



Appendix E– Case Study Modelling

This appendix provides the detailed tables of the case studies discussed and summarised in in Section 7.3. They should be read in conjunction with Figure 7.1 and the transport costs/travel time rate assumptions discussed in Section 7.3. Other key assumptions for the modelling (many of which have been discussed in earlier sections of the report) include:

- Curtain-sider trucks carry 35 tonnes per load.
- Each TEU equates to 12.5 tonnes of product.
- Container skel trucks carry 2 x TEUs per load, so a total payload of 25 tonnes.
- Shuttle trains have 24 wagons and each rail wagon is able to take 2 x TEUs.
- Total payload per shuttle train is therefore estimated at 600 tonnes.

CO₂e Emissions Factors

Savvy has identified two key sources of CO₂e emissions factors that could be used in the modelling. One is the Vehicle Emissions Prediction Model v7.0 (VEPM) – a data source of emissions factors recommended to be used by NZTA in traffic modelling such as that used in transport business cases – and the other is the freight transport emissions factors produced by MfE – a data source of emission factors to be used by organisations wanting to calculate their GHG emissions).

The advantage of the VEPM data is that you are able to account for the effect of average vehicle speed on emissions. Broadly, higher emissions are generated when average speeds are lower (i.e. more stopping and starting) and vice versa (less emissions when vehicles are travelling more efficiently at higher speeds).¹²⁵ The unit of the emissions factors from the VEPM is g/km. Using the VEPM, Savvy has generated two emission factors (CO₂e) for heavy goods vehicles (i.e. the sorts of trucks used by Icon) when travelling in the Open Highway Zone and Urban Area Zone. The calculations adopt the average speed settings supplied by Icon for the two zones.

The emissions factors from the VEPM are as follows:

- 700 g/km CO₂e – Open Highway Zone – VEPM settings: based on reticulated heavy vehicle 28–34 tonnes, 100% load, 86km/hour average speed (max option), 0% gradient

¹²⁵ See for example: Emissions Impossible. Effect of speed on emissions. May 2023.



average, cold start and degradation included, ambient temperature 13.1 degrees Celsius (default), average distance 25km (max option).

- 1,125 g/km CO₂e – Urban Area Zone – VEPM settings: based on reticulated heavy vehicle 28–34 tonnes, 100% load, 30km/hour average speed, 0% gradient average, cold start and degradation included, ambient temperature 13.1 degrees Celsius (default), average distance 15km.

The VEPM implies (based on the settings adopted) that heavy vehicles goods truck CO₂e emissions are 61% higher when travelling in the Urban Area Zone compared to the Open Highway Zone.

The VEPM does not provide an equivalent emissions factor for rail (as the model has only been developed for road traffic modelling). A rail emissions factor (CO₂e) is however available from the MfE dataset.¹²⁶ The units used in the MfE dataset are kg CO₂e/net Tonne Kms. The emissions factor for rail freight is 0.0276 kg/tonne Kms.¹²⁷ This rate is relied on in a number of KiwiRail reports, including for example, 'The Value of Rail in New Zealand' (February 2021).

The MfE dataset also provides a range of emissions factors for freighting goods by truck, using the same unit as the rail figures. This data source is therefore preferred because it allows for consistent units of measurement.¹²⁸ Savvy has adopted the 'Long-haul heavy truck' emissions factor from Table 27¹²⁹ of the MfE dataset to represent emissions generated in the Open Highway Zone. The guide describes this as applying to vehicles with 3 or more axels used for relatively long distance travel. This has an emissions factor of 0.105 kg CO₂e/tonne Km.

The MfE dataset does not provide a comparable figure for the same heavy freight vehicles travelling in urban environments (with the same/similar load). While there is an Urban Delivery Heavy Truck emissions factor, the detailed guidance indicates that this vehicle fleet is generally for small trucks, and not those used by Icon. As such, Savvy has applied the ratio of emissions factors calculated from the VEPM (1.61 (Urban Area Zone: Open Highway Zone) to the MfE Long-haul heavy truck emissions factor. This gives an estimated emissions factor for those same vehicles when travelling through the Urban Area Zone of 0.169 kg CO₂e/tonne Km.

¹²⁶ Freight transport emissions factors (Summary Guide), Table 28 – Freighting goods in Aotearoa New Zealand (or Table 60 in the Detailed Guide).

¹²⁷ MfE note that the figure for net tonne Kms includes the weight for third-party tare weight containers. The figures reflect the actual freight that KiwiRail moved.

¹²⁸ MfE emphasise that all emissions factors in the guide are average emissions factors for certain vehicle categories in the New Zealand vehicle fleet. The actual emissions for a specific vehicle in a specific trip could be different.

¹²⁹ Or Table 55 in the Detailed Guide.



Other Assumptions in Modelling

The detailed tables below include the status quo supply chain scenario (no Inland Port) and the future supply chain scenario with the Inland Port. For consistency, the scenarios use the same tonnes of product so do not assume any growth (despite the fact that the Inland Port would not be operational for a few years if approved). Other key assumptions/limitations for the modelling include:

- The scenarios relate only to one-way trips from the processing plants to Port Chalmers. As such, they do not account for truck movements from Dunedin to the processing plants, travel to/from the Icon/Dynes truck depot Dunedin (or [REDACTED]) at the beginning and end of each day, travel associated with the movement of empty containers, or travel associated with the movement of imported goods for the same export customer (whether on net additional or back loaded trips).
- The with Inland Port scenario equally does not include the return trip of the shuttle trains from Port Chalmers back to the Inland Port (which may be used for empty container transport and full container transport (i.e. back loading).
- Any marshalling/shunting of the shuttle train that is required (for example if the trains need to turn around) is not included, although any delays for this activity are assumed to be captured in the total travel time assumption for the train to travel between the Inland Port and Port Chalmers.
- The modelling matches travel distance by Transport Productivity Zone with the nature of the product being moved (i.e., bulk/palletised or containerised). This is because this impacts the truck that is used and therefore the payload of those trucks.
- While the report has focussed on TEUs as the metric to explain container trade, this modelling is based on tonnes as the key input. This was necessary as the GHG emission (CO₂e) factors applied use a 'Tonne Kilometres' metric.
- Vehicle movements are derived from total tonnes of product and payload assumptions. These may differ from actual truck movements for a range of operational reasons. Vehicle movements are not additive across the zones (when totalled), as it is the same vehicle travelling through the zones until such time as they reach the warehouse, and a separate (and different type of) truck then makes a separate trip. For that section of the table, the Total row is the maximum number of vehicle movements per year.



- Transport costs are costs to the service provider and may not be the costs charged to customers. They are indicative only based on averages, with the focus being on the relative changes.
- While the modelling could be extended to estimate changes in urban road maintenance costs or fuel consumption, for brevity this is excluded. Such benefits are addressed qualitatively in the report.
- The colours used in the following tables signal the change in metric being measured / reported. They are however all linked to the same inputs.



– One Way Export Supply Chain (Plant to Port Chalmers)

Transport Productivity Zone (Figure 7.1)	Status Quo Export Supply Chain			Export Supply Chain With Inland Port			Change (n)	Change (%)
	Palletised Goods	Containerised Goods	Total	Palletised Goods	Containerised Goods	Total		
Kilometers (One Way Factory to Port Chalmers)								
Open Highway Zone	97	-	97	92	-	92	- 5	-5%
Urban Area Zone	13	2	15	-	-	-	- 15	-100%
Rail Zone	-	-	-	-	28	28	28	0%
Total	110	2	112	92	28	120	8	7%
Share of Kilometers by Productivity Zone and Load Type								
Open Highway Zone	87%	0%	87%	77%	0%	77%		
Urban Area Zone	12%	2%	13%	0%	0%	0%		
Rail Zone	0%	0%	0%	0%	23%	23%		
Total	98%	2%	100%	77%	23%	100%		
Tonnes Lifted per Annum								
	50,000			50,000				
Tonnes Moved per Annum (Tonne km) (One Way Factory to Port Chalmers)								
Open Highway Zone	4,850,000	-	4,850,000	4,600,000	-	4,600,000	- 250,000	-5%
Urban Area Zone	650,000	100,000	750,000	-	-	-	- 750,000	-100%
Rail Zone	-	-	-	-	1,400,000	1,400,000	1,400,000	0%
Total	5,500,000	100,000	5,600,000	4,600,000	1,400,000	6,000,000	400,000	7%
Tonnes/Load by Vehicle Type								
Payload (Tonnes)	34	25		34	600			
Vehicle Type	Curtain Sider Truck	Container Skel Truck		Curtain Sider Truck	Shuttle Train			
Vehicle Kilometers Travelled per Annum (One Way Factory to Port Chalmers)								
Open Highway Zone	142,647	-	142,647	135,294	-	135,294	- 7,353	-5%
Urban Area Zone	19,118	4,000	23,118	-	-	-	- 23,118	-100%
Rail Zone	-	-	-	-	2,333	2,333	2,333	0%
Total	161,765	4,000	165,765	135,294	2,333	137,627	- 28,137	-17%
Indicative Transport Cost per Annum (\$) (One Way Factory to Port Chalmers) **								
Open Highway Zone	\$ 499,265	\$ -	\$ 499,265	\$ 473,529	\$ -	\$ 473,529	- 25,735	-5%
Urban Area Zone	\$ 82,206	\$ 17,200	\$ 99,406	\$ -	\$ -	\$ -	- 99,406	-100%
Rail Zone	\$ -	\$ -	\$ -	\$ -	\$ 308,000	\$ 308,000	308,000	0%
Total	\$ 581,471	\$ 17,200	\$ 598,671	\$ 473,529	\$ 308,000	\$ 781,529	\$ 182,859	31%
Vehicle Movements per Annum (One Way Factory to Port Chalmers)								
Open Highway Zone	1,471	-	1,471	1,471	-	1,471	-	0%
Urban Area Zone	1,471	2,000	3,471	-	-	-	- 3,471	-100%
Rail Zone	-	-	-	-	83	83	83	0%
Total *	1,471	2,000	3,471	1,471	83	1,471	- 2,000	-58%
Vehicle Travel Time - Hours per Annum (One Way Factory to Port Chalmers) (applies to transit time only) **								
Open Highway Zone	1,783	-	1,783	1,691	-	1,691	- 92	-5%
Urban Area Zone	722	151	873	-	-	-	- 873	-100%
Rail Zone	-	-	-	-	63	63	63	0%
Total	2,505	151	2,656	1,691	63	1,754	- 903	-34%
Indicative Transport Emissions (CO2-e Tonnes per Annum) (One Way Factory to Port Chalmers) **								
Open Highway Zone	509	-	509	483	-	483	- 26	-5%
Urban Area Zone	110	17	127	-	-	-	- 127	-100%
Rail Zone	-	-	-	-	38	38	38	0%
Total	619	17	636	483	38	521	- 115	-18%

Source: Sawy, Port Otago, Icon, Dymes Transport Group, MfE (for Emissions Factors). The change in vehicle type represents the warehouse packing stage of the supply chain.

* This total is not additive as it is the same truck moving through multiple zones. The total is the maximum only to reflect unique vehicles per trip.

** Refer assumptions listed in Section 7.3 and/or Appendix E.



One Way Export Supply Chain (Plant to Port Chalmers)

Transport Productivity Zone (Figure 7.1)	Status Quo Export Supply Chain			Export Supply Chain With Inland Port			Change (n)	Change (%)
	Palletised Goods	Containerised Goods	Total	Palletised Goods	Containerised Goods	Total		
Kilometers (One Way Factory to Port Chalmers)								
Open Highway Zone	76	18	94	76	-	76	- 17	-18%
Urban Area Zone	-	15	15	-	-	-	- 15	-100%
Rail Zone	-	-	-	-	28	28	28	0%
Total	76	32	108	76	28	104	-4	-4%
Share of Kilometers by Productivity Zone and Load Type								
Open Highway Zone	70%	16%	86%	73%	0%	73%		
Urban Area Zone	0%	14%	14%	0%	0%	0%		
Rail Zone	0%	0%	0%	0%	27%	27%		
Total	70%	30%	100%	73%	27%	100%		
Tonnes Lifted per Annum								
	38,000			38,000				
Tonnes Moved per Annum (Tonne km) (One Way Factory to Port Chalmers)								
Open Highway Zone	2,888,000	668,800	3,556,800	2,899,400	-	2,899,400	- 657,400	-18%
Urban Area Zone	-	562,400	562,400	-	-	-	- 562,400	-100%
Rail Zone	-	-	-	-	1,064,000	1,064,000	1,064,000	0%
Total	2,888,000	1,231,200	4,119,200	2,899,400	1,064,000	3,963,400	- 155,800	-4%
Tonnes/Load by Vehicle Type								
Payload (Tonnes)	34	25		34	600			
Vehicle Type	Curtain Sider Truck	Container Skel Truck		Curtain Sider Truck	Shuttle Train			
Vehicle Kilometers Travelled per Annum (One Way Factory to Port Chalmers)								
Open Highway Zone	84,941	26,752	111,693	85,276	-	85,276	- 26,417	-24%
Urban Area Zone	-	22,496	22,496	-	-	-	- 22,496	-100%
Rail Zone	-	-	-	-	1,773	1,773	1,773	0%
Total	84,941	49,248	134,189	85,276	1,773	87,050	- 47,139	-35%
Indicative Transport Cost per Annum (One Way Factory to Port Chalmers) **								
Open Highway Zone	\$ 297,294	\$ 93,632	\$ 390,926	\$ 298,468	\$ -	\$ 298,468	- 92,458	-24%
Urban Area Zone	\$ -	\$ 96,733	\$ 96,733	\$ -	\$ -	\$ -	- 96,733	-100%
Rail Zone	\$ -	\$ -	\$ -	\$ -	\$ 234,080	\$ 234,080	234,080	0%
Total	\$ 297,294	\$ 190,365	\$ 487,659	\$ 298,468	\$ 234,080	\$ 532,548	\$ 44,889	9%
Vehicle Movements per Annum (One Way Factory to Port Chalmers)								
Open Highway Zone	1,118	1,520	2,638	1,118	-	1,118	- 1,520	-58%
Urban Area Zone	-	1,520	1,520	-	-	-	- 1,520	-100%
Rail Zone	-	-	-	-	63	63	63	0%
Total *	1,118	1,520	2,638	1,118	63	1,118	- 1,520	-58%
Vehicle Travel Time Hours per Annum (One Way Factory to Port Chalmers) (applies to transit time only) **								
Open Highway Zone	1,062	334	1,396	1,066	-	1,066	- 330	-24%
Urban Area Zone	-	850	850	-	-	-	- 850	-100%
Rail Zone	-	-	-	-	48	48	48	0%
Total	1,062	1,184	2,246	1,066	48	1,113	- 1,133	-50%
Indicative Transport Emissions (CO2-e Tonnes per Annum) (One Way Factory to Port Chalmers) **								
Open Highway Zone	303	70	373	304	-	304	- 69	-18%
Urban Area Zone	-	95	95	-	-	-	- 95	-100%
Rail Zone	-	-	-	-	29	29	29	0%
Total	303	165	468	304	29	333	- 135	-29%

Source: Sawy, Port Otago, Icon, Dymco Transport Group, MfE (for Emissions Factors). The change in vehicle type represents the warehouse packing stage of the supply chain.

* This total is not additive as it is the same truck moving through multiple zones. The total is the maximum only to reflect unique vehicles per trip.

** Refer assumptions listed in Section 7.3 and/or Appendix E.



One Way Export Supply Chain (Plant to Port Chalmers)

Transport Productivity Zone (Figure 7.1)	Status Quo Export Supply Chain			Export Supply Chain With Inland Port			Change (n)	Change (%)
	Palletised Goods	Containerised Goods	Total	Palletised Goods	Containerised Goods	Total		
Kilometers (One Way Factory to Port Chalmers)								
Open Highway Zone	205	18	223	206	-	206	- 17	-7%
Urban Area Zone	-	15	15	-	-	-	- 15	-100%
Rail Zone	-	-	-	-	28	28	28	0%
Total	205	32	237	206	28	234	-3	-1%
Share of Kilometers by Productivity Zone and Load Type								
Open Highway Zone	86%	7%	94%	88%	0%	88%		
Urban Area Zone	0%	6%	6%	0%	0%	0%		
Rail Zone	0%	0%	0%	0%	12%	12%		
Total	86%	14%	100%	88%	12%	100%		
Tonnes Lifted per Annum								
	3,000			3,000				
Tonnes Moved per Annum (Tonne km) (One Way Factory to Port Chalmers)								
Open Highway Zone	615,000	52,800	667,800	618,000	-	618,000	- 49,800	-7%
Urban Area Zone	-	44,400	44,400	-	-	-	- 44,400	-100%
Rail Zone	-	-	-	-	84,000	84,000	84,000	0%
Total	615,000	97,200	712,200	618,000	84,000	702,000	- 10,200	-1%
Tonnes/Load by Vehicle Type								
Payload (Tonnes)	34	25		34	600			
Vehicle Type	Curtain Sider Truck	Container Skel Truck		Curtain Sider Truck	Shuttle Train			
Vehicle Kilometers Travelled per Annum (One Way Factory to Port Chalmers)								
Open Highway Zone	18,088	2,112	20,200	18,176	-	18,176	- 2,024	-10%
Urban Area Zone	-	1,776	1,776	-	-	-	- 1,776	-100%
Rail Zone	-	-	-	-	140	140	140	0%
Total	18,088	3,888	21,976	18,176	140	18,316	- 3,660	-17%
Indicative Transport Cost per Annum (One Way Factory to Port Chalmers) **								
Open Highway Zone	\$ 63,309	\$ 7,392	\$ 70,701	\$ 63,618	\$ -	\$ 63,618	- 7,083	-10%
Urban Area Zone	\$ -	\$ 7,637	\$ 7,637	\$ -	\$ -	\$ -	- 7,637	-100%
Rail Zone	\$ -	\$ -	\$ -	\$ -	\$ 18,480	\$ 18,480	18,480	0%
Total	\$ 63,309	\$ 15,029	\$ 78,338	\$ 63,618	\$ 18,480	\$ 82,098	\$ 3,760	5%
Vehicle Movements per Annum (One Way Factory to Port Chalmers)								
Open Highway Zone	88	120	208	88	-	88	- 120	-58%
Urban Area Zone	-	120	120	-	-	-	- 120	-100%
Rail Zone	-	-	-	-	5	5	5	0%
Total *	88	120	208	88	5	88	- 120	-58%
Vehicle Travel Time Hours per Annum (One Way Factory to Port Chalmers) (applies to transit time only) **								
Open Highway Zone	226	26	253	227	-	227	- 25	-10%
Urban Area Zone	-	67	67	-	-	-	- 67	-100%
Rail Zone	-	-	-	-	4	4	4	0%
Total	226	93	320	227	4	231	- 89	-28%
Indicative Transport Emissions (CO2-e Tonnes per Annum) (One Way Factory to Port Chalmers) **								
Open Highway Zone	65	6	70	65	-	65	- 5	-7%
Urban Area Zone	-	7	7	-	-	-	- 7	-100%
Rail Zone	-	-	-	-	2	2	2	0%
Total	65	13	78	65	2	67	- 10	-13%

Source: Sawy, Port Otago, Icon, Dynes Transport Group, MfE (for Emissions Factors). The change in vehicle type represents the warehouse packing stage of the supply chain.

* This total is not additive as it is the same truck moving through multiple zones. The total is the maximum only to reflect unique vehicles per trip.

** Refer assumptions listed in Section 7.3 and/or Appendix E.



(Hypothetical One Way Export Supply Chain (Distribution Centre to Port Chalmers Only))

Transport Productivity Zone (Figure 7.1)	Supply Chain with Rail Siding (Status Quo)			Supply Chain if no Rail Siding (Conterfactual)			Change (n)	Change (%)
	Palletised Goods	Containerised Goods	Total	Palletised Goods	Containerised Goods	Total		
Kilometers (One Way Distribution Centre to Port Chalmers)								
Open Highway Zone		0	-		17	17	17	0%
Urban Area Zone		0	-		15	15	15	0%
Rail Zone		28	28		-	-	- 28	-100%
Total	-	28	28	-	32	32	4	14%
Share of Kilometers by Productivity Zone and Load Type								
Open Highway Zone	0%	0%	0%	0%	53%	53%		
Urban Area Zone	0%	0%	0%	0%	47%	47%		
Rail Zone	0%	100%	100%	0%	0%	0%		
Total	0%	100%	100%	0%	100%	100%		
Tonnes Lifted per Annum								
	175,000			175,000				
Tonnes Moved per Annum (Tonne km) (One Way Distribution Centre to Port Chalmers)								
Open Highway Zone	-	-	-	-	2,975,000	2,975,000	2,975,000	0%
Urban Area Zone	-	-	-	-	2,625,000	2,625,000	2,625,000	0%
Rail Zone	-	4,900,000	4,900,000	-	-	-	- 4,900,000	-100%
Total	-	4,900,000	4,900,000	-	5,600,000	5,600,000	700,000	14%
Tonnes/Load by Vehicle Type								
Payload (Tonnes)	34	600		34	25			
Vehicle Type	Curtain Sider Truck	Shuttle Train		Curtain Sider Truck	Container Skel Truck			
Vehicle Kilometers Travelled per Annum (One Way Distribution Centre to Port Chalmers)								
Open Highway Zone	-	-	-	-	119,000	119,000	119,000	0%
Urban Area Zone	-	-	-	-	105,000	105,000	105,000	0%
Rail Zone	-	8,167	8,167	-	-	-	- 8,167	-100%
Total	-	8,167	8,167	-	224,000	224,000	215,833	2643%
Indicative Transport Cost per Annum (One Way Distribution Centre to Port Chalmers) **								
Open Highway Zone	\$ -	\$ -	\$ -	\$ -	\$ 416,500	\$ 416,500	416,500	0%
Urban Area Zone	\$ -	\$ -	\$ -	\$ -	\$ 451,500	\$ 451,500	451,500	0%
Rail Zone	\$ -	\$ 1,078,000	\$ 1,078,000	\$ -	\$ -	\$ -	- 1,078,000	-100%
Total	\$ -	\$ 1,078,000	\$ 1,078,000	\$ -	\$ 868,000	\$ 868,000	- 210,000	-19%
Vehicle Movements per Annum (One Way Distribution Centre to Port Chalmers)								
Open Highway Zone	-	-	-	-	7,000	7,000	7,000	0%
Urban Area Zone	-	-	-	-	7,000	7,000	7,000	0%
Rail Zone	-	292	292	-	-	-	- 292	-100%
Total *	-	292	292	-	7,000	7,000	6,708	2300%
Vehicle Travel Time Hours per Annum (One Way Distribution Centre to Port Chalmers) (applies to transit time only) **								
Open Highway Zone	-	-	-	-	1,488	1,488	1,488	0%
Urban Area Zone	-	-	-	-	3,967	3,967	3,967	0%
Rail Zone	-	219	219	-	-	-	- 219	-100%
Total	-	219	219	-	5,454	5,454	5,235	2393%
Indicative Transport Emissions (CO2-e Tonnes per Annum) (One Way Distribution Centre to Port Chalmers) **								
Open Highway Zone	-	-	-	-	312	312	312	0%
Urban Area Zone	-	-	-	-	443	443	443	0%
Rail Zone	-	132	132	-	-	-	- 132	-100%
Total	-	132	132	-	755	755	623	471%

Source: Sawy, Port Otago, Icon, Dynes Transport Group, MfE (for Emissions Factors).

* This total is not additive as it is the same truck moving through multiple zones. The total is the maximum only to reflect unique vehicles per trip.

** Refer assumptions listed in Section 7.3 and/or Appendix E.