)	Discounted Annual Saving ($)
2017	951,369	897,518	252,000	237,736	699,369	659,782
2018	951,369	846,715	252,000	224,279	699,369	622,436
2019	951,369	798,788	252,000	211,584	699,369	587,204
2020	951,369	753,574	252,000	199,608	699,369	553,966
2021	951,369	710,918	252,000	188,309	699,369	522,609
2022	951,369	670,678	252,000	177,650	699,369	493,028
2023	951,369	632,715	252,000	167,594	699,369	465,120
2024	951,369	596,901	252,000	158,108	699,369	438,793
2025	951,369	563,114	252,000	149,158	699,369	413,956
2026	951,369	531,240	252,000	140,715	699,369	390,524
2027	951,369	501,169	252,000	132,750	699,369	368,419
2028	951,369	472,801	252,000	125,236	699,369	347,565
2029	951,369	446,039	252,000	118,147	699,369	327,892
2030	951,369	420,792	252,000	111,460	699,369	309,332
2031	951,369	396,973	252,000	105,151	699,369	291,822
2032	951,369	374,503	252,000	99,199	699,369	275,304
2033	951,369	353,305	252,000	93,584	699,369	259,721
2034	951,369	333,306	252,000	88,287	699,369	245,020
2035	951,369	314,440	252,000	83,289	699,369	231,151
2036	951,369	296,641	252,000	78,575	699,369	218,067
2037	951,369	279,850	252,000	74,127	699,369	205,723
2038	951,369	264,010	252,000	69,931	699,369	194,079
2039	951,369	249,066	252,000	65,973	699,369	183,093
2040	951,369	234,968	252,000	62,239	699,369	172,729
TOTALS		**$11,940,024**		**$3,162,690**		**$8,777,334**

11.4 Saved Truck-km

The Trust has also requested that the analysis be presented in terms of the amount of Truck kilometres saved for the above scenarios and original analysis. This is shown in the following tables.

11.4.1 Scenario 1: (350,000 tpy)

Table 37: Saved Truck-Km per Year

	2017-2040
Saved	4,252,700
Added	13,300.00
Net Saved	**4,239,400**

The total over the 24 years of the evaluation is 101,745,600 truck-km.

11.4.2 Scenario 2

Table 38: Saved Truck-Km per Year

	2017-2040
Saved	6,074,900
Added	19,100.00
Net Saved	**6,055,800**

The total over the 24 years of the evaluation is 145,339,200 truck-km.

11.4.3 Scenario 3: (700,000 tpy)

Table 39: Saved Truck-Km per Year

	2017-2040
Saved	8,505,200
Added	26,700.00
Net Saved	**8,478,500**

The total over the 24 years of the evaluation is 203,484,000 truck-km.

11.5 Fatal and Serious Accident Numbers

The Trust also requested that the accident savings be depicted in terms of the number of deaths or serious injuries that they might represent.

In the main analysis accident costs have derived by calculating expected accident rates and multiplying these by standard costs. The rates are a weighted sum of published typical rates determined from a large amount of historic crash data on similar road types, and specific rates taken from records on the particular road sections involved in the study.

Typical rates are set out as injury rates, combining fatal and severe injury accidents. These rates can then be multiplied by the published cost of a single injury accident involving a heavy vehicle – Table A6.5(c) of the EEM.

The weighting process can be regarded as using local records to modify the typical rates according to whether there has been a strong history of crashes on the roads being considered, or whether local road circumstances have led to a relatively safe section of highway.

If this assumption is made about specific rates, the resulting accident rates can be regarded as, on average, following the proportion or ratio of fatal, serious, minor, and non-injury rates incorporated in the typical rate analysis, factored to relate to local circumstances. It is then possible to work back from the calculated accident cost savings to obtain savings in numbers of the different accident types.

EEM Tables A6.4(e) to (h) give the following costs by accident type involving a truck:

Fatal	Serious	Minor	Non-Injury
$4,750,000	$505,000	$28,000	$9,500

Crash analysis tables give the ratio of reported accidents types and the factor to increase these because of under-reporting.

	Fatal	Serious	Minor	Non-Injury
Ratio	0.15	0.85	1	1

One reported fatal or serious injury is recorded as an 'injury cost' and statistically, in the analysis of expected accidents, represents the possibility of 0.15 fatal and 0.85 serious accidents, giving a cost of $1.142 million.

Typical rates in the study have been multiplied by the figure of $1,155,000 specifically for heavy vehicle crashes given by Table A6.5(c), further modified for speed and road type to $825,000. Thus a cost of $825,000 represents the fatal and serious accidents given in the table above multiplied by 825,000/1,155,000. The result is that a cost of $825,000 represents 0.107 fatal accidents, and 0.607 severe accidents.

Fatal	Serious	Minor	Non-Injury
$4,750,000	$505,000	$28,000	$9,500

Crash analysis tables give the ratio of reported accidents types and the factor to increase these because of under-reporting.

	Fatal	Serious	Minor	Non-Injury
Ratio	0.15	0.85	1	1

One reported fatal or serious injury is recorded as an 'injury cost' and statistically, in the analysis of expected accidents, represents the possibility of 0.15 fatal and 0.85 serious accidents, giving a cost of $1.142 million.

Typical rates in the study have been multiplied by the figure of $1,155,000 specifically for heavy vehicle crashes given by Table A6.5(c), further modified for speed and road type to $825,000. Thus a cost of $825,000 represents the fatal and serious accidents given in the table above multiplied by 825,000/1,155,000. The result is that a cost of $825,000 represents 0.107 fatal accidents, and 0.607 severe accidents.

11.5.1 Scenario 1

Table 40: Saved Fatal and Serious Accident Numbers per Year

	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Fatal (No./yr)	0.56	0.61	0.68	0.74	0.80
Serious (No./yr)	3.19	3.47	3.83	4.19	4.54

The totals over the 24 years of the evaluation are the saving of 16 deaths and 93 serious injuries.

11.5.2 Scenario 2

Table 41: Saved Fatal and Serious Accident Numbers per Year

	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Fatal (No./yr)	0.80	0.85	0.92	0.99	1.06
Serious (No./yr)	4.51	4.82	5.22	5.61	6.00

The totals over the 24 years of the evaluation are the saving of 22 deaths and 126 serious injuries.

11.5.3 Scenario 3

Table 42: Saved Fatal and Serious Accident Numbers per Year

	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Fatal (No./yr)	1.11	1.17	1.25	1.32	1.40
Serious (No./yr)	6.27	6.63	7.07	7.51	7.95

The totals over the 24 years of the evaluation are the saving of 30 deaths and 171 serious injuries.

11.6 Summary

The following table summarises the additional analysis.

Table 43: Additional Analysis Summary

SAVINGS	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3
Outlet 11	**350000 m³ yr 1**	**500,000 m³ yr 1**	**700,000 m³ yr 1**
Road Wear ($m)	29.2	41.7	58.4
Accident Costs ($m)	63.0	86.4	117.6
CO_2 Emissions ($m)	4.4	6.3	8.8
TOTAL ($m)	**96.6**	**134.4**	**184.8**
Truck-km 24yr total	101.75 million	145.34 million	203.45 million
Deaths 24yr total	16	22	15
Serious Injury 24yr total	93	126	171

Appendix A
Road Repair Costs

Road repair costs taken from RAMM records of treatment to the SH35 sections are set out in the following tables.

road_id	road_id	financial_year	cost_group	cost	cost_rci*	Cost /km
035-0159	354	1991/92	Surfacing	$18,107.96		$1,415.13
035-0159	354	1992/93	Surfacing	$22,252.73		$1,739.04
035-0159	354	1993/94	Surfacing	$5,738.61	$10,111.59	$448.47
035-0159	354	1994/95	Surfacing	$39,156.90	$68,219.32	$3,060.09
035-0159	354	1995/96	Surfacing	$23,256.24	$39,905.58	$1,817.46
035-0159	354	1996/97	Surfacing	$2,741.94	$4,592.49	$214.28
035-0159	354	1997/98	Surfacing	$20,892.45	$34,835.96	$1,632.73
035-0159	354	1998/99	Surfacing	$15,835.38	$26,112.92	$1,237.53
035-0159	354	1999/00	Surfacing	$8,763.50	$13,909.77	$684.86
035-0159	354	2000/01	Surfacing	$29,852.52	$44,367.59	$2,332.96
035-0159	354	2001/02	Surfacing	$10,008.86	$14,697.27	$782.19
035-0159	354	2002/03	Surfacing	$10,187.10	$14,609.12	$796.12
035-0159	354	2003/04	Surfacing	$31,575.33	$45,391.82	$2,467.59
035-0159	354	2004/05	Surfacing	$10,147.46	$13,975.68	$793.02
035-0159	354	2005/06	Surfacing	$16,143.04	$21,088.89	$1,261.57
035-0159	354	2006/07	Surfacing	$18,633.24	$22,059.04	$1,456.18
035-0159	354	2007/08	Surfacing	$20,686.67	$23,042.99	$1,616.65
035-0159	354	2008/09	Surfacing	$10,131.78	$11,122.86	$791.79
035-0159	354	2009/10	Surfacing	$11,463.62	$12,347.07	$895.88
035-0159	354	2010/11	Surfacing	$1,365.06	$1,400.02	$106.68
035-0159	354	2011/12	Surfacing	$11,267.40	$11,382.26	$880.54
035-0159	354	2012/13	Surfacing	$1,502.28	$1,492.96	$117.40
035-0159	354	2013/14	Surfacing	$18,872.48	$18,681.61	$1,474.87
035-0159	354	2014/15	Surfacing	$14,670.19	$14,521.83	$1,146.47
035-0159	354	2015/16	Surfacing	$385.20	$381.30	$30.10

* updated by road cost inflation index to present-day costs

Table 44: Historic Road Surfacing Costs – Section 159

road_id	road_id	financial_year	cost_group	cost	cost_rci*	Cost /km
035-0159	354	1991/92	Pavement	$136,128.66		$10,638.38
035-0159	354	1992/93	Pavement	$100,639.36		$7,864.91
035-0159	354	1993/94	Pavement	$106,305.07	$187,243.30	$8,307.68
035-0159	354	1994/95	Pavement	$53,323.63	$92,793.01	$4,167.21
035-0159	354	1995/96	Pavement	$119,075.88	$204,618.23	$9,305.71
035-0159	354	1996/97	Pavement	$55,257.79	$92,844.94	$4,318.36
035-0159	354	1997/98	Pavement	$48,255.51	$80,432.95	$3,771.14
035-0159	354	1998/99	Pavement	$62,570.56	$103,527.14	$4,889.85
035-0159	354	1999/00	Pavement	$42,104.66	$67,228.45	$3,290.45
035-0159	354	2000/01	Pavement	$52,894.60	$79,360.43	$4,133.68
035-0159	354	2001/02	Pavement	$75,603.48	$111,196.60	$5,908.37
035-0159	354	2002/03	Pavement	$48,078.31	$69,767.49	$3,757.29
035-0159	354	2003/04	Pavement	$61,129.49	$88,245.91	$4,777.23
035-0159	354	2004/05	Pavement	$21,503.35	$29,610.28	$1,680.47
035-0159	354	2005/06	Pavement	$66,749.06	$86,992.56	$5,216.40
035-0159	354	2006/07	Pavement	$44,938.97	$53,307.41	$3,511.95
035-0159	354	2007/08	Pavement	$137,891.16	$158,661.42	$10,776.11
035-0159	354	2008/09	Pavement	$17,718.37	$19,010.43	$1,384.68
035-0159	354	2009/10	Pavement	$85,395.40	$92,930.20	$6,673.60
035-0159	354	2010/11	Pavement	$19,470.62	$20,585.78	$1,521.62
035-0159	354	2011/12	Pavement	$61,360.93	$61,759.13	$4,795.32
035-0159	354	2012/13	Pavement	$54,950.28	$54,446.16	$4,294.33
035-0159	354	2013/14	Pavement	$26,844.28	$26,572.81	$2,097.86
035-0159	354	2014/15	Pavement	$8,822.63	$8,733.41	$689.48
035-0159	354	2015/16	Pavement	$37,522.24	$36,948.68	$2,932.34
035-0159	354	2016/17	Pavement	$528.00		$41.26

* updated by road cost inflation index to present-day costs

Table 45: Historic Road Pavement Costs – Section 159

Road Name	Start m	End m	area	Surface function	Surface date	Fin_year	Rate	Cost
035-0159	2760	2840	560	Reseal	25/10/2012	2012/13	$7.00	$3,920.00
035-0159	2840	3140	2100	Reseal	25/10/2012	2012/13	$7.00	$14,700.00
035-0159	3140	3160	140	Reseal	25/10/2012	2012/13	$7.00	$980.00
035-0159	3160	3260	750	Reseal	25/10/2012	2012/13	$7.00	$5,250.00
035-0159	3655	4450	5167.5	Reseal	24/10/2012	2012/13	$7.00	$36,172.50
035-0159	4450	5460	7575	2nd Coat	24/10/2012	2012/13	$7.00	$53,025.00
035-0159	6180	6830	4225	Reseal	24/10/2012	2012/13	$7.00	$29,575.00
035-0159	6830	7180	2450	Reseal	24/10/2012	2012/13	$7.00	$17,150.00
035-0159	7180	7490	2325	Reseal	12/02/2013	2012/13	$7.00	$16,275.00
035-0159	8730	9830	8250	Reseal	26/10/2012	2012/13	$7.00	$57,750.00
035-0159	9830	9920	675	Reseal	26/10/2012	2012/13	$7.00	$4,725.00
035-0159	9920	10500	4350	Reseal	26/10/2012	2012/13	$7.00	$30,450.00
035-0159	12400	12796	2772	Reseal	26/10/2012	2012/13	$7.00	$19,404.00
035-0159	2150	2520	2960	Reseal	4/02/2014	2013/14	$7.00	$20,720.00
035-0159	8550	8720	1360	Reseal	6/02/2014	2013/14	$7.00	$9,520.00

Table 46: Historic Road Resealing Costs – Section 159

Table 47: Evaluation of Historical ESA-km

Count Date	ADT	% Cars	% LCV	% MCV	% HCV I	% HCV II	% Bus	% Heavy Vehicles	ESA MCV	ESA HCV I	ESA HCV II	ESA Heavy Vehicles	ESA Bus	Distance	ESA-km	VKT	ESA per Day
31/12/2001	244	85	2	4	5	4	0	13	0.4	0.996	2.034	1.15	0	12.796	169896	1139612	36
31/12/2002	389	84	2	3	5	6	0	14	0.3	0.882	1.913	1.2	0	12.796	305693	1816840	65
31/12/2003	456	84	2	3	5	6	0	14	0.3	0.882	1.913	1.2	0	12.796	358344	2129766	77
31/12/2004	492	85	3	7	3	2	0	12	0.3	0.882	1.913	0.72	0	12.796	198675	2297906	43
31/12/2005	416	84	2	7	3	4	0	14	0.1	0.545	1.553	0.61	0	12.796	166858	1942945	36
31/12/2006	388	86	3	6	2	3	0	11	0.2	0.837	1.808	0.77	0	12.796	153396	1812170	33
31/12/2007	428	83	3	7	3	4	0	14	0.2	0.905	1.92	0.86	0	12.796	241684	1998991	52
31/12/2008	410	82	3	6	4	5	0	15	0.2	0.905	1.92	0.98	0	12.796	280824	1914921	60
31/12/2009	426	81	3	7	4	5	0	16	0.2	0.782	1.652	0.8	0	12.796	253257	1989650	54
31/12/2010	384	85	3	8	2	2	0	12	0.2	0.935	1.884	0.6	0	12.796	129866	1793487	28
31/12/2011	393	81	3	7	5	4	0	16	0.2	0.748	1.882	0.79	0	12.796	232463	1835522	50
31/12/2012	376	77	3	9	6	5	0	20	0.2	0.622	1.908	0.75	0	12.796	264302	1756123	57
31/12/2013	386	75	2	11	6	6	0	23	0.2	0.643	1.966	0.78	0	12.796	322404	1802828	69
31/12/2014	314	84	6	6	1	3	0	10	0.2	0.665	2.042	0.81	0	12.796	118138	1466550	25
31/12/2015	387	78	8	8	1	5	0	14	0.2	0.671	2.033	0.9	0	12.796	227394	1807499	49
28/12/2016	381	78	2	10	5	5	0	20	0.2	0.679	2.072	0.8	0	12.796	283487	1779476	61
															3706679		

					Total Cost to Gisborne from the Road Outlets Below					
Section		Length (km)	Cost ($/ESA-km)	Volume (t/yr)	11	12	13	14	15	16
From ID	To ID									
11	12	5.3	1.249	876,700	528678					
12	13	2.2	1.249	7,400	219451	1852				
13	172	5.3	1.249	16,600	528678	4462	10010			
172	14	3.6	1.367	16,600	392798	3316	7437			
14	15	0.9	1.367	15,000	98200	829	1859	1680		
15	180	3.9	1.367	28,800	425531	3592	8057	7281	13979	
190	190	9.5	0.277	11,800	210218	1774	3980	3597	6906	1427
17	17	4.6	0.289		105987	895	2007	1813	3482	1333
200	200	4.3	0.289		99074	836	1876	1695	3255	707
19	19	2.8	0.235		52536	443	995	899	1726	1061
20	20	4.2	0.235		78804	665	1492	1348	2589	1162
21	21	4.6	0.235		86310	729	1634	1477	2835	783
213	213	3.1	0.235		58165	491	1101	995	1911	847
22	22	1.8	0.438		62950	531	1192	1077	2068	2024
23	23	4.3	0.438		150380	1269	2847	2573	4940	847
24	24	1.8	0.438		62950	531	1192	1077	2068	1836
225	225	3.9	0.438		136392	1151	2583	2334	4481	525
25	25	1.0	0.489		39010	329	739	667	1281	578
26	26	1.1	0.489		42911	362	813	734	1410	683
27	27	1.3	0.489		50713	428	960	868	1666	2888
28	28	5.5	0.489		214555	1811	4063	3671	7048	1628
238	238	3.1	0.489		120931	1021	2290	2069	3973	1421
29	29	5.4	0.245		105608	891	2000	1807	3469	1948
250	250	7.4	0.245		144722	1222	2740	2476	4754	3971
263	263	12.2	0.303		295023	2490	5586	5048	9692	5371
274	274	11.2	0.446		399075	3368	7556	6828	13110	3411
289	289	15.4	0.206		253438	2139	4799	4336	8326	7280
300	300	11.0	0.616		540844	4565	10241	9254	17767	2075
308	308	8.0	0.241		154137	1301	2919	2637	5063	4252
321	321	13.0	0.304		315908	2667	5982	5405	10378	1962
327	327	6.0	0.304		145804	1231	2761	2495	4790	294
190	end	0.9	0.304		21817	184	413	373	717	0
Total cost from each outlet					6141600	47377	102123	76514	143681	50312
Total cost from all outlets									**$6,561,608**	

Table 48: Road Repair Cost (Outlets 11 to 16) to Gisborne by Road – 2017 to 2020

					Total Cost to Gisborne from the Road Outlets Below					
Section		Length (km)	Cost ($/ESA-km)	Volume (t/yr)	11	12	13	14	15	16
From ID	To ID									
11	12	5.3	1.249	384,600	231926					
12	13	2.2	1.249	14,900	96271	3730				
13	172	5.3	1.249	35,200	231926	8985	21227			
172	14	3.6	1.367	35,200	172317	6676	15771			
14	15	0.9	1.367	31,300	43079	1669	3943	3506		
15	180	3.9	1.367	95,600	186677	7232	17085	46402	46402	
190	190	9.5	0.277	42,600	92221	3573	8440	22923	10215	10215
17	17	4.6	0.289		46495	1801	4255	11557	5150	1333
200	200	4.3	0.289		43463	1684	3978	10804	4814	707
19	19	2.8	0.235		23047	893	2109	5729	2553	1061
20	20	4.2	0.235		34571	1339	3164	8593	3829	1162
21	21	4.6	0.235		37863	1467	3465	9412	4194	783
213	213	3.1	0.235		25516	989	2335	6343	2826	847
22	22	1.8	0.438		27616	1070	2527	6864	3059	2024
23	23	4.3	0.438		65970	2556	6038	16398	7307	847
24	24	1.8	0.438		27616	1070	2527	6864	3059	1836
225	225	3.9	0.438		59834	2318	5476	14873	6627	525
25	25	1.0	0.489		17113	663	1566	4254	1896	578
26	26	1.1	0.489		18825	729	1723	4679	2085	683
27	27	1.3	0.489		22247	862	2036	5530	2464	2888
28	28	5.5	0.489		94123	3646	8615	23396	10426	1628
238	238	3.1	0.489		53051	2055	4855	13187	5876	1421
29	29	5.4	0.245		46329	1795	4240	11516	5132	1948
250	250	7.4	0.245		63488	2460	5811	15781	7032	3971
263	263	12.2	0.303		129424	5014	11845	32171	14336	5371
274	274	11.2	0.446		175070	6782	16023	43517	19392	3411
289	289	15.4	0.206		111181	4307	10176	27636	12315	7280
300	300	11.0	0.616		237263	9192	21715	58976	26280	2075
308	308	8.0	0.241		67618	2620	6189	16808	7490	4252
321	321	13.0	0.304		138586	5369	12684	34448	15350	1962
327	327	6.0	0.304		63963	2478	5854	15899	7085	294
190	end	0.9	0.304		9571	371	876	2379	1060	0
Total cost from each outlet					2694262	95395	216551	480448	238253	59101
Total cost from all outlets								**$3,784,009**		

Table 49: Road Repair Cost (Outlets 11 to 16) to Gisborne by Road – 2021 to 2025

					Total Cost to Gisborne from the Road Outlets Below					
Section		Length (km)	Cost ($/ESA-km)	Volume (t/yr)	11	12	13	14	15	16
From ID	To ID									
11	12	5.3	1.249	528,300	318582					
12	13	2.2	1.249	4,800	132241	1202				
13	172	5.3	1.249	85,500	318582	2895	51559			
172	14	3.6	1.367	85,500	236700	2151	38308			
14	15	0.9	1.367	27,500	59175	538	9577	3080		
15	180	3.9	1.367	162,800	256425	2330	41500	13348	79020	
190	190	9.5	0.277	118,600	126678	1151	20501	6594	39037	14338
17	17	4.6	0.289		63868	580	10336	3325	19681	13403
200	200	4.3	0.289		59702	542	9662	3108	18398	7107
19	19	2.8	0.235		31658	288	5124	1648	9756	10661
20	20	4.2	0.235		47488	431	7685	2472	14634	11676
21	21	4.6	0.235		52010	473	8417	2707	16027	7869
213	213	3.1	0.235		35050	318	5673	1825	10801	8516
22	22	1.8	0.438		37934	345	6139	1975	11690	20343
23	23	4.3	0.438		90619	823	14666	4717	27925	8516
24	24	1.8	0.438		37934	345	6139	1975	11690	18451
225	225	3.9	0.438		82190	747	13302	4278	25327	5277
25	25	1.0	0.489		23508	214	3804	1224	7244	5805
26	26	1.1	0.489		25858	235	4185	1346	7968	6860
27	27	1.3	0.489		30560	278	4946	1591	9417	29025
28	28	5.5	0.489		129291	1175	20924	6730	39842	16360
238	238	3.1	0.489		72873	662	11794	3793	22456	14287
29	29	5.4	0.245		63639	578	10299	3313	19611	19578
250	250	7.4	0.245		87210	792	14114	4540	26874	39911
263	263	12.2	0.303		177781	1615	28772	9254	54785	53987
274	274	11.2	0.446		240483	2185	38920	12518	74107	34285
289	289	15.4	0.206		152722	1388	24716	7950	47062	73165
300	300	11.0	0.616		325913	2961	52746	16965	100433	20852
308	308	8.0	0.241		92883	844	15032	4835	28623	42736
321	321	13.0	0.304		190367	1730	30809	9909	58663	19724
327	327	6.0	0.304		87861	798	14219	4574	27075	2951
190	end	0.9	0.304		13147	119	2128	684	4051	0
Total cost from each outlet					3700932	30731	525997	140276	812198	505683
Total cost from all outlets									**$5,785,817**	

Table 50: Road Repair Cost (Outlets 11 to 16) to Gisborne by Road – 2026 to 2030

					Total Cost to Gisborne from the Road Outlets Below					
Section		Length (km)	Cost ($/ESA-km)	Volume (t/yr)	11	12	13	14	15	16
From ID	To ID									
11	12	5.3	1.249	644,100	388413					
12	13	2.2	1.249	-	161228	0				
13	172	5.3	1.249	130,500	388413	0	78696			
172	14	3.6	1.367	130,500	288584	0	58469			
14	15	0.9	1.367	26,400	72146	0	14617	2957		
15	180	3.9	1.367	130,500	312632	0	63342	12814	63342	
190	190	9.5	0.277	60,900	154445	0	31292	6330	31292	7362
17	17	4.6	0.289		77867	0	15776	3192	15776	6882
200	200	4.3	0.289		72789	0	14748	2983	14748	3649
19	19	2.8	0.235		38598	0	7820	1582	7820	5474
20	20	4.2	0.235		57897	0	11730	2373	11730	5995
21	21	4.6	0.235		63410	0	12847	2599	12847	4040
213	213	3.1	0.235		42733	0	8658	1752	8658	4373
22	22	1.8	0.438		46248	0	9370	1896	9370	10446
23	23	4.3	0.438		110483	0	22385	4528	22385	4373
24	24	1.8	0.438		46248	0	9370	1896	9370	9474
225	225	3.9	0.438		100205	0	20302	4107	20302	2710
25	25	1.0	0.489		28660	0	5807	1175	5807	2981
26	26	1.1	0.489		31526	0	6387	1292	6387	3523
27	27	1.3	0.489		37258	0	7549	1527	7549	14904
28	28	5.5	0.489		157631	0	31937	6461	31937	8400
238	238	3.1	0.489		88847	0	18001	3642	18001	7336
29	29	5.4	0.245		77589	0	15720	3180	15720	10053
250	250	7.4	0.245		106325	0	21542	4358	21542	20494
263	263	12.2	0.303		216750	0	43915	8884	43915	27722
274	274	11.2	0.446		293195	0	59404	12017	59404	17605
289	289	15.4	0.206		186198	0	37725	7632	37725	37570
300	300	11.0	0.616		397351	0	80507	16286	80507	10707
308	308	8.0	0.241		113242	0	22944	4642	22944	21945
321	321	13.0	0.304		232094	0	47024	9513	47024	10128
327	327	6.0	0.304		107120	0	21703	4391	21703	1516
190	end	0.9	0.304		16029	0	3248	657	3248	0
Total cost from each outlet					4512153	0	802838	134665	651055	259663
Total cost from all outlets									**$6,360,374**	

Table 51: Road Repair Cost (Outlets 11 to 16) to Gisborne by Road – 2031 to 2035

					Total Cost to Gisborne from the Road Outlets Below					
Section		**Length (km)**	**Cost ($/ESA-km)**	**Volume (t/yr)**	**11**	**12**	**13**	**14**	**15**	**16**
From ID	**To ID**									
11	12	5.3	1.249	212,100	127903					
12	13	2.2	1.249	-	53092	0				
13	172	5.3	1.249	39,500	127903	0	23820			
172	14	3.6	1.367	39,500	95030	0	17698			
14	15	0.9	1.367	17,900	23757	0	4424	2005		
15	180	3.9	1.367	51,400	102949	0	19172	8688	24948	
190	190	9.5	0.277	22,000	50858	0	9471	4292	12325	2660
17	17	4.6	0.289		25641	0	4775	2164	6214	2486
200	200	4.3	0.289		23969	0	4464	2023	5809	1318
19	19	2.8	0.235		12710	0	2367	1073	3080	1978
20	20	4.2	0.235		19065	0	3551	1609	4620	2166
21	21	4.6	0.235		20881	0	3889	1762	5060	1460
213	213	3.1	0.235		14072	0	2621	1188	3410	1580
22	22	1.8	0.438		15229	0	2836	1285	3691	3774
23	23	4.3	0.438		36382	0	6775	3070	8817	1580
24	24	1.8	0.438		15229	0	2836	1285	3691	3423
225	225	3.9	0.438		32997	0	6145	2785	7996	979
25	25	1.0	0.489		9438	0	1758	796	2287	1077
26	26	1.1	0.489		10381	0	1933	876	2516	1273
27	27	1.3	0.489		12269	0	2285	1035	2973	5384
28	28	5.5	0.489		51907	0	9667	4381	12579	3035
238	238	3.1	0.489		29257	0	5449	2469	7090	2650
29	29	5.4	0.245		25550	0	4758	2156	6192	3632
250	250	7.4	0.245		35013	0	6520	2955	8485	7403
263	263	12.2	0.303		71375	0	13292	6024	17297	10014
274	274	11.2	0.446		96548	0	17980	8148	23397	6360
289	289	15.4	0.206		61314	0	11419	5175	14859	13572
300	300	11.0	0.616		130846	0	24368	11043	31709	3868
308	308	8.0	0.241		37290	0	6945	3147	9037	7927
321	321	13.0	0.304		76428	0	14233	6450	18521	3659
327	327	6.0	0.304		35274	0	6569	2977	8548	547
190	end	0.9	0.304		5278	0	983	445	1279	0
Total cost from each outlet					1485837	0	243005	91307	256431	93803
Total cost from all outlets										**$2,170,382**

Table 52: Road Repair Cost (Outlets 11 to 16) to Gisborne by Road – 2036 to 2040

					Total Cost to Te Araroa from the Road Outlets Below					
Section										
From ID	To ID	Length (km)	Cost ($/ESA-km)	Volume (t/yr)	16	15	14	13	12	11
12	**159**	5.3	1.249	7,400	7116	17367	9045	9045	10010	4462
13	12	2.2	1.249	16,600	2954	7209	3755	3755	4155	
172	13	5.3	1.249	16,600	7116	17367	9045	9045		
14	**172**	3.6	1.367	15,000	5287	12904	6721			
15	14	0.9	1.367	28,800	1322	3226				
180	15	3.9	1.367	11,800	5727					
Total cost from each outlet					**29521**	**58073**	**28566**	**21846**	**14166**	**4462**
Total cost from all outlets										**156635**

Table 53: Road Repair Cost (Outlets 11 to 16) to Te Araroa by Road – 2017 to 2020

					Total Cost to Te Araroa from the Road Outlets Below					
Section										
From ID	To ID	Length (km)	Cost ($/ESA-km)	Volume (t/yr)	16	15	14	13	12	11
12	**159**	5.3	1.249	14,900	25689	57650	18875	18875	21227	8985
13	12	2.2	1.249	35,200	10663	23930	7835	7835	8811	
172	13	5.3	1.249	35,200	25689	57650	18875	18875		
14	**172**	3.6	1.367	31,300	19087	42833	14024			
15	14	0.9	1.367	95,600	4772	10708				
180	15	3.9	1.367	42,600	20677					
Total cost from each outlet					**106577**	**192771**	**59608**	**45585**	**30038**	**8985**
Total cost from all outlets										**443564**

Table 54: Road Repair Cost (Outlets 11 to 16) to Te Araroa by Road – 2021 to 2025

					Total Cost to Te Araroa from the Road Outlets Below					
Section										
From ID	To ID	Length (km)	Cost ($/ESA-km)	Volume (t/yr)	16	15	14	13	12	11
12	**159**	5.3	1.249	4,800	71520	98174	16583	16583	51559	2895
13	12	2.2	1.249	85,500	29687	40751	6884	6884	21402	
172	13	5.3	1.249	85,500	71520	98174	16583	16583		
14	**172**	3.6	1.367	27,500	53138	72941	12321			
15	14	0.9	1.367	162,800	13284	18235				
180	15	3.9	1.367	118,600	57566					
Total cost from each outlet					**296715**	**328275**	**52372**	**40050**	**72961**	**2895**
Total cost from all outlets										**793267**

Table 55: Road Repair Cost (Outlets 11 to 16) to Te Araroa by Road – 2026 to 2030

					Total Cost to Te Araroa from the Road Outlets Below					
Section										
From ID	**To ID**	**Length (km)**	**Cost ($/ESA-km)**	**Volume (t/yr)**	**16**	**15**	**14**	**13**	**12**	**11**
12	**159**	5.3	1.249	-	36725	78696	15920	15920	78696	0
13	12	2.2	1.249	130,500	15244	32666	6608	6608	32666	
172	13	5.3	1.249	130,500	36725	78696	15920	15920		
14	**172**	3.6	1.367	26,400	27286	58469	11828			
15	14	0.9	1.367	130,500	6821	14617				
180	15	3.9	1.367	60,900	29560					
Total cost from each outlet					**152360**	**263144**	**50277**	**38448**	**111362**	**0**
Total cost from all outlets										**615591**

Table 56: Road Repair Cost (Outlets 11 to 16) to Te Araroa by Road – 2031 to 2035

					Total Cost to Te Araroa from the Road Outlets Below					
Section										
From ID	**To ID**	**Length (km)**	**Cost ($/ESA-km)**	**Volume (t/yr)**	**16**	**15**	**14**	**13**	**12**	**11**
12	**159**	5.3	1.249	-	13267	30996	10794	10794	23820	0
13	12	2.2	1.249	39,500	5507	12866	4481	4481	9887	
172	13	5.3	1.249	39,500	13267	30996	10794	10794		
14	**172**	3.6	1.367	17,900	9857	23029	8020			
15	14	0.9	1.367	51,400	2464	5757				
180	15	3.9	1.367	22,000	10678					
Total cost from each outlet					**55040**	**103645**	**34089**	**26069**	**33707**	**0**
Total cost from all outlets										**252550**

Table 57: Road Repair Cost (Outlets 11 to 16) to Te Araroa by Road – 2036 to 2040

Appendix B
Saved Accident Costs

Method

Method C of the EEM (A6.3) has been used in determining future accident costs. This method uses typical predictions of crash rates determined from country-wide records and adapted for particular road circumstances, weighted also by the specific record of accidents along the SH35 sections.

Specific Accident Costs

The New Zealand Transport Agency has supplied the following information on crashes involving heavy vehicles between the reference stations specified in the table, by crash severity, crash year and crash location. Because the road sections have low daily traffic numbers, the data covers ten years instead of the normal five.

SH35 Section	Non-Injury	Minor	Severe	Fatal
172	3			
180	1	1		
190	4	2		
200	6			
213	4	3		
225	2	1		
238	3	2		
250	5	2		
263	6	2	2	2
274	8	2		
289	4	1	1	
300	3	2	2	
308	6	3		
321	9	2		

Table 58: Accident Statistics on SH35

EEM Tables A6.4(a) to A6.4(f) provide individual accident costs (involving trucks) by severity and these have been adjusted from the tables to apply to average speeds of 80kph (design speed 100kph/1.13 = mean speed, x 90/100 for truck specific mean speed).

A crash-by-crash analysis for each SH35 section is given in the following Table 59 to Table 72.

	Section 172	**Severity**			**Non-injury**
		Fatal	**Serious**	**Minor**	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period	0			3
3	Fatal/serious severity adjustment			1	1
4	Number of reported crashes adjusted by severity (2) × (3)			3	3
5	Crashes per year = (4)/(1)			0.3	0.3
6	Under-reporting factors			3	10
7	Total estimated crashes per year = (5) x (6)			0.9	3
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			24,840	26,460
10	Total cost of crashes per year (sum of columns in row **(9)** fatal + serious + minor + non-injury)	$51,300			

Table 59: Specific Accident Cost Analysis – Section 172

	Section 180	**Severity**			**Non-injury**
		Fatal	**Serious**	**Minor**	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period	0		1	1
3	Fatal/serious severity adjustment			1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)			1	1
5	Crashes per year = (4)/(1)			0.1	0.1
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			.3	1
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			8,280	8,820
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$17,100			

Table 60: Specific Accident Cost Analysis – Section 180

	Section 190	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period			2	4
3	Fatal/serious severity adjustment			1.0	1.0
4	Number of reported crashes adjusted by severity **(2)** × **(3)**			4	4
5	Crashes per year = **(4)/(1)**			.4	0.4
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = **(5)** x **(6)**			1.2	4
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = **(7)** x **(8)**			33,120	35,280
10	Total cost of crashes per year (sum of columns in row **(9)** fatal + serious + minor + non-injury)	$68,400			

Table 61: Specific Accident Cost Analysis – Section 190

	Section 200	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period				6
3	Fatal/serious severity adjustment				
4	Number of reported crashes adjusted by severity (2) × (3)				6
5	Crashes per year = (4)/(1)				0.6
6	Under-reporting factors				10
7	Total estimated crashes per year = (5) x (6)				6
8	Crash cost (Table 74) adjusted for 80kph average speed				8820
9	Crash cost per year = (7) x (8)				52,920
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$52,920			

Table 62: Specific Accident Cost Analysis – Section 200

	Section 213	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period			3	4
3	Fatal/serious severity adjustment			1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)			4	4
5	Crashes per year = (4)/(1)			0.4	0.4
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			1.2	4
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			33,120	35,280
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$68,400			

Table 63: Specific Accident Cost Analysis – Section 213

	Section 225	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period			1	2
3	Fatal/serious severity adjustment			1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)			2	2
5	Crashes per year = (4)/(1)			0.2	0.2
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			0.6	2
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			16,560	17,640
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$34,200			

Table 64: Specific Accident Cost Analysis – Section 225

	Section 238	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period			2	3
3	Fatal/serious severity adjustment			1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)			3	3
5	Crashes per year = (4)/(1)			0.3	0.3
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			0.9	3
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			24,840	26,460
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$51,300			

Table 65: Specific Accident Cost Analysis – Section 238

	Section 250	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period			2	5
3	Fatal/serious severity adjustment			1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)			5	5
5	Crashes per year = (4)/(1)			0.5	0.5
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			1.5	5
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			41,400	44,100
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$85,500			

Table 66: Specific Accident Cost Analysis – Section 250

	Section 263	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period	4			
3	Fatal/serious severity adjustment	0.15	0.85	1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)	0.6	3.4	4	4
5	Crashes per year = (4)/(1)	0.06	0.34	0.4	0.4
6	Under-reporting factors	1.0	2.0	3.0	10
7	Total estimated crashes per year = (5) x (6)	0.06	0.68	1.2	4
8	Crash cost (Table 74) adjusted for 80kph average speed	4510000	497000	27600	8820
9	Crash cost per year = (7) x (8)	270,600	337,960	33,120	35,280
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$676,960			

Table 67: Specific Accident Cost Analysis – Section 263

	Section 274	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported crashes over period	0		2	8
3	Fatal/serious severity adjustment				
4	Number of reported crashes adjusted by severity (2) × (3)			2	8
5	Crashes per year = (4)/(1)			0.2	0.8
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			0.6	8
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			16,560	70,560
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$87,120			

Table 68: Specific Accident Cost Analysis – Section 274

	Section 289	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported crashes over period	1			
3	Fatal/serious severity adjustment	0.15	0.85	1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)	0.15	0.85	1	1
5	Crashes per year = (4)/(1)	0.015	0.085	0.1	0.1
6	Under-reporting factors	1.0	2.0	3.0	10
7	Total estimated crashes per year = (5) x (6)	0.015	0.17	0.3	1
8	Crash cost (Table 74) adjusted for 80kph average speed	4510000	497000	27600	8820
9	Crash cost per year = (7) x (8)	67,650	84,490	8,280	8,820
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$169,240			

Table 69: Specific Accident Cost Analysis – Section 289

	Section 300	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period	2			
3	Fatal/serious severity adjustment	0.15	0.85	1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)	0.3	1.7	1	1
5	Crashes per year = (4)/(1)	0.03	0.17	1	1
6	Under-reporting factors	1.0	2.0	3.0	10
7	Total estimated crashes per year = (5) x (6)	0.03	0.34	3	10
8	Crash cost (Table 74) adjusted for 80kph average speed	4510000	497000	27600	8820
9	Crash cost per year = (7) x (8)	135,300	168,980	82,800	88,200
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	475,280			

Table 70: Specific Accident Cost Analysis – Section 300

	Section 308	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period	0		3	6
3	Fatal/serious severity adjustment				
4	Number of reported crashes adjusted by severity (2) × (3)			3	6
5	Crashes per year = (4)/(1)			0.3	0.6
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			0.9	6
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			24,840	52,920
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	77,760			

Table 71: Specific Accident Cost Analysis – Section 308

	Section 321	Severity			Non-injury
		Fatal	Serious	Minor	
1	Number of years of typical crash rate records	10	10	10	10
2	Number of reported (fatal + serious) crashes over period	0		2	9
3	Fatal/serious severity adjustment			1.0	1.0
4	Number of reported crashes adjusted by severity (2) × (3)			2	9
5	Crashes per year = (4)/(1)			.2	.9
6	Under-reporting factors			3.0	10
7	Total estimated crashes per year = (5) x (6)			0.6	9
8	Crash cost (Table 74) adjusted for 80kph average speed			27600	8820
9	Crash cost per year = (7) x (8)			16,560	79,380
10	Total cost of crashes per year (sum of columns in row (9) fatal + serious + minor + non-injury)	$95,940			

Table 72: Specific Accident Cost Analysis – Section 321

The results, annual accident costs per year and per km, are summarised in Table 73.

SH35 SECTION	Accident Cost ($/ yr)	Length (km)	A_S Cost ($/km/yr)
172	51,300	8.41	6,100
180	17,100	9.47	1,806
190	68,400	10.40	6,577
200	52,920	13.21	4,006
213	68.400	11.74	5,826
225	34,200	12.39	2,760
238	51,300	12.65	4,055
250	85,500	12.22	6,997
263	676,960	11.16	60,659
274	87,120	15.36	5,672
289	169,240	10.62	15,936
300	475,280	8.00	59,410
308	77,760	11.17	6,962
321	95,940	6.17	15,549

Table 73: Specific Site Accident Costs

Typical Accident Costs

The second part of method C involves an evaluation of the crash costs that could be expected, as determined by analysis of a long set of records over the country.

Accident rates have been determined by the formula:

$A_T = (b_o \text{ x CMF}) \text{ x AADT x } 365 / 10^8$

Where

A_T = Typical injury crash rate (per yr)

b_o is a coefficient from CEC Table 2

CMF is a product of modification factors, in this case being only the seal width factor (CEC Table 5)

AADT is Average Annual Daily Traffic, AADT x 365 / 10^8 is the site exposure.

Crash costs have been taken from EEM Table A6.5(c), modified to a speed of 80kph where the figure is set out for 100kph.

Results are given in Table 74.

Table 74: Typical Site Accident Costs

Ref.	Terrain	Length (km)	AADT (Car LCV MCV)	AADT (HCV)	Total AADT	Exposure Factor bo	Seal Width CMF	Exposure	Injury Crash Rate	Speed Type	Typical Cost (per crash)	Total Site Cost ($/yr)	A_T Cost/km ($/Yr)
159	hilly	12.80	350	38	388	25	1	0.018122	0.453042	Remote Rural	825000	373760	29209
172	hilly	8.41	350	38	388	25	1	0.01191	0.297756	Remote Rural	825000	245649	29209
180	rolling	9.47	427	48	475	18	1	0.01642	0.295566	Remote Rural	825000	243842	25746
190	flat	10.40	500	59	559	13	1	0.021226	0.275935	Remote Rural	825000	227646	21883
200	flat	13.21	700	85	785	13	1	0.037844	0.491975	Remote Rural	825000	405879	30730
213	rolling	11.74	885	97	982	18	1	0.04208	0.757434	Remote Rural	825000	624883	53227
225	rolling	12.39	882	97	979	18	1	0.044267	0.7968	Remote Rural	825000	657360	53064
238	rolling	12.65	990	100	1090	18	1	0.050308	0.905546	Remote Rural	825000	747076	59081
250	flat	12.22	1008	102	1110	13	1	0.049505	0.643569	Remote Rural	825000	530944	43452
263	flat	11.16	1077	137	1214	13	1	0.049469	0.643094	Remote Rural	825000	530553	47524
274	flat	15.36	1985	311	2296	13	1	0.128723	1.673398	Remote Rural	825000	1380554	89880
289	flat	10.62	1549	306	1855	13	1	0.071885	0.934506	Remote Rural	825000	770967	72616
300	flat	8.00	1546	287	1833	13	1	0.053524	0.695807	Near Rural	588000	409134	51142
308	flat	11.17	1688	302	1990	13	0.82	0.066529	0.864881	70 kph	550000	475685	42586
321	flat	6.17	7756	585	8339	13	0.5	0.093869	1.220294	50 kph	330000	402697	65288

The weighted cost is derived from the formula:
$A_W = w \times A_T + (1 - w) \times A_S$
Where:
A_W = Weighted Cost
w is the weighting factor
A_T and A_S are the typical and specific accident rates $w = k/(k + A_T \times Y)$
Where k is taken from CEC Table 2.

SH35 Section	Typical Rate A_T (per km per yr)	Specific Rate AS (10-yr total)	Specific Rate AS (per yr)	k	Y (yrs)	w	Weighted Rate A_W (per km per yr)	Cost/yr	cost/km/yr
159	0.03541	0	0	3	10	0.8944	0.03167	825000	26126
172	0.03541	0	0	3	10	0.8944	0.03167	825000	26126
180	0.03121	1	0.1	3	10	0.9058	0.03769	825000	31094
190	0.02652	2	0.2	3	10	0.9188	0.04062	825000	33509
200	0.03725	0	0	3	10	0.8896	0.03313	825000	27336
213	0.06452	3	0.3	3	10	0.8230	0.10620	825000	87612
225	0.06432	1	0.1	3	10	0.8235	0.07062	825000	58261
238	0.07161	2	0.2	3	10	0.8073	0.09635	825000	79492
250	0.05267	2	0.2	3	10	0.8507	0.07467	825000	61605
263	0.05760	6	0.6	3	10	0.8389	0.14498	825000	119605
274	0.10895	2	0.2	3	10	0.7336	0.13320	825000	109892
289	0.08802	2	0.2	3	10	0.7732	0.11342	825000	93573
300	0.08698	4	0.4	3	10	0.7752	0.15733	588000	92510
308	0.07743	3	0.3	3	10	0.7949	0.12309	550000	67699
321	0.19784	2	0.2	3	10	0.6026	0.19870	330000	65571

Table 75: Weighted Section Accident Costs

The final accident cost/km/yr has been applied to the additional numbers of truck traffic on each section. Additional accident numbers related to log trucks have been determined as the product of (base number of car,LCV,MCV / growth in car,LCV,MCV) x (base number HCV / base number HCV + future additional log traffic) – 1.

Table A6.1(b) requires account to be taken of the falling rate of accidents per year by introducing a negative growth rate (-2%) into discounting over future years. This is difficult to apply in this case as there is no steadily increasing growth rate in forestry output. Instead it is firstly assumed that the negative rate is an arithmetic rate i.e. 2% of the first year rate applied each year into the future, and that this is applied to the additional accident costs (taking off 0.02 x 1st year cost x 'years' into future). Adjustment is further made to the reduction to account for the differences in output between the 5-year periods by multiplying the negative adjustment in each 5-year case by that periods total annual output divided by the 1st year total annual output. The truck numbers to Gisborne that would be taken off SH35 in the case of a barge terminal at Te Araroa are set out in Table 76to Table 80, and resulting saved accident costs in Table 81 to Table 85.

Section		Length (km)	Volume (t/yr)	Additional Trucks to Gisborne from the Road Outlets Below						Total Additional Trucks on each Section
From ID	To ID			11	12	13	14	15	16	
11	12	5.3	876,700	85.78						85.78
12	13	2.2	7,400	85.78	0.72					86.51
13	172	5.3	16,600	85.78	0.72	1.62				88.13
172	14	3.6	16,600	85.78	0.72	1.62				88.13
14	15	0.9	15,000	85.78	0.72	1.62	1.47			89.60
15	180	3.9	28,800	85.78	0.72	1.62	1.47	2.82		92.42
180	190	9.5	11,800	85.78	0.72	1.62	1.47	2.82	1.15	93.57
190	To Gisborne			85.78	0.72	1.62	1.47	2.82	1.15	93.57

Table 76: Additional Trucks to Gisborne 2017 – 2020

Section		Length (km)	Volume (t/yr)	Additional Trucks to Gisborne from the Road Outlets Below						Total Additional Trucks on each Section
From ID	To ID			11	12	13	14	15	16	
11	12	5.3	384,600	37.63						37.63
12	13	2.2	14,900	37.63	1.46					39.09
13	172	5.3	35,200	37.63	1.46	3.44				42.53
172	14	3.6	35,200	37.63	1.46	3.44				42.53
14	15	0.9	31,300	37.63	1.46	3.44	3.06			45.60
15	180	3.9	95,600	37.63	1.46	3.44	3.06	9.35		54.95
180	190	9.5	42,600	37.63	1.46	3.44	3.06	9.35	4.17	59.12
190	To Gisborne			37.63	1.46	3.44	3.06	9.35	4.17	59.12

Table 77: Additional Trucks to Gisborne 2021 – 2025

Section		Length (km)	Volume (t/yr)	Additional Trucks to Gisborne from the Road Outlets Below						Total Additional Trucks on each Section
From ID	To ID			11	12	13	14	15	16	
11	12	5.3	528,300	51.69						51.69
12	13	2.2	4,800	51.69	0.47					52.16
13	172	5.3	85,500	51.69	0.47	8.37				60.53
172	14	3.6	85,500	51.69	0.47	8.37				60.53
14	15	0.9	27,500	51.69	0.47	8.37	2.69			63.22
15	180	3.9	162,800	51.69	0.47	8.37	2.69	15.93		79.15
180	190	9.5	118,600	51.69	0.47	8.37	2.69	15.93	11.60	90.75
190	To Gisborne			51.69	0.47	8.37	2.69	15.93	11.60	90.75

Table 78: Additional Trucks to Gisborne 2026 – 2030

Section		Length (km)	Volume (t/yr)	Additional Trucks to Gisborne from the Road Outlets Below						Total Additional Trucks on each Section
From ID	To ID			11	12	13	14	15	16	
11	12	5.3	644,100	63.02						63.02
12	13	2.2	0	63.02	0.00					63.02
13	172	5.3	130,500	63.02	0.00	12.77				75.79
172	14	3.6	130,500	63.02	0.00	12.77				75.79
14	15	0.9	26,400	63.02	0.00	12.77	2.58			78.38
15	180	3.9	130,500	63.02	0.00	12.77	2.58	12.77		91.14
180	190	9.5	60,900	63.02	0.00	12.77	2.58	12.77	5.96	97.10
190	To Gisborne			63.02	0.00	12.77	2.58	12.77	5.96	97.10

Table 79: Additional Trucks to Gisborne 2031 – 2035

Section		Length (km)	Volume (t/yr)	Additional Trucks to Gisborne from the Road Outlets Below						Total Additional Trucks on each Section
From ID	To ID			11	12	13	14	15	16	
11	12	5.3	212,100	20.75						20.75
12	13	2.2	0	20.75	0.00					20.75
13	172	5.3	39,500	20.75	0.00	3.86				24.62
172	14	3.6	39,500	20.75	0.00	3.86				24.62
14	15	0.9	17,900	20.75	0.00	3.86	1.75			26.37
15	180	3.9	51,400	20.75	0.00	3.86	1.75	5.03		31.40
180	190	9.5	22,000	20.75	0.00	3.86	1.75	5.03	2.15	33.55
190	To Gisborne			20.75	0.00	3.86	1.75	5.03	2.15	33.55

Table 80: Additional Trucks to Gisborne 2036 – 2040

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2019	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV)-1 (Ratio)	Cost Saving
From ID	To ID									
11	12	5.3	876,700	171.57	350	350	38	26126	4.51	604438
12	13	2.2	7,400	173.01	350	350	38	26126	4.55	255257
13	172	5.3	16,600	176.26	350	350	38	26126	4.64	626423
172	14	3.6	16,600	176.26	350	350	38	26126	4.64	425495
14	15	0.9	15,000	179.20	350	350	38	26126	4.72	108136
15	180	3.9	28,800	184.83	350	350	38	26126	4.86	483255
180	190	9.5	11,800	187.14	427	427	48	24141	3.90	871819
190	17	4.6		187.14	500	500	68	21394	2.75	264076
17	200	4.3		187.14	500	500	68	21394	2.75	246854
18	19	2.8		187.14	500	700	85	27336	3.48	259743
19	20	4.2		187.14	700	700	85	27336	2.20	246464
20	21	4.6		187.14	700	700	85	27336	2.20	269937
21	213	3.1		187.14	700	700	85	27336	2.20	181914
213	22	1.8		187.14	885	904	97	47537	1.99	166329
22	23	4.3		187.14	885	904	97	47537	1.99	397342
23	24	1.8		187.14	885	904	97	47537	1.99	166329
24	225	3.9		187.14	885	904	97	47537	1.99	360380
225	25	1		187.14	882	900	105	44872	1.84	80409
25	26	1.1		187.14	882	900	105	44872	1.84	88450

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2019	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV)-1 (Ratio)	Cost Saving
From ID	To ID									
26	27	1.3		187.14	882	900	105	44872	1.84	104532
27	28	5.5		187.14	882	900	105	44872	1.84	442249
28	238	3.1		187.14	882	900	105	44872	1.84	249268
238	29	5.4		187.14	990	990	100	50210	1.87	494735
29	250	7.4		187.14	990	990	100	50210	1.87	677970
250	263	12.2		187.14	1008	1016	102	38980	1.86	861225
263	274	11.2		187.14	1077	1092	137	47011	1.40	718241
274	289	15.4		187.14	1985	2120	311	68797	0.71	733790
289	300	11		187.14	1549	1623	287	59669	0.73	467902
300	308	8		187.14	1546	1568	305	46255	0.64	229506
308	321	13		187.14	1688	1705	225	36880	0.85	397353
321	327	6		187.14	9265	9358	585	43595	0.33	84941
327	end	0.9		187.14	9265	9358	585	43595	0.33	12741
									Total Saving ($/yr)	**11,577,502**

Table 81: Accident Cost Savings – Years 2017 – 2020

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2023	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV (Ratio)	Cost Saving
From ID	To ID									
11	12	5.3	384,600	75.26	350	350	38	26126	1.98	220529
12	13	2.2	14,900	78.18	350	350	38	26126	2.06	95723
13	172	5.3	35,200	85.07	350	350	38	26126	2.24	254480
172	14	3.6	35,200	85.07	350	350	38	26126	2.24	172854
14	15	0.9	31,300	91.19	350	350	38	26126	2.40	46815
15	180	3.9	95,600	109.90	350	350	38	26126	2.89	251464
180	190	9.5	42,600	118.24	427	427	48	24141	2.46	486771
190	17	4.6		118.24	500	500	68	21394	1.74	147444
17	200	4.3		118.24	500	500	68	21394	1.74	137828
18	19	2.8		118.24	500	700	85	27336	2.35	155879
19	20	4.2		118.24	700	700	85	27336	1.39	137611
20	21	4.6		118.24	700	700	85	27336	1.39	150717
21	213	3.1		118.24	700	700	85	27336	1.39	101570
213	22	1.8		118.24	885	943	97	47537	1.37	101890
22	23	4.3		118.24	885	943	97	47537	1.37	243403
23	24	1.8		118.24	885	943	97	47537	1.37	101890
24	225	3.9		118.24	885	943	97	47537	1.37	220761
225	25	1		118.24	882	935	105	44872	1.25	49030
25	26	1.1		118.24	882	935	105	44872	1.25	53933
26	27	1.3		118.24	882	935	105	44872	1.25	63739
27	28	5.5		118.24	882	935	105	44872	1.25	269664
28	238	3.1		118.24	882	935	105	44872	1.25	151992
238	29	5.4		118.24	990	990	100	50210	1.18	276230
29	250	7.4		118.24	990	990	100	50210	1.18	378538
250	263	12.2		118.24	1008	1032	102	38980	1.21	498634
263	274	11.2		118.24	1077	1122	137	47011	0.94	431103
274	289	15.4		118.24	1985	2390	311	68797	0.66	634115
289	300	11		118.24	1549	1772	287	59669	0.62	361387
300	308	8		118.24	1546	1611	305	46255	0.45	144357
308	321	13		118.24	1688	1739	225	36880	0.57	238186
321	327	6		118.24	9265	9543	585	43595	0.24	54642
327	end	0.9		118.24	9265	9543	585	43595	0.24	8196
									Total Saving ($/yr)	**6,641,376**

Table 82: Accident Cost Savings – Years 2021 - 2025

Section		Length	Volume	Total Additional Trucks on each Section	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2028	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV (Ratio)	Cost Saving
		(km)	(t/yr)							
From ID	To ID									
11	12	5.3	528,300	103.39	350	350	38	26126	2.72	228009
12	13	2.2	4,800	104.32	350	350	38	26126	2.75	95437
13	172	5.3	85,500	121.06	350	350	38	26126	3.19	287490
172	14	3.6	85,500	121.06	350	350	38	26126	3.19	195276
14	15	0.9	27,500	126.44	350	350	38	26126	3.33	51628
15	180	3.9	162,800	158.30	350	350	38	26126	4.17	304809
180	190	9.5	118,600	181.51	427	427	48	24141	3.78	650865
190	17	4.6		181.51	500	500	68	21394	2.67	197149
17	200	4.3		181.51	500	500	68	21394	2.67	184291
18	19	2.8		181.51	500	700	85	27336	3.39	193564
19	20	4.2		181.51	700	700	85	27336	2.14	184000
20	21	4.6		181.51	700	700	85	27336	2.14	201524
21	213	3.1		181.51	700	700	85	27336	2.14	135810
213	22	1.8		181.51	885	992	97	47537	2.22	148475
22	23	4.3		181.51	885	992	97	47537	2.22	354691
23	24	1.8		181.51	885	992	97	47537	2.22	148475
24	225	3.9		181.51	885	992	97	47537	2.22	321696
225	25	1		181.51	882	979	105	44872	2.03	71039
25	26	1.1		181.51	882	979	105	44872	2.03	78143
26	27	1.3		181.51	882	979	105	44872	2.03	92351
27	28	5.5		181.51	882	979	105	44872	2.03	390716
28	238	3.1		181.51	882	979	105	44872	2.03	220222
238	29	5.4		181.51	990	990	100	50210	1.82	369349
29	250	7.4		181.51	990	990	100	50210	1.82	506145
250	263	12.2		181.51	1008	1028	102	38980	1.84	658774
263	274	11.2		181.51	1077	1115	137	47011	1.41	561832
274	289	15.4		181.51	1985	2322	311	68797	0.85	718131
289	300	11		181.51	1549	1735	287	59669	0.83	426102
300	308	8		181.51	1546	1671	305	46255	0.72	210828
308	321	13		181.51	1688	1781	225	36880	0.91	335572
321	327	6		181.51	9265	9497	585	43595	0.34	68525
327	end	0.9		181.51	9265	9497	585	43595	0.34	10279
								Total Saving ($/yr)		**8,601,197**

Table 83: Accident Cost Savings – Years 2026 – 2030

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2033	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV (Ratio)	Cost Saving
From ID	To ID									
11	12	5.3	644,100	126.05	350	350	38	26126	3.32	227659
12	13	2.2	0	126.05	350	350	38	26126	3.32	93521
13	172	5.3	130,500	151.59	350	350	38	26126	3.99	313067
172	14	3.6	130,500	151.59	350	350	38	26126	3.99	212649
14	15	0.9	26,400	156.75	350	350	38	26126	4.13	55547
15	180	3.9	130,500	182.29	350	350	38	26126	4.80	302426
180	190	9.5	60,900	194.21	427	427	48	24141	4.05	590903
190	17	4.6		194.21	500	500	68	21394	2.86	178986
17	200	4.3		194.21	500	500	68	21394	2.86	167313
18	19	2.8		194.21	500	700	85	27336	3.60	172843
19	20	4.2		194.21	700	700	85	27336	2.28	167049
20	21	4.6		194.21	700	700	85	27336	2.28	182958
21	213	3.1		194.21	700	700	85	27336	2.28	123298
213	22	1.8		194.21	885	1041	97	47537	2.53	152098
22	23	4.3		194.21	885	1041	97	47537	2.53	363344
23	24	1.8		194.21	885	1041	97	47537	2.53	152098
24	225	3.9		194.21	885	1041	97	47537	2.53	329545
225	25	1		194.21	882	1023	105	44872	2.31	72307
25	26	1.1		194.21	882	1023	105	44872	2.31	79538
26	27	1.3		194.21	882	1023	105	44872	2.31	93999
27	28	5.5		194.21	882	1023	105	44872	2.31	397689
28	238	3.1		194.21	882	1023	105	44872	2.31	224152
238	29	5.4		194.21	990	990	100	50210	1.94	335322
29	250	7.4		194.21	990	990	100	50210	1.94	459516
250	263	12.2		194.21	1008	1048	102	38980	2.02	627516
263	274	11.2		194.21	1077	1152	137	47011	1.59	557322
274	289	15.4		194.21	1985	2660	311	68797	1.18	957938
289	300	11		194.21	1549	1921	287	59669	1.08	525133
300	308	8		194.21	1546	1725	305	46255	0.83	216790
308	321	13		194.21	1688	1823	225	36880	1.01	331345
321	327	6		194.21	9265	9728	585	43595	0.40	71234
327	end	0.9		194.21	9265	9728	585	43595	0.40	10685
									Total Saving ($/yr)	8,745,790

Table 84: Accident Cost Savings – Years 2031 – 2035

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2038	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV (Ratio)	Cost Saving
From ID	To ID									
11	12	5.3								
12	13	2.2								
13	172	5.3								
172	14	3.6								
14	15	0.9								
15	180	3.9								
180	190	9.5								
190	17	4.6								
17	200	4.3								
18	19	2.8								
19	20	4.2								
20	21	4.6								
21	213	3.1								
213	22	1.8								
22	23	4.3								
23	24	1.8								
24	225	3.9								
225	25	1								
25	26	1.1								
26	27	1.3								
27	28	5.5								
28	238	3.1								
238	29	5.4								
29	250	7.4								
250	263	12.2								
263	274	11.2								
274	289	15.4								
289	300	11								
300	308	8								
308	321	13								
321	327	6								
327	end	0.9								
									Total Saving ($/yr)	

Table 85: Accident Cost Savings – Years 2036 – 2040

Section		Length	Volume	Total Additional Trucks on each Section	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2038	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV (Ratio)	Cost Saving
		(km)	(t/yr)							
From ID	To ID									
11	12	5.3	212,100	41.51	350	350	38	26126	1.09	52218
12	13	2.2	0	41.51	350	350	38	26126	1.09	21257
13	172	5.3	39,500	49.24	350	350	38	26126	1.30	77115
172	14	3.6	39,500	49.24	350	350	38	26126	1.30	52380
14	15	0.9	17,900	52.74	350	350	38	26126	1.39	14915
15	180	3.9	51,400	62.80	350	350	38	26126	1.65	88716
180	190	9.5	22,000	67.10	427	427	48	24141	1.40	176545
190	17	4.6		67.10	500	500	68	21394	0.99	53476
17	200	4.3		67.10	500	500	68	21394	0.99	49988
18	19	2.8		67.10	500	700	85	27336	1.51	71348
19	20	4.2		67.10	700	700	85	27336	0.79	49910
20	21	4.6		67.10	700	700	85	27336	0.79	54663
21	213	3.1		67.10	700	700	85	27336	0.79	36838
213	22	1.8		67.10	885	1089	97	47537	1.08	65090
22	23	4.3		67.10	885	1089	97	47537	1.08	155492
23	24	1.8		67.10	885	1089	97	47537	1.08	65090
24	225	3.9		67.10	885	1089	97	47537	1.08	141028
225	25	1		67.10	882	1067	105	44872	0.98	30807
25	26	1.1		67.10	882	1067	105	44872	0.98	33888
26	27	1.3		67.10	882	1067	105	44872	0.98	40049
27	28	5.5		67.10	882	1067	105	44872	0.98	169438
28	238	3.1		67.10	882	1067	105	44872	0.98	95501
238	29	5.4		67.10	990	990	100	50210	0.67	100185
29	250	7.4		67.10	990	990	100	50210	0.67	137290
250	263	12.2		67.10	1008	1068	102	38980	0.76	217727
263	274	11.2		67.10	1077	1190	137	47011	0.65	221342
274	289	15.4		67.10	1985	2997	311	68797	0.84	762042
289	300	11		67.10	1549	2107	287	59669	0.68	366710
300	308	8		67.10	1546	1779	305	46255	0.40	111497
308	321	13		67.10	1688	1865	225	36880	0.43	142532
321	327	6		67.10	9265	9960	585	43595	0.20	37755
327	end	0.9		67.10	9265	9960	585	43595	0.20	5663
									Total Saving ($/yr)	**3,698,495**

The previous tables give the savings in accident costs, but there are also additional costs incurred in the Te Araroa case, with the output from outlets 12 to 16 taken north to the barge port. Additional log truck numbers are evaluated in Table 86 to Table 90, and accident costs in Table 91 to Table 95.

Section		Length (km)	Volume (t/yr)	Additional Trucks to Te Araroa from the Road Outlets Below (2017 – 2020)						Total Additional Trucks on each Section
From ID	To ID			16	15	14	13	12	11	
12	159	5.3	7,400	2.31	5.64	2.94	2.94	3.25	1.45	18.51
13	12	2.2	16,600	2.31	5.64	2.94	2.94	3.25		17.06
172	13	5.3	15,000	2.31	5.64	2.94	2.94			13.82
14	172	3.6	15,000	2.31	5.64	2.94				10.88
15	14	0.9	28,800	2.31	5.64					7.95
180	15	3.9	11,800	2.31						2.31
									Total Additional Trucks	**70.53**

Table 86: Additional Trucks to Te Araroa 2017 – 2020

Section		Length (km)	Volume (t/yr)	Additional Trucks to Te Araroa from the Road Outlets Below (2021 – 2025)						Total Additional Trucks on each Section
From ID	To ID			16	15	14	13	12	11	
12	159	5.3	14900	8.34	18.71	6.13	6.13	6.89	2.92	49.10
13	12	2.2	35200	8.34	18.71	6.13	6.13	6.89		46.18
172	13	5.3	31300	8.34	18.71	6.13	6.13			39.30
14	172	3.6	31300	8.34	18.71	6.13				33.17
15	14	0.9	95600	8.34	18.71					27.05
180	15	3.9	42600	8.34						8.34
									Total Additional Trucks	**203.13**

Table 87: Additional Trucks to Te Araroa 2021 – 2025

Section		Length (km)	Volume (t/yr)	Additional Trucks to Te Araroa from the Road Outlets Below (2026 – 2030)						Total Additional Trucks on each Section
From ID	To ID			16	15	14	13	12	11	
12	159	5.3	4800	23.2	31.9	5.4	5.4	16.7	0.9	83.50
13	12	2.2	85500	23.2	31.9	5.4	5.4	16.7		82.56
172	13	5.3	27500	23.2	31.9	5.4	5.4			65.83
14	172	3.6	27500	23.2	31.9	5.4				60.45
15	14	0.9	162800	23.2	31.9					55.07
180	15	3.9	118600	23.2						23.21
									Total Additional Trucks	**370.63**

Table 88: Additional Trucks to Te Araroa 2026 – 2030

Section		Lengt h	Volum e	Additional Trucks to Te Araroa from the Road Outlets Below (2031 – 2035)						Total Additional Trucks on each Section
		(km)	(t/yr)							
From ID	To ID			16	15	14	13	12	11	
12	159	5.3	0	11.9	25.5	5.2	5.2	25.5	0.0	73.33
13	12	2.2	130500	11.9	25.5	5.2	5.2	25.5		73.33
172	13	5.3	26400	11.9	25.5	5.2	5.2			47.79
14	172	3.6	26400	11.9	25.5	5.2				42.62
15	14	0.9	130500	11.9	25.5					37.46
180	15	3.9	60900	11.9						11.92
									Total Additional Trucks	**286.44**

Table 89: Additional Trucks to Te Araroa 2031 – 2035

Section		Length	Volume	Additional Trucks to Te Araroa from the Road Outlets Below (2036 – 2040)						Total Additional Trucks on each Section
		(km)	(t/yr)							
From ID	To ID			16	15	14	13	12	11	
12	159	5.3	0	4.31	10.06	3.50	3.50	7.73	0.00	29.10
13	12	2.2	39500	4.31	10.06	3.50	3.50	7.73		29.10
172	13	5.3	17900	4.31	10.06	3.50	3.50			21.37
14	172	3.6	17900	4.31	10.06	3.50				17.87
15	14	0.9	51400	4.31	10.06					14.36
180	15	3.9	22000	4.31						4.31
									Total Additional Trucks	**116.11**

Table 90: Additional Trucks to Te Araroa 2036 – 2040

Section		Length	Volume	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2019	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV	Additional Accident Cost
From ID	To ID	(km)	(t/yr)							
12	159	5.3	7,400	18.51	350	350	38	26126	0.49	67434
13	12	2.2	16,600	17.06	350	350	38	26126	0.45	25785
172	13	5.3	15,000	13.82	350	350	38	26126	0.36	50000
14	172	3.6	15,000	10.88	350	350	38	26126	0.29	26903
15	14	0.9	8,800	7.95	350	350	38	26126	0.21	4886
180	15	3.9	1,800	2.31	350	350	38	26126	0.06	5832
									Total Additional Accident Cost	**180,840**

Table 91: Additional Accident Costs 2017 – 2020

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2019	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV	Additional Accident Cost
From ID	To ID									
12	159	5.3	14900	49.10	350	350	38	26126	1.29	178914
13	12	2.2	35200	46.18	350	350	38	26126	1.22	69856
172	13	5.3	31300	39.30	350	350	38	26126	1.03	143188
14	172	3.6	31300	33.17	350	350	38	26126	0.87	82100
15	14	0.9	95600	27.05	350	350	38	26126	0.71	16735
180	15	3.9	42600	8.34	350	350	38	26126	0.22	22353
									Total Additional Accident Cost	**513,146**

Table 92: Additional Accident Costs 2021 – 2025

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2019	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV	Additional Accident Cost
From ID	To ID									
12	159	5.3	4800	83.50	350	350	38	26126	2.20	304275
13	12	2.2	85500	82.56	350	350	38	26126	2.17	124882
172	13	5.3	27500	65.83	350	350	38	26126	1.73	239883
14	172	3.6	27500	60.45	350	350	38	26126	1.59	149620
15	14	0.9	162800	55.07	350	350	38	26126	1.45	34075
180	15	3.9	118600	23.21	350	350	38	26126	0.61	62233
									Total Additional Accident Cost	**914,968**

Table 93: Additional Accident Costs 2026 – 2030

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2019	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV	Additional Accident Cost
From ID	To ID									
12	159	5.3	0	73.33	350	350	38	26126	1.93	267195
13	12	2.2	130500	73.33	350	350	38	26126	1.93	110911
172	13	5.3	26400	47.79	350	350	38	26126	1.26	174137
14	172	3.6	26400	42.62	350	350	38	26126	1.12	105494
15	14	0.9	130500	37.46	350	350	38	26126	0.99	23177
180	15	3.9	60900	11.92	350	350	38	26126	0.31	31956
									Total Additional Accident Cost	**712,869**

Table 94: Additional Accident Costs 2031 – 2035

Section		Length (km)	Volume (t/yr)	Total Additional Trucks on each Section x 2	Base AADT (Car, LCV, MCV)	AADT (Car, LCV, MCV) 2019	Base HCV	Base Accident Cost	Increase in AADT (car-MCV) x Increase in HCV	Additional Accident Cost
From ID	To ID									
12	159	5.3	0	29.10	350	350	38	26126	0.77	106036
13	12	2.2	39500	29.10	350	350	38	26126	0.77	44015
172	13	5.3	17900	21.37	350	350	38	26126	0.56	77869
14	172	3.6	17900	17.87	350	350	38	26126	0.47	44222
15	14	0.9	51400	14.36	350	350	38	26126	0.38	8888
180	15	3.9	22000	4.31	350	350	38	26126	0.11	11544
Total Additional Accident Cost										**292,575**

Table 95: Additional Accident Costs 2036 – 2040

Appendix C
Emissions Savings

Annual savings in CO2 emissions have been evaluated from EEM A9.7 procedures.

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	86.81	31685	109599
172	2.27	90.05	32868	74722
180	2.34	93.57	34154	79934
190	2.37	93.57	34154	80937
200	3.01	93.57	34154	102760
213	2.90	93.57	34154	99085
225	3.06	93.57	34154	104554
238	3.12	93.57	34154	106723
250	2.78	93.57	34154	95066
263	2.54	93.57	34154	86858
274	3.50	93.57	34154	119503
289	2.42	93.57	34154	82602
300	1.82	93.57	34154	62241
308	2.54	93.57	34154	86904
321	1.41	93.57	34154	47988
			Total ($/yr)	**$1,339,475**

Table 96: Annual Emission Cost Saving 2017 – 2020

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	39.75	14510	50189
172	2.27	47.69	17408	39576
180	2.34	59.12	21579	50503
190	2.37	59.12	21579	51137
200	3.01	59.12	21579	64925
213	2.90	59.12	21579	62603
225	3.06	59.12	21579	66058
238	3.12	59.12	21579	67429
250	2.78	59.12	21579	60063
263	2.54	59.12	21579	54878
274	3.50	59.12	21579	75503
289	2.42	59.12	21579	52189
300	1.82	59.12	21579	39325
308	2.54	59.12	21579	54907
321	1.41	59.12	21579	30319
			Total ($/yr)	**$819,604**

Table 97: Annual Emission Cost Saving 2021 – 2025

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	54.79	20000	69181
172	2.27	67.63	24686	56121
180	2.34	90.75	33125	77527
190	2.37	90.75	33125	78499
200	3.01	90.75	33125	99665
213	2.90	90.75	33125	96101
225	3.06	90.75	33125	101405
238	3.12	90.75	33125	103509
250	2.78	90.75	33125	92203
263	2.54	90.75	33125	84242
274	3.50	90.75	33125	115904
289	2.42	90.75	33125	80114
300	1.82	90.75	33125	60367
308	2.54	90.75	33125	84287
321	1.41	90.75	33125	46543
			Total ($/yr)	**$1,245,668**

Table 98: Annual Emission Cost Saving 2026 – 2030

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	67.28	24557	84945
172	2.27	81.77	29846	67853
180	2.34	97.10	35443	82952
190	2.37	97.10	35443	83992
200	3.01	97.10	35443	106639
213	2.90	97.10	35443	102825
225	3.06	97.10	35443	108501
238	3.12	97.10	35443	110752
250	2.78	97.10	35443	98654
263	2.54	97.10	35443	90136
274	3.50	97.10	35443	124014
289	2.42	97.10	35443	85720
300	1.82	97.10	35443	64591
308	2.54	97.10	35443	90185
321	1.41	97.10	35443	49799
			Total ($/yr)	**$1,351,559**

Table 99: Annual Emission Cost Saving 2031 – 2035

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	22.04	8045	27829
172	2.27	27.46	10024	22788
180	2.34	33.55	12246	28662
190	2.37	33.55	12246	29022
200	3.01	33.55	12246	36847
213	2.90	33.55	12246	35529
225	3.06	33.55	12246	37490
238	3.12	33.55	12246	38268
250	2.78	33.55	12246	34088
263	2.54	33.55	12246	31144
274	3.50	33.55	12246	42850
289	2.42	33.55	12246	29619
300	1.82	33.55	12246	22318
308	2.54	33.55	12246	31161
321	1.41	33.55	12246	17207
			Total ($/yr)	**$464,820**

Table 100: Annual Emission Cost Saving 2036 – 2040

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	8.32	3037	10504
172	2.27	3.29	1201	2730
			Total ($/yr)	**$13,234**

Table 101: Annual Additional Emission Costs 2017 – 2020

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	22.65	8267	28597
172	2.27	10.49	3829	8705
			Total ($/yr)	**$37,301**

Table 102: Annual Additional Emission Costs 2021 – 2025

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	43.69	15947	55161
172	2.27	21.29	7771	17666
			Total ($/yr)	**$72,827**

Table 103: Annual Additional Emission Costs 2026 – 2030

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	41.56	15169	52472
172	2.27	13.91	5077	11542
			Total ($/yr)	**$64,014**

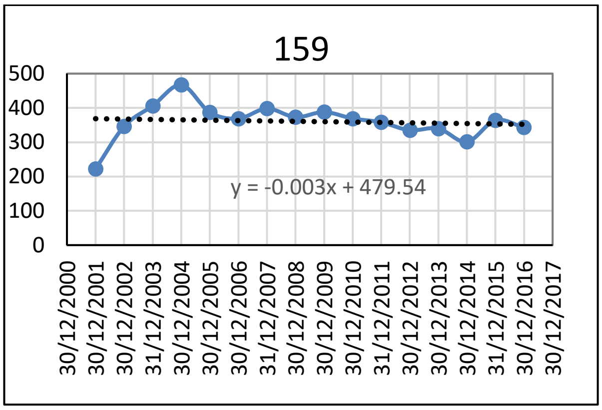
Table 104: Annual Additional Emission Costs 2031 – 2035

Ref.	Cost ($/rtn. Trip)	Return Trips Per Day	Return Trips Per Year	Annual Cost ($)
159	3.46	15.06	5497	19014
172	2.27	5.60	2044	4647
			Total ($/yr)	**$23,661**

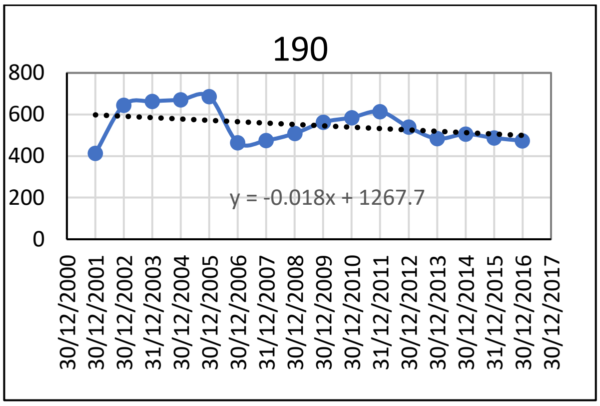
Table 105: Annual Additional Emission Costs 2036 – 2040

Appendix D
Growth Rates

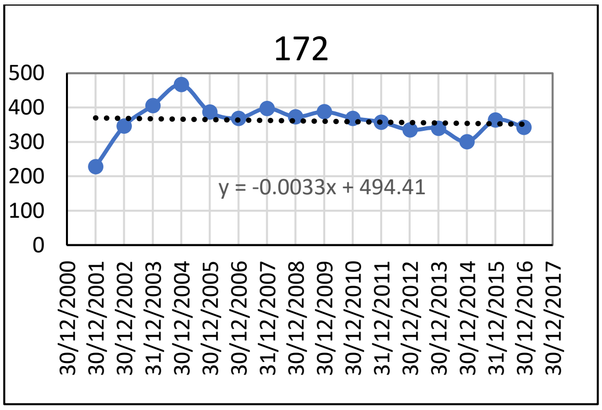
AADT (Cars, LCV, MCV) at SH 35 Reference Sections



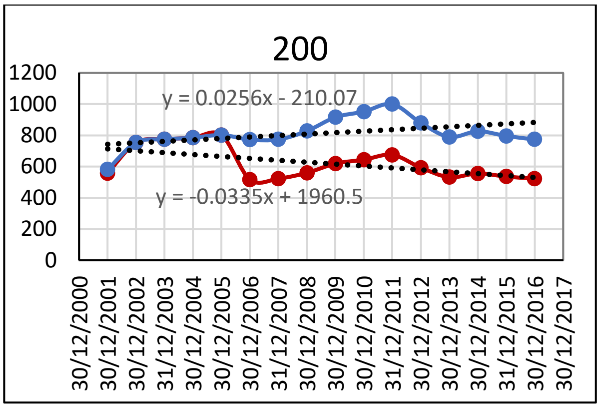
159 – No Growth Year 0 - 350



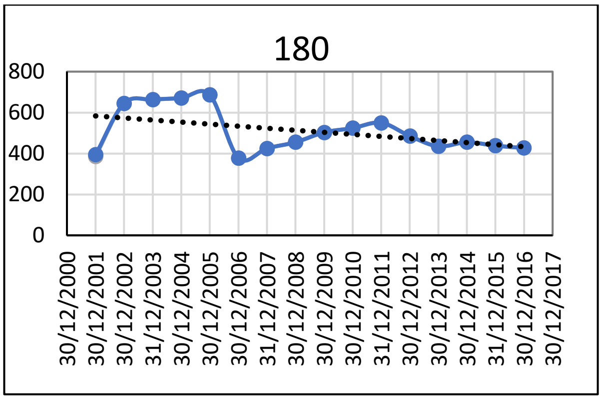
190 – No Growth Year 0 - 500



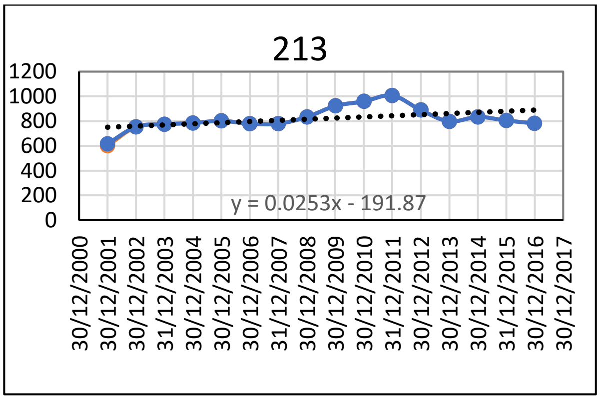
172 – No Growth Year 0 - 350



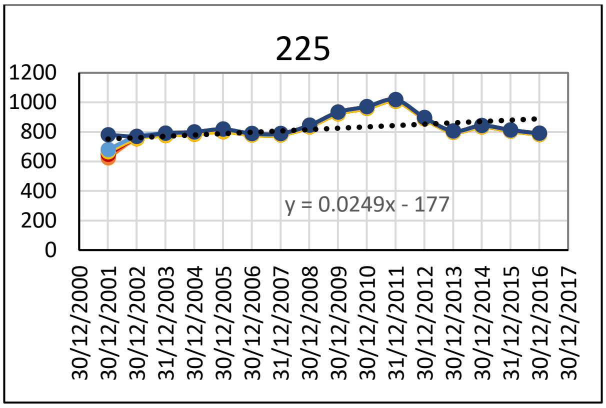
200 – No Growth Year 0 - 700



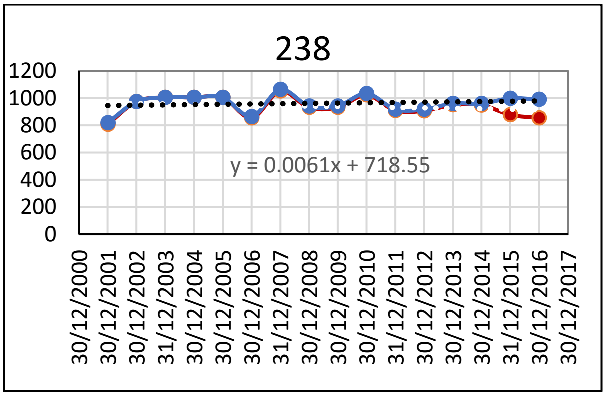
180 – No Growth Year 0 - 427



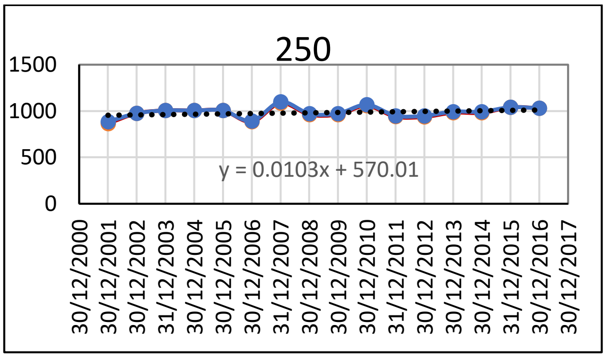
213 – 1.1% pa, 9/yr Year 0 - 885



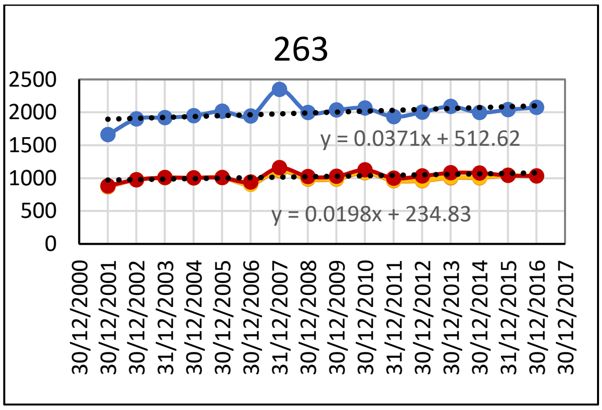
225 – 1.0% pa, 9/yr Year 0 - 882



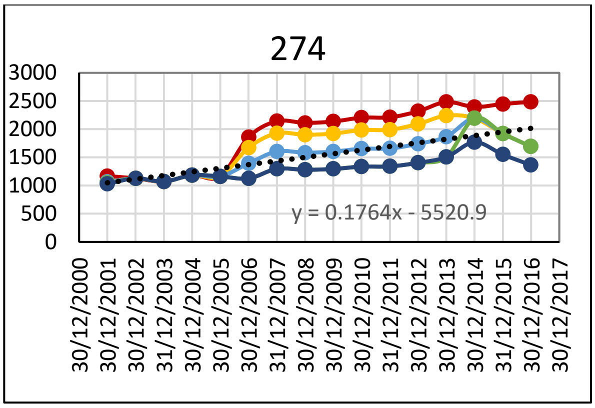
238 – No Growth Year 0 990



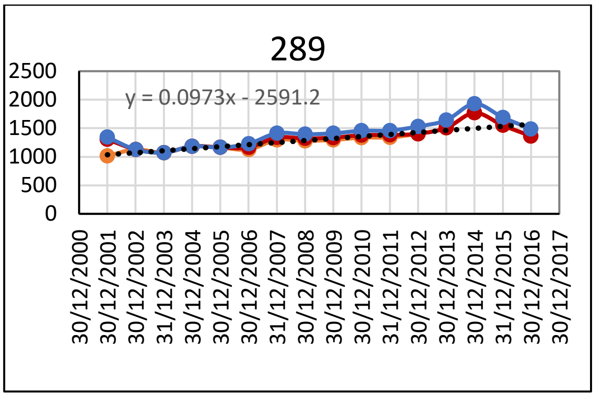
250 – 0.4% pa, 4/yr Year 0 - 1008



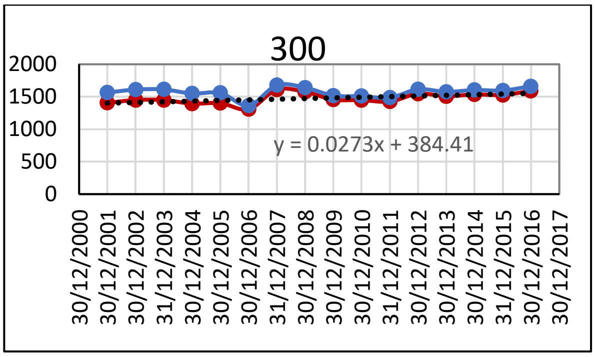
263 – 0.7% pa, 7/yr Year 0 - 1077



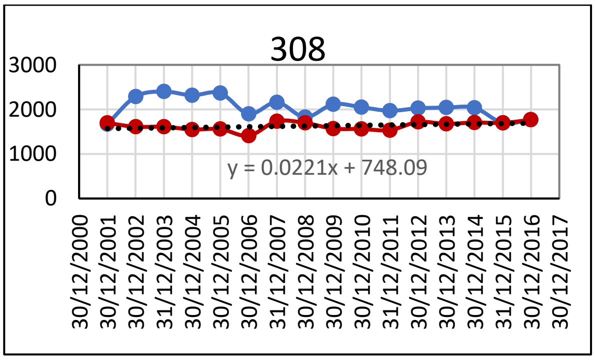
274 – 3.4% pa, 65/yr Year 0 - 1985



289 – 2.4% pa, 36/yr Year 0 - 1549



300 – 0.7% pa, 10/yr Year 0 - 1546



308 –0.50% pa, 8/yr Year 0 – 1688

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