Bonneagar Iompair Éireann
Transport Infrastructure Ireland

IMPACT OF NATIONAL ROAD SPEED LIMIT REDUCTIONS ON GREENHOUSE GAS EMISSIONS

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Table of Contents

Figures

Tables

Updates to Note – Impact of National Road Speed Limits Reductions on Greenhouse Gas Emissions

Date:	October 2022
Page No:	18
Section No:	Appendix A

Amendment Details:

The emission rates for Heavy Goods Vehicles (Small, Medium and Large) travelling at speed limits above 90kph in Table A.1 have been removed as the maximum legal speed limit for a Heavy Goods Vehicle in Ireland is 90kph. This update has no material impact on the assessment or its findings.

Date:	October 2022
Page No:	19
Section No:	Appendix B

Amendment Details:

The modelled speed limits in Table B.2 and Table B.3 for Scenarios 5 and 6 have been updated from 50kph to 60kph to reflect the correct speed limit modelled in these scenarios as part of the assessment. This update has no material impact on the assessment or its findings.

EXECUTIVE SUMMARY

The Department of Transport is investigating measures to reduce carbon emissions in the transport sector. A measure under consideration is the potential reduction of speed limits on the National Roads Network. A range of speed limit reduction scenarios have therefore been assessed by Transport Infrastructure Ireland as part of this note to understand their potential impact in terms of reducing Greenhouse Gas emissions.

As part of the assessment consideration has also been given to the associated impacts that speed limits changes on the National Roads Network may have on other areas such as road safety and the economy.

The National Roads Network

The National Roads Network in Ireland is over 5,300km in length with each road classified as a Motorway, National Primary or National Secondary Road. The legal posted speed limit on these roads varies from 50kph in urban areas up to 120kph on the Motorway network. In addition to the National Roads Network there is a non-national road network in Ireland of Regional Roads (over 13,000km) and Local Roads (over 81,000km). Although the National Roads Network only forms a small proportion of the overall road network length in Ireland, it is estimated to carry approximately 45% of all vehicle kilometres of travel on the road network.

The National Roads Network plays a significant role in the Irish economy as the core corridor through which goods and services are transported throughout the country. The network facilitates a wide range of travel purposes and services, including the movement of goods both at a strategic level (e.g. to/from ports and airports) and at a local level (e.g. retail distribution). It provides access to employment, education and healthcare services and is a lifeline to some rural or peripheral areas of the country that communities depend on.

A feature of the Motorway network in Ireland, in general, is that a former single carriageway National Road runs parallel or adjacent to the Motorway and therefore provides an alternative route. These can be high quality roads with posted speeds limits of up 100kph; but do not have the key road safety characteristics associated with a motorway (e.g. high capacity, no direct access, no at-grade junctions, median separation).

Efficiency, Reliability and Safety

Drivers generally choose the most efficient and reliable route for their journey and motorways have these key characteristics. A journey via a motorway, in general, will offer a driver the fastest route between two points in the country even when there may be shorter routes by distance. If motorway speed limits are reduced, drivers may re-route onto the parallel former national roads as that route may then be more time competitive. This could result in drivers switching from the motorways to the regional or former national road network. Given that these roads are less safe than motorways, it would be expected that a transfer of traffic to these routes would come at a cost in terms of road safety. This would incorporate expected increases in vehicular collisions and collisions involving vulnerable road users. In addition, these former national roads can pass through towns and villages which may result in an increase in air pollutant emissions through those areas.

TII Emissions and Air Quality Modelling

The relationship between the rate of greenhouse gases (GHGs) emitted by a vehicle and the speed at which the vehicle is travelling is non-linear. Emissions are highest at low speeds while the optimum speed range for vehicles in terms of limiting their GHG emissions is in the range of 50kph - 90kph. The GHG emissions characteristics of the entire national vehicle fleet, along with a detailed representation of travel patterns and traffic conditions on the network, are included in TII's National Transport Model and

Emissions and Air Quality Tool and were used in this assessment. This integrates data on the vehicle fleet from UCC[1] with emission rates derived from DEFRA[2] tools.

Assessment Results

The assessment has estimated that a 10 kph reduction in speed limits on Motorways would equate to an approximate reduction in total GHG emissions of less than 0.7%, on the existing situation[3]. Under the most extreme speed-limit change scenario tested, a 30kph reduction across all of the National Roads Network would equate to less than a 2.7% reduction in GHG emissions.

Reductions in speed limits on National Roads are estimated to result in an increase in collisions and fatalities (e.g. 35 additional fatalities a year under the 30kph reduction scenario) on the road network. This is brought about by a portion of traffic avoiding the higher quality and safer (but now slower) National Roads Network in favour of more direct but less safe routes. Reductions in these speed limits means that it will take longer for goods to be transported, services to be provided and employment destinations to be reached all of which lead to economic costs (€217m a year under the 30kph reduction scenario).

It should be noted that the assessment was based on the 2018 Irish vehicle stock model which is expected to significantly change over the coming years as the proportion of electric vehicles increases. As such any potential reduction in emissions by lowering speed limits will reduce over time as the car fleet is increasingly composed of electric vehicles.

An Alternative Approach

A focus on the reduction of congestion in urban areas could yield more favourable results. Concentrated, slow-moving traffic in congested urban areas results in higher amounts of emissions per vehicle-kilometre, whilst also increasing the time spent travelling and vehicle operating costs. Demand and traffic management in urban areas could yield more emissions reductions whilst also allowing for additional benefits such as less time travelled and reduced vehicle operating costs.

[1] University College Cork (2021) Irish Car Stock Model v2.1

[2] DEFRA Emission Factor Toolkit. Available online at: https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

[3] 12.3Mt CO_2e emitted from transport in 2018 (Source 2018 Sustainable Energy Authority Ireland) https://www.seai.ie/data-and-insights/seai-statistics/key-publications/co2-emissions-report/

1. Introduction

1.1 Introduction

The Department of Transport (DoT) is investigating measures to reduce carbon emissions in the transport sector. An initial measure under consideration is the potential reduction of speed limits on the National Roads Network.

To assist the DoT, Transport Infrastructure Ireland (TII) assessed the potential change in Greenhouse Gas (GHG) emissions which may result from lowering the speed limit of various road types in Ireland, as well as considering any associated impacts of such a change. Greenhouse Gases are gases that trap heat in the atmosphere and come from many sources including Carbon Dioxide (CO_2) and Methane (CH_4).

This note provides an overview of the potential changes in GHG emissions resulting from reduced speed limits on Motorways and National Primary/Secondary Roads in Ireland. In addition, consideration has also been given to the associated impacts that speed limits changes on the National Roads Network may have on other areas such as road safety and the economy.

1.2 National Roads Network Speed Limits

The National Roads Network in Ireland is over 5,300km[4] in length and is classified into 3 road types:

- Motorways – 998km
- Dual Carriageways – 332km
- Single Carriageways – 4,023km

Dual or Single Carriageway Road types may from part of either the National Primary or National Secondary road network. The current legal posted speed limits on National Roads Network are set out in Table 1.1 for both general traffic (Cars & Light Goods Vehicles (LGV)) and Heavy Goods Vehicles (HGV).

Table 1.1 National Roads Network Speed Limits

National Roads Network	General Traffic (Cars & LGV)	Heavy Goods Vehicles
Motorways	120kph	90kph
National Primary/Secondary Roads (Rural)	100kph	80kph
National Primary/Secondary Roads (Urban)	50kph	50kph

There are a number of variations to the speed limit on Motorways such as sections of the M50 (100kph) and Dublin Tunnel (80kph). In addition short 60kph speed transition zones are also in place on the National Roads Network when approaching/leaving a 50kph urban area.

In addition to the National Roads Network there is a non-national road network in Ireland of Regional Roads (over 13,000km) and Local Roads (over 81,000km). Although the National Roads Network only forms a small proportion of the overall road network length in Ireland, it is estimated to carry approximately 45% of all vehicle kilometres of travel on the road network.

[4] Transport infrastructure Ireland National Roads Network Indicators 2020 – A: Length of National Roads Network

1.3 GHG Emissions and Vehicle Speed Relationship

The relationship between the rate of GHG emissions emitted by a vehicle and the speed at which the vehicle is travelling is non-linear. Simply put, vehicles travelling at lower speeds (i.e. <50kph) have the highest emission rate. The optimum speed range for vehicles in terms of limiting their GHG emissions is in the range of 50kph - 90kph. The following discussion is based on the national fleet composition and vehicle-km (i.e. distance travelled per vehicle type) in 2018 and is intended to indicate the relative relationships between speed and CO_2e emissions.

Cars & Vans – Emission Rates

The data displayed in Figure 1.1[5] demonstrates that vehicle emissions for light vehicles in the national fleet (I.e. cars & vans) are at their highest when the vehicle is travelling at a lower speed (e.g. <50kph). The emission rate decreases as speed increases up to approximately 65 kph. After that, the emission rate increases once again as speed increases.

Heavy Goods Vehicles – Emission Rates

Figure 1.2 illustrates the vehicle emission rates for the national Heavy Goods Vehicle (HGV) fleet, classified as small, medium, or large HGVs. The emissions rates for individual HGVs are significantly higher than for cars and vans, most notably large HGVs, but follow the same trend as the rest of the national vehicle fleet, with higher emissions at lower speeds which reduce towards the optimum speed of approximately 65kph. Beyond this, emission rates increase marginally as speeds increase.

The data presented in Figure 1.1 and Figure 1.2 is combined and tabulated in Appendix A.

[5] Emissions curve was developed using the TII Emissions and Air Quality Tool, using data from the 2018 Irish vehicle fleet in conjunction with emissions curves derived from COPERT/EFT. The emission rate is an average derived from weighting of vehicle type/age according to their vehicle kilometres travelled.

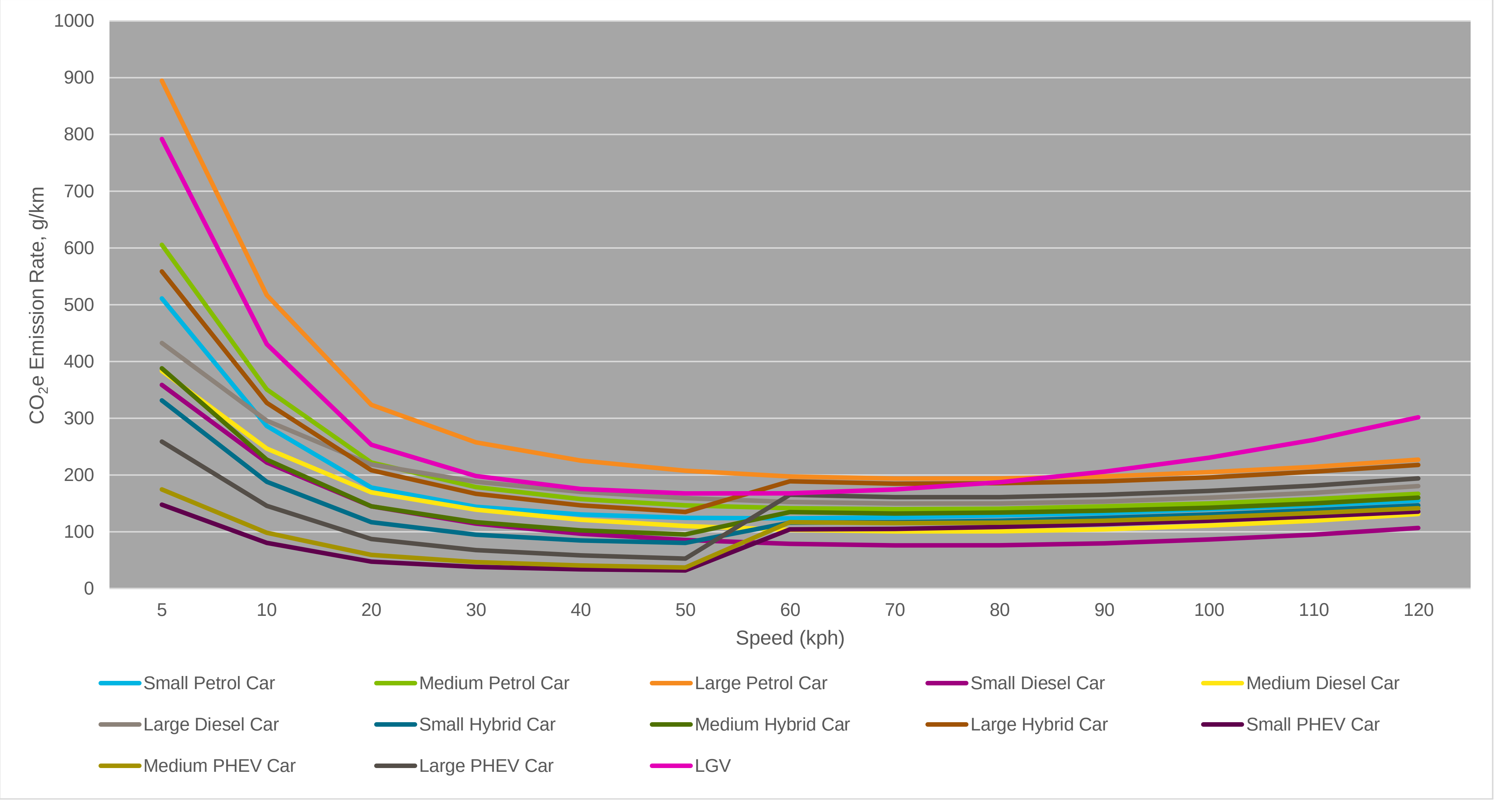

Figure 1.1 Classified CO_2e Emissions Rates based on National Car & Van Fleet Breakdown[6]

Source: TII Emissions and Air Quality Tool

[6] Emission rates from hybrid and PHEV (plug-in hybrid) cars increase to rates comparable to petrol cars at speeds above 50 km/hr as they switch to internal combustion engine (ICE)

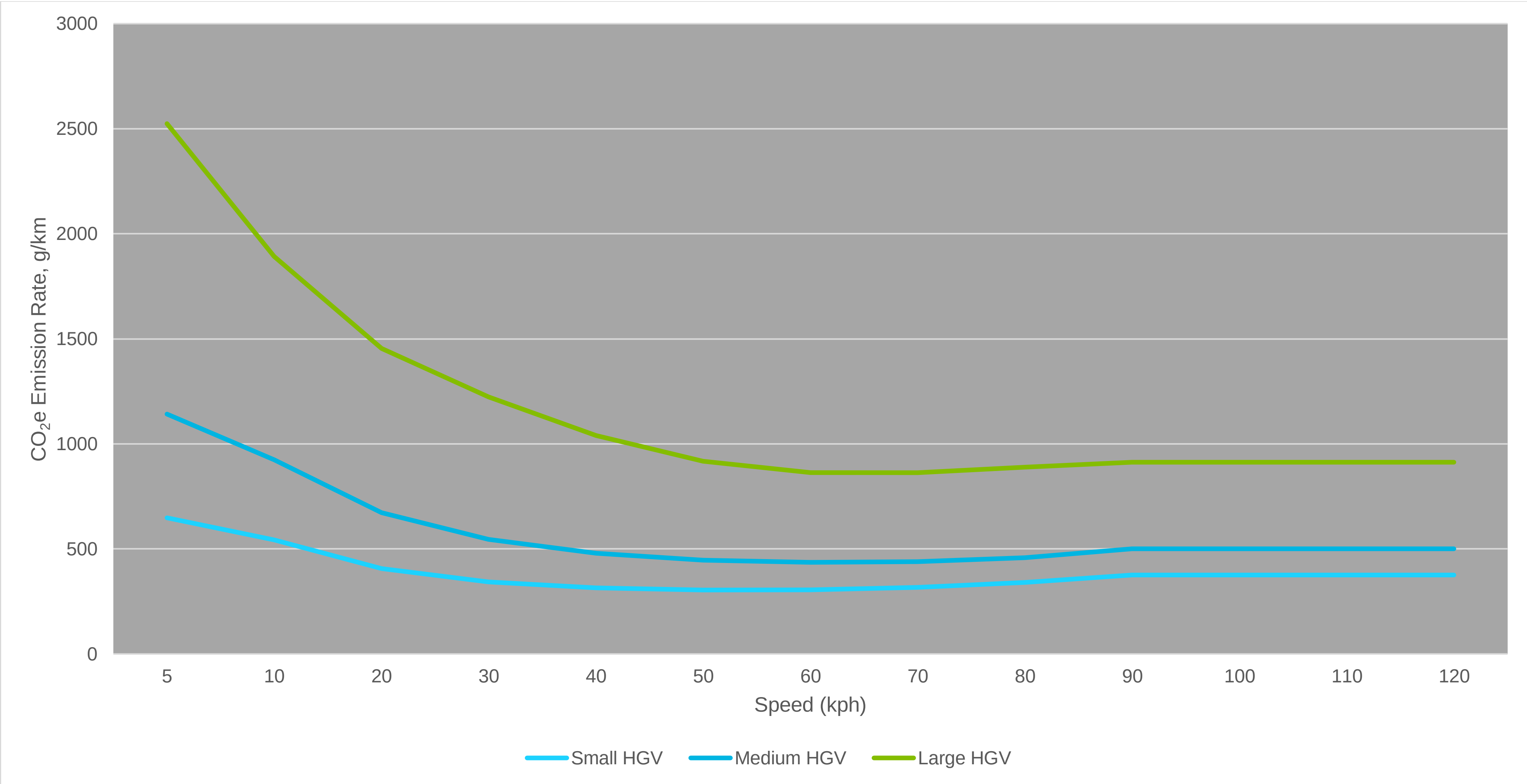

Figure 1.2 Classified CO_2e Emissions Rates based on National HGV Fleet Breakdown

Source: TII Emissions and Air Quality Tool

2. Methodology

2.1 Speed Limit Reduction Scenarios

The initial step in the process was to identify the speed limit reduction scenarios to be assessed. A total of 6 scenarios were identified for assessment and these scenarios are set out in Table 2.1. Details on the speed limits assumed under each scenario (by road type) are provided in Appendix B.

Table 2.1 Speed Limit Reduction Scenarios

Scenario	Speed Limit Reduction	Comment
1	10kph on Motorways Only	Applicable to all National Roads with a posted speed limit above 60kph
2	10kph on all National Roads	
3	10kph on all National Secondary Roads Only	
4	20kph on all National Roads	
5	30kph on all National Roads	
6	30kph on all National Roads with lower reductions on targeted roads to minimise re-routing of traffic	

2.2 Transport Modelling

Following the identification of the 6 speed limit reduction scenarios, each scenario was coded and then modelled to understand its impacts using the TII National Transport Model. The TII National Transport Model is a strategic transport assignment model, which includes all Motorways, National Primary, National Secondary and Regional Roads in Ireland.

The National Transport Model represents the choices a person has when making a trip such as:

- Whether to make the trip;
- What time to make the trip at; and
- What mode of transport to use when making the trip.

The above choices form part of the "variable demand" element of the model which can represent how changes to network conditions will impact travel demand on the National Roads Network, heavy rail network and on inter-urban bus services.

The road traffic assignment element of the model represents vehicle drivers' choice of route between start (origin) and end (destination) point based on the 'Generalised Cost' of travel. This cost includes the travel time, travel distance and any tolls along a specific route for road traffic. Changes in travel time associated with lower speeds on the National Roads Network have a direct impact on the route a vehicle may choose to take between its origin and destination. For public transport services, other costs such as people's walk times to stops, wait times at stops and fares are also considered. The model captures people's choices across all relevant inter-urban modes and therefore changes in travel time associated with lower speeds may also cause a person to switch from a car trip to a public transport trip where a competitive alternative exists.

Vehicle speeds in the model are determined through the application of a speed-flow curve for each road link. The model assumes average conditions over the hour of a typical weekday (AM peak and Inter-peak), therefore modelled speed outputs are average speeds over an hour. The speed-flow curve is generated using the speed limit of each link along with link capacity characteristics such as the number of lanes in each direction. The curve captures the impact of traffic volumes on the link speeds for various types of road link (e.g. motorway or single carriageway). Low volume or "free-flowing" traffic is assumed to travel at or close to the speed limit on average over the modelled hour and, as traffic increases, modelled speeds reduce. Each scenario tested involves changing the speed limit across different road links which resulted in an adjusted speed-flow relationship. The model accounts for the different speed limits for light and heavy vehicles but does not account for compliance of motorists with speed limits.

Each of the 6 scenarios were modelled using the TII National Transport Model for the average AM peak hour (07:00-09:00) and the average Interpeak hour (12:00-14:00). The modelling accounted for variable demand responses associated with lower travel speeds on the National Roads Network.

For each of the 6 scenarios and the baseline scenario (i.e. the existing situation) the following Key Performance Indicators (KPI) were generated using the TII National Transport Model to understand the aggregate impacts:

- Total Network Travel Time – the total time (hours) spent travelling on the modelled road network in the applicable time period (average AM Peak or average Inter Peak hour); and
- Total Network Travel Distance – the total distance (kilometres) travelled on the modelled road network in the applicable time period (average AM Peak or average Inter Peak hour).

In addition to the AM and Inter Peak hour KPIs, daily estimates of traffic and average speeds on each road link in the TII National Transport Model were generated for each scenario for use within the TII Emissions and Air Quality Tool. A summary of the TII Emissions and Air Quality Tool is provided in Appendix C.

2.3 GHG Emissions Modelling

As outlined above the TII National Transport Model was used to generate the required traffic inputs for the TII Emissions and Air Quality Tool. The TII Emissions and Air Quality Tool was then used to assess the change in GHG emissions as a result of each of the speed limit reduction scenarios. More detail on the TII Emissions and Air Quality Tool is provided in Appendix C.

2.4 Associated Impacts

As part of the assessment, associated impacts in relation to road safety and economic impacts arising from the speed limit reduction scenarios have been considered.

3. Impacts of the Scenarios

3.1 Key Performance Indicators

The KPIs for each of the scenarios (listed in Table 2.1) extracted from the TII National Transport Model are presented in Figure 3.1 and Figure 3.2 in relation to the change in Total Network Travel Time and Total Network Travel Distance respectively.

As expected, the total network travel time on the road network increased in each scenario as a result of the lowering of the speed limits, with Scenario 5 (30kph reduction on all National Roads) experiencing the largest increase overall (5.6% and 6.3% increase over the baseline scenario in the AM Peak and Inter Peak hours).

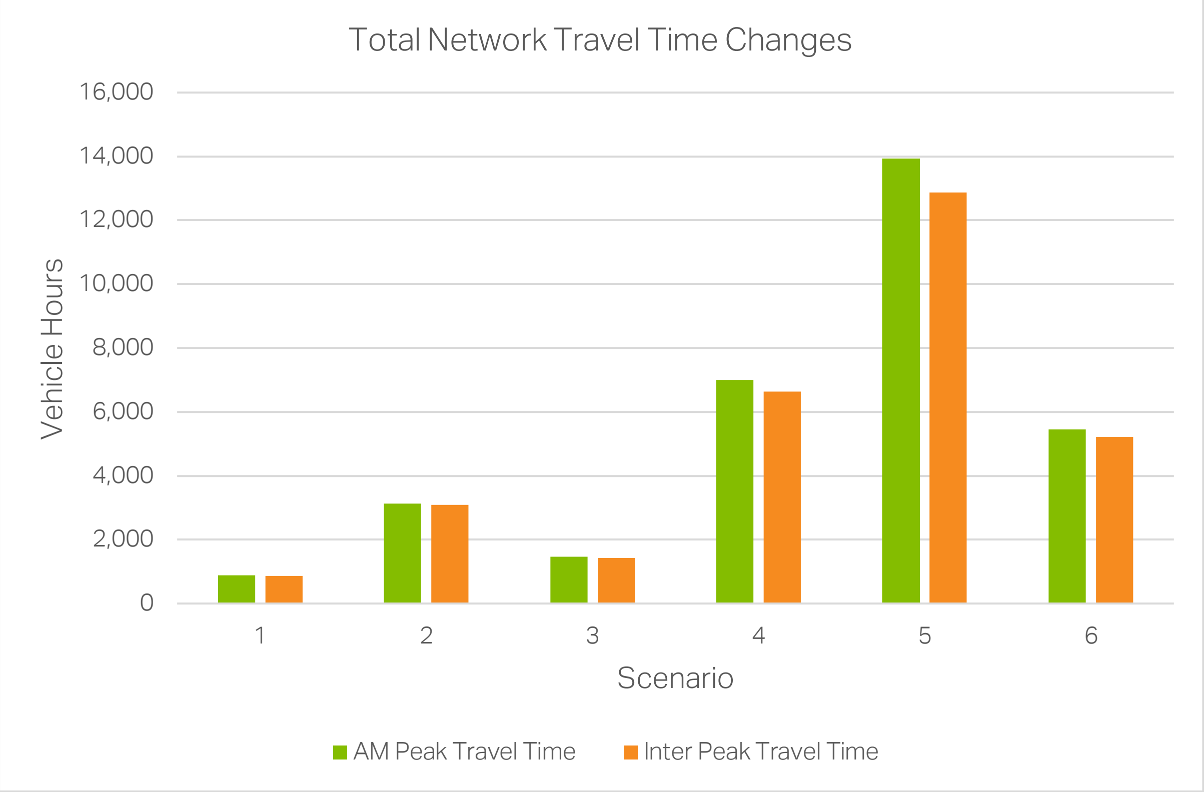

Figure 3.1 Total Network Travel Time Changes

In relation to total network travel distance on the road network, all scenarios experienced a reduction except for Scenario 3 (10kph reduction on all National Secondary Roads Only). The largest change occurred in Scenario 5 (0.5% reduction over the baseline in the AM Peak and Inter Peak hours). Further details are provided in the network statistics located in Appendix D.

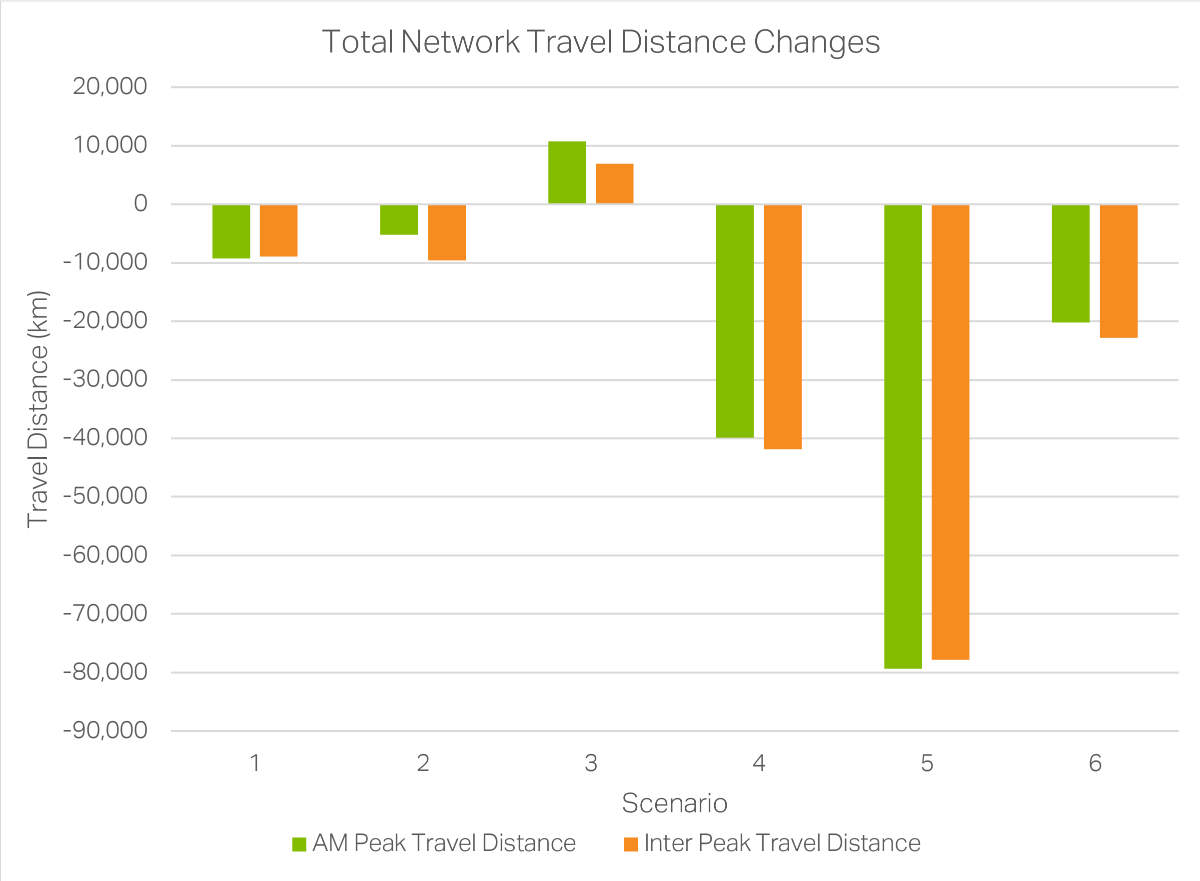

Figure 3.2 Total Network Travel Distance Changes

3.2 Greenhouse Gas Emissions Impacts

In 2018, 12.3 Million tonnes (Mt) of CO_2e[7] was emitted from transport in Ireland[8]. Table 3.1, illustrate the impact of each of 6 speed limit reduction scenarios in terms of the change in CO_2e relative to the 2018 baseline CO_2e. The change in CO_2e has been calculated using the TII Emissions and Air Quality Tool.

Table 3.1 TII Emissions and Air Quality Tool CO_2e Scenario Comparison 2018

Scenario	2018 Baseline CO_2e Emitted (tonnes/year)	Change in CO_2e Emitted (tonnes/year)	Difference (%)
1	12,236,990	-75,604	-0.62%
2		-97,177	-0.79%
3		+2,173	0.02%
4		-214,050	-1.75%
5		-328,521	-2.86%
6		-178,788	-1.46%

[7] $CO2_e$ – Carbon dioxide equivalent
[8] Source - Sustainable Energy Authority Ireland https://www.seai.ie/data-and-insights/seai-statistics/key-publications/co2-emissions-report/

The speed limit reduction scenarios tested are estimated to reduce emissions by between 0.62% and 2.86%, except for Scenario 3, which resulted in a slight increase (0.02%) in emissions. This was due to an overall increase in network travel distance in Scenario 3 as a result of speed limit reductions on the national secondary roads only. Scenario 5 showed the largest decrease in emissions which is reflective of the scale of reductions in speed limits (i.e. 30kph reduction on all National Roads).

3.3 Associated Impacts

The reduction of speed limits also impacts on a number of other aspects, such as road safety and economy, which is discussed in the following sections.

<u>Safety</u>

The lowering of speed limits can lead to traffic re-routing from roads with lower collision rates (e.g. motorways) to roads with higher collision rates (e.g. single carriageway roads).

This re-routing of traffic[9] is illustrated in Figure 3.3 which shows the re-routing of traffic in Scenario 1 (10kph reduction on Motorways). This decreases road user safety, as collisions are least likely on Motorways when compared to other road types which have a higher collision rate.

A safety assessment was undertaken using collision rates from TII Project Appraisal Guidelines Unit 6.11 – National Parameters Values Sheet[10] to quantify the impact of additional traffic traveling on less safe roads. It found that for the scenarios with some emissions savings (all scenarios with the exception of scenarios 2 and 3) 29 to 217 additional collisions a year could be expected, resulting in 5 to 35 more fatalities a year. This would incorporate increases in vehicular collisions and collisions involving vulnerable road users. Further details for each scenario are provided in Appendix F.

<u>Economic</u>

Lowering speed limits will lead to increased journey times for road users, this will have an impact on freight (both HGV and light goods), drivers commuting to work, business travel etc. The economic impact in terms of travel time increases for each scenario has been assessed using the Transport User Benefits Analysis tool (TUBA). The economic impacts were calculated based on one modelled year (2018) extrapolated to a standard 30-year appraisal period expressed in 2011 prices. This is the standard methodology by which transport interventions are appraised in line with the Department of Transport "Common Appraisal Framework for Transport Projects and Programmes".

Each scenario tested resulted in millions of euros per year in economic costs as a result of journey time increases, vehicle operating cost changes, and indirect tax changes (fuel duty/VAT) between the Baseline and the various scenarios.

The biggest impact was found in Scenario 5 (€3.8 billion in economic costs over 30 years), while the least impacted was found in Scenario 1 (€255 million in costs over 30 years). The economic costs for each scenario tested are presented in Appendix G.

[9] Traffic re-routing maps for each scenario are presented in Appendix E.
[10] https://www.tiipublications.ie/library/PE-PAG-02030-04.pdf

Figure 3.3 Re-routing of Traffic (AM Peak Scenario 1 – 10kph reduction on Motorways)

4. Conclusions

The assessment has estimated that a 10 kph reduction in speed limits on Motorways would equate to less than a 0.7% reduction in GHG emissions relative to the existing situation. Under the most extreme scenario tested, a 30kph reduction across all of the National Roads Network would equate to less than a 2.7% reduction in GHG emissions.

Reductions in speed limits on National Roads are estimated to result in an increase in collisions and fatalities (e.g. 35 additional fatalities a year under the 30kph reduction scenario) on the road network. This is brought about by a portion of traffic avoiding the higher quality and safer (but now slower) National Roads Network in favour of more direct but less safe routes. Reductions in these speed limits means that it will take longer for goods to be transported, services to be provided and employment destinations to be reached all of which lead to economic costs (€217m a year under the 30kph reduction scenario).

It should be noted that the assessment was based on the 2018 Irish vehicle stock model which is expected to significantly change over the coming years as the proportion of electric vehicles increases. As such any potential reduction in emissions by lowering speed limits will reduce over time as the vehicle fleet moves away from the combustion engine.

An Alternative Approach

A focus on the reduction of congestion in urban areas could yield more favourable results. Concentrated, slow moving traffic in congested urban areas has higher amounts of emissions associated with it, whilst also increasing the time spent travelling and vehicle operating costs. By removing congestion and allowing for smoother driving, with fewer accelerations and decelerations, this generates fewer particulate emissions from tyre and brake wear as well as CO_2 emissions. Reducing congestion in urban areas could yield more emissions reductions whilst also allowing for additional benefits such as less time travelled and reduced vehicle operating costs.

Appendix A

Table A.1 Classified CO_2e Emissions Rates at Different Speeds based on National Fleet Breakdown, g/veh-km

Vehicle Type	5 kph	10 kph	20 kph	30 kph	40 kph	50 kph	60 kph	70 kph	80 kph	90 kph	100 kph	110 kph	120 kph
Small Petrol Car	511.04	286.67	177.47	144.22	130.43	124.77	123.48	124.95	128.37	133.29	139.44	146.65	154.81
Medium Petrol Car	605.56	350.67	221.74	178.55	157.81	146.84	141.43	139.76	140.94	144.46	150.01	157.42	166.54
Large Petrol Car	894.73	516.51	323.71	257.89	225.35	207.38	197.71	193.67	193.93	197.74	204.65	214.38	226.75
Small Diesel Car	358.71	221.95	145.09	113.97	96.14	85.08	78.65	75.90	76.38	79.83	86.09	95.07	106.69
Medium Diesel Car	383.36	246.60	169.74	138.63	120.79	109.74	103.30	100.56	101.04	104.48	110.74	119.72	131.35
Large Diesel Car	432.55	295.78	218.92	187.81	169.98	158.92	152.49	149.74	150.22	153.67	159.93	168.90	180.53
Small Hybrid Car	331.37	187.90	116.97	94.54	84.71	80.27	115.76	116.62	119.62	124.33	130.49	137.96	146.62
Medium Hybrid Car	387.92	226.95	144.70	116.57	102.75	95.26	134.21	132.38	133.46	136.97	142.63	150.26	159.74
Large Hybrid Car	558.62	326.90	208.01	166.89	146.31	134.80	188.77	184.92	185.21	188.97	195.78	205.41	217.67
Small PHEV Car	147.68	80.37	47.61	37.63	33.49	31.80	103.74	105.21	108.63	113.55	119.71	126.92	135.08
Medium PHEV Car	174.49	98.02	59.34	46.39	40.16	36.87	116.55	114.88	116.06	119.58	125.13	132.54	141.66
Large PHEV Car	258.81	145.35	87.51	67.76	58.00	52.61	164.73	160.70	160.95	164.76	171.67	181.41	193.77
LGV	792.02	430.67	252.96	198.14	175.64	167.47	168.02	174.85	187.43	205.77	230.39	261.98	301.67
Small HGV	647.98	541.93	406.96	343.16	314.09	304.21	306.04	317.28	339.38	376.26	-	-	-
Medium HGV	1141.64	925.07	672.22	546.14	479.16	446.98	436.04	439.76	458.47	500.17	-	-	-
Large HGV	2524.17	1892.73	1454.43	1223.04	1039.15	917.27	863.43	862.71	887.91	912.95	-	-	-

Appendix B

Table B.1. Motorway Speed Limits (By Scenario)

Scenario	Light Vehicle Speed Limit (Cars & LGV)	Heavy Vehicle Speed Limit (HGVs & Buses)
Baseline	120 kph	90 kph
1	110 kph	80 kph
2	110 kph	80 kph
3	120 kph	90 kph
4	100 kph	70 kph
5	90 kph	60 kph
6	90 kph	60 kph

Table B.2. National Primary Road Network Speed Limits (By Scenario)

Scenario	Light Vehicle Speed Limit (Cars & LGV)	Heavy Vehicle Speed Limit (HGVs & Buses)
Baseline	100kph	80 kph
1	100 kph	80 kph
2	90 kph	70 kph
3	100 kph	80 kph
4	80kph	60 kph
5	70 kph	60 kph
6	70 kph	60 kph

Table B.3. National Secondary Road Network Speed Limits (By Scenario)

Scenario	Light Vehicle Speed Limit (Cars & LGV)	Heavy Vehicle Speed Limit (HGVs & Buses)
Baseline	100kph	80 kph
1	100 kph	80 kph
2	90 kph	70 kph
3	90 kph	70 kph
4	80kph	60 kph
5	70 kph	60 kph
6	70 kph	60 kph

Appendix C

Transport Infrastructure Ireland Emissions and Air Quality Tool Summary

Transport Infrastructure Ireland (TII) has developed and maintained the TII National Transport Model (NTpM) over the last decade to support its strategic management of and planning for the National Roads Network. The strategic transport model contains information on the current and future National Roads Network and the traffic carried on those networks. It contains information on travel for a number of trip types between over 1,100 spatial zones, including principal ports and airports. It contains information on the volume of light and heavy vehicles, and the speed at which these vehicles travel, for all links on the road network.

In order to improve its understanding of greenhouse and non-greenhouse gas emissions associated with vehicle travel on the National Roads Network, in late 2020 TII commenced work on a new Emissions and Air Quality Tool for use alongside the NTpM. The Emissions and Air Quality Tool is capable of estimating vehicle emissions associated with travel on the National Roads Network from 2018 onwards.

The emissions calculated by the TII Emissions and Air Quality Tool include: Nitrogen Oxides (NOx), Particulate Matter (PM10) and Carbon Dioxide (CO2e)[11] from the vehicle fleet on a county basis. This is done using existing fleet information from sources such as the Central Statistics Office (CSO)[12], projections concerning the vehicle fleet such as that from University College Cork (UCC)[13] for cars, standard emission rates from COPERT[14] and Defra's Emissions Factors Toolkit[15]. This information is combined to generate estimates of emissions for all links on the National Road Network.

The TII Emissions and Air Quality Tool, used in conjunction with the National Transport Model, facilitates an understanding of the emissions associated with changes in key high-level variables including the physical road network, road network speed limits, population and employment distributions, vehicle ownership, travel cost and changes to the vehicle fleet.

The first version of the TII Emissions and Air Quality Tool has now been completed and has been used to inform the TII National Roads Network Indicators 2020 report[16]. Further works are ongoing to further develop the tool to include a range of future fleet projections and add further functionality. In parallel to tool upgrades, a review is underway to better understand the relationship between congestion and emissions.

The tool has been developed in the R programming language which is well suited to coding emissions and air quality calculations.

[11] CO_2e: Carbon dioxide equivalent (CO_2e) is a term for describing different direct greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact. The seven direct greenhouse gases recognised by the Kyoto Protocol, and included within the definition of CO_2e, are: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3. Most CO_2e datasets, for road transport, include only CO_2, CH_4, N_2O.
[12] Central Statistics Office data search https://data.cso.ie/#
[13] University College Cork (2021) Irish Car Stock Model v2.1
[14] COPERT EU standard vehicle emissions calculator. Available from: https://www.eea.europa.eu/themes/air/links/guidance-and-tools/copert4-road-transport-emissions-model
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Appendix D

Table D.1. NTpM Network Statistics for Each Test Scenario (All Vehicles)

Scenario	Total Network Travel Time (Vehicle Hours)	Total Network Travel Distance (Vehicle km)	Difference (Scenario – Baseline)	
			Total Network Travel Time (Vehicle Hours)	Total Network Travel Distance (Vehicle km)
AM Peak				
Baseline	249,737	14,959,171	-	-
1	250,626	14,949,879	889	-9,292
2	252,871	14,953,946	3,133	-5,225
3	251,204	14,969,873	1,467	10,702
4	256,730	14,919,300	6,993	-39,871
5	263,673	14,879,820	13,936	-79,351
6	255,188	14,938,954	5,451	-20,217
Inter Peak				
Baseline	203,047	12,735,548	-	-
1	203,916	12,726,632	869	-8,917
2	206,142	12,725,987	3,095	-9,561
3	204,481	12,742,499	1,434	6,951
4	209,680	12,693,738	6,633	-41,810
5	215,925	12,657,760	12,878	-77,788
6	208,263	12,712,727	5,216	-22,821

Appendix E

Figure E.1: Traffic Flow Difference – Scenario 1 vs. Baseline (AM Peak)

Figure E2: Traffic Flow Difference – Scenario 2 vs. Baseline (AM Peak)

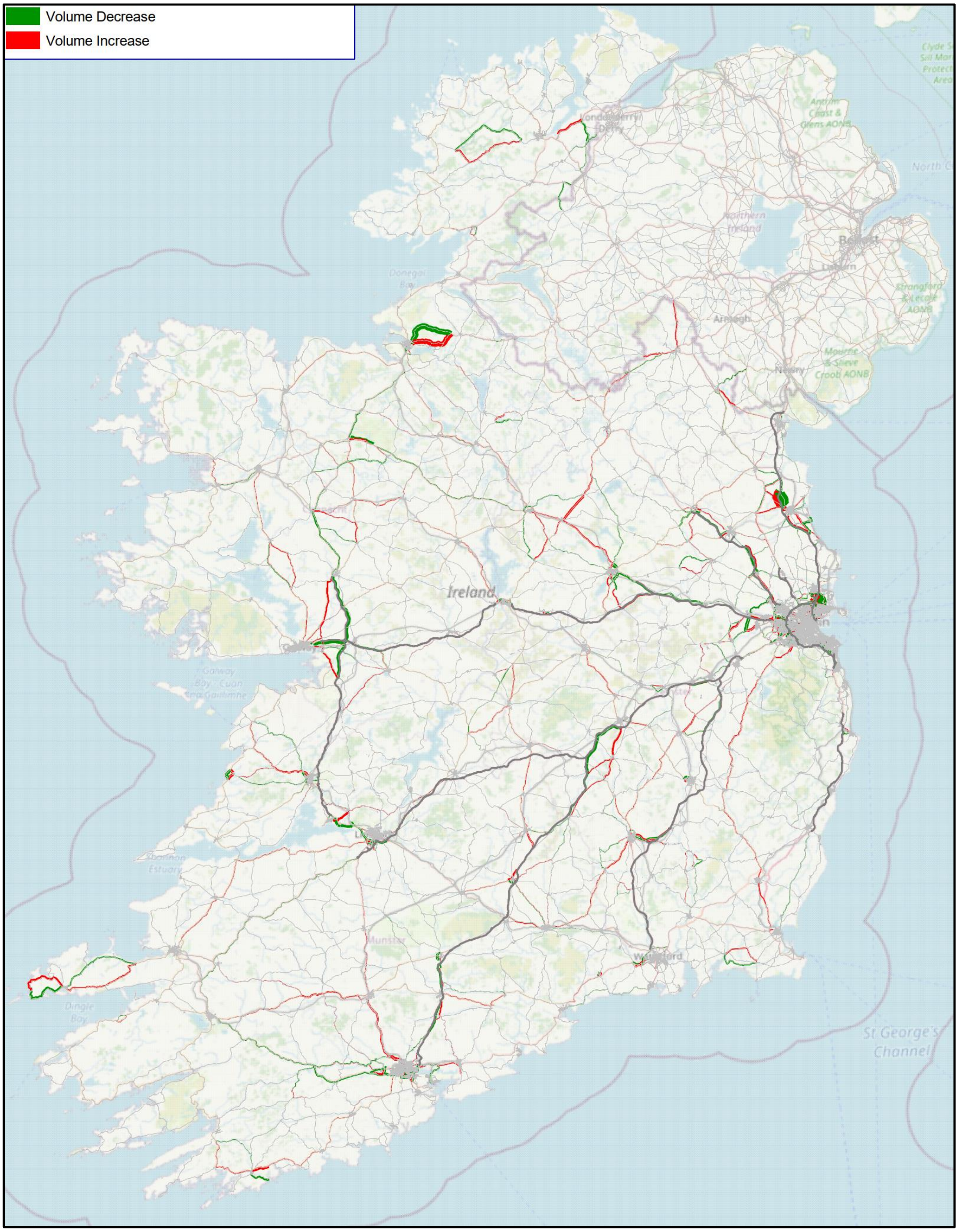


Figure E.3: Traffic Flow Difference – Scenario 3 vs. Baseline (AM Peak)

Figure E.4: Traffic Flow Difference – Scenario 4 vs. Baseline (AM Peak)

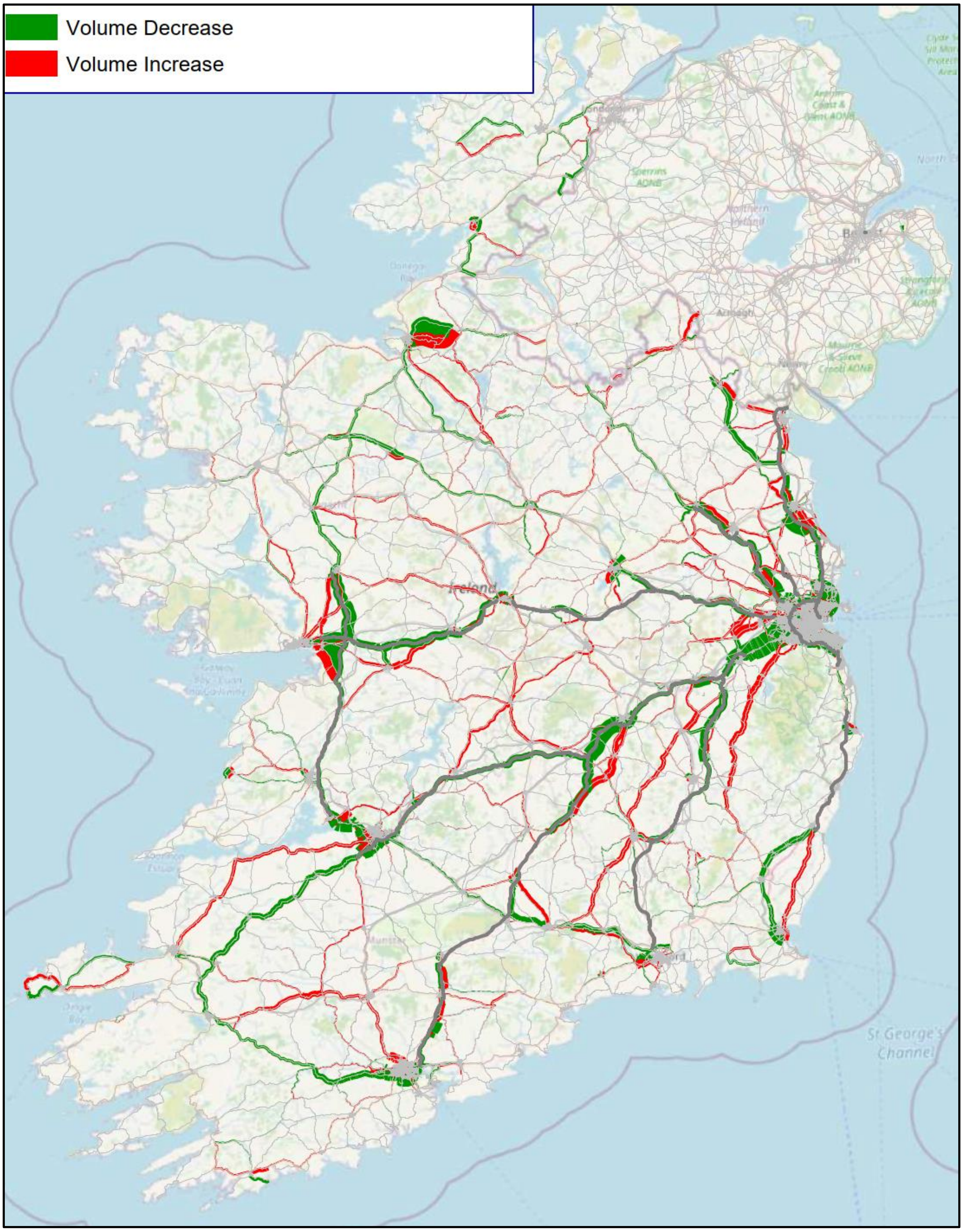


Figure E.5: Traffic Flow Difference – Scenario 5 vs. Baseline (AM Peak)

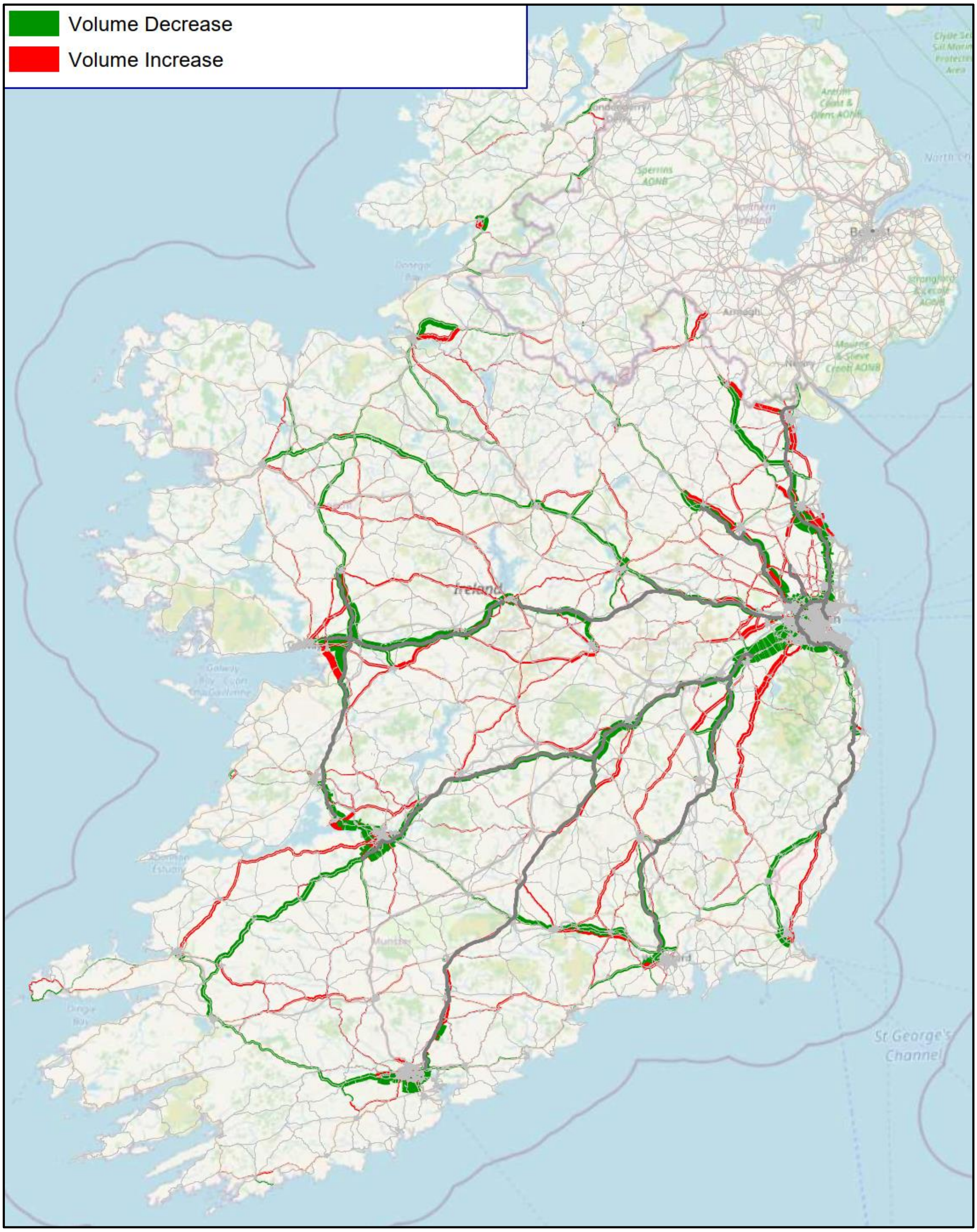
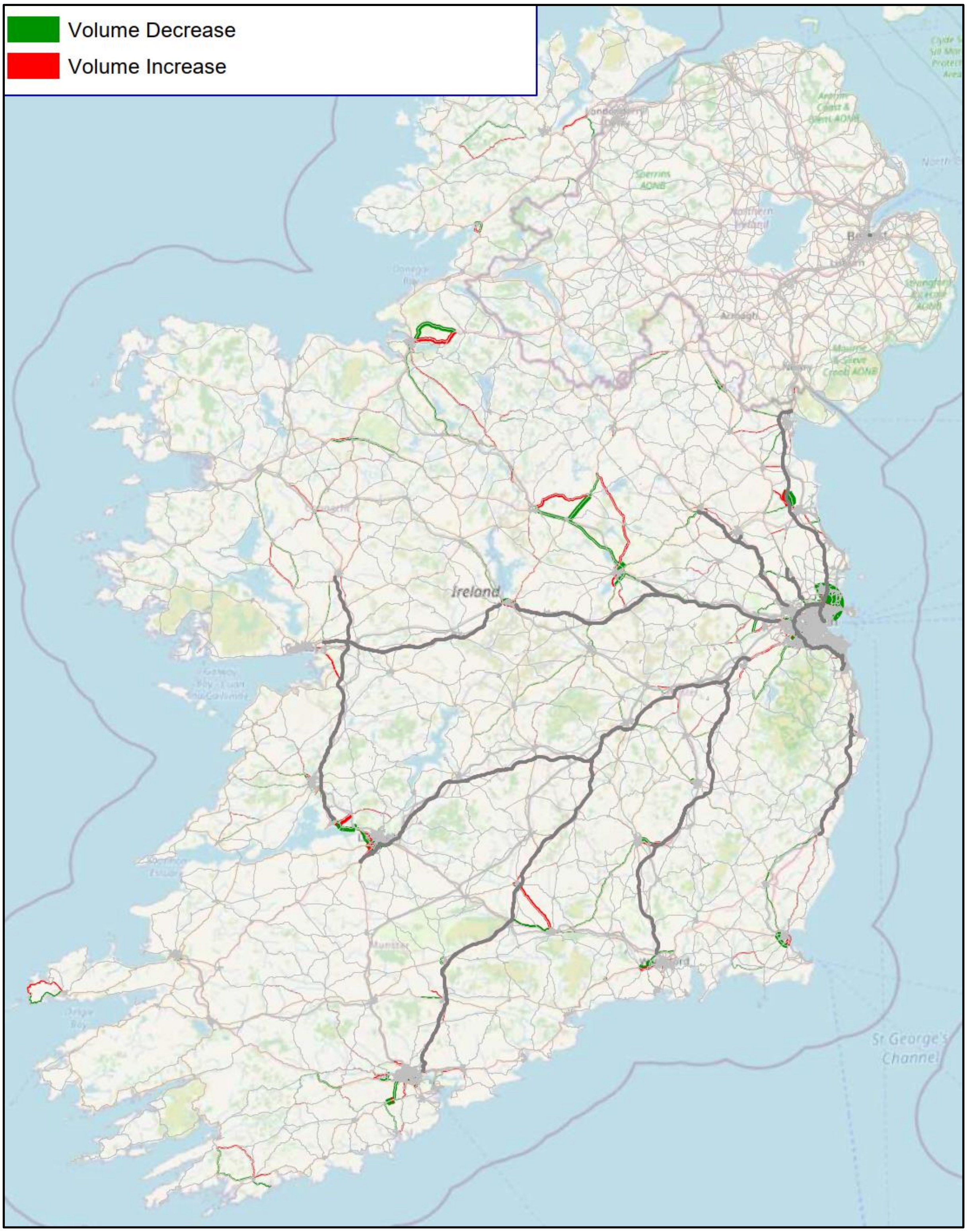


Figure E.6: Traffic Flow Difference – Scenario 5 vs. Baseline (AM Peak)



Appendix F

Table F.1. Impact on Collision and Casualty on Irish Road Network

	Baseline	Scenario					
		1	2	3	4	5	6
mvkm	37,380	37,344	37,370	37,420	37,217	37,062	37,266
Collisions	4,629	4,657	4,629	4,591	4,713	4,846	4,699
Casualties							
Fatal	662	667	662	656	676	698	673
Serious	927	934	927	918	947	977	942
Slight	6,576	6,618	6,577	6,520	6,700	6,897	6,677

	Baseline	Scenario					
		1 Diff	2 Diff	3 Diff	4 Diff	5 Diff	6 Diff
mvkm	-	-27	-11	40	-163	-318	-115
Collisions	-	+29	0	-38	+84	+217	+67
Casualties							
Fatal	-	+5	0	-6	+14	+35	+11
Serious	-	+7	0	-9	+20	+50	+16
Slight	-	+42	+1	-56	+124	+321	+101

Appendix G

Table G.1. Economic Impact from TUBA in '000s (Speed Reduction Models)

Scenario	Total Discounted Impacts over 1 year ('000s)	Total Discounted Impacts over 30 Years ('000s)
1	-€ 14,463	-€ 255,972
2	-€ 52,637	-€ 931,592
3	-€ 25,173	-€ 445,523
4	-€ 110,771	-€ 1,960,473
5	-€ 217,409	-€ 3,847,798
6	-€ 88,052	-€ 1,558,382