Auckland LIGHT RAIL
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Demand forecasting

Technical note

24 September 2021

Revision | FINAL

Issue and revision record

Demand forecasting					
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Concept design report

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1. Executive Summary

This report documents the results of the demand modelling done for various options within the CC2M corridor. The initial short list consists of five options, 2 light rail, 2 light metro and a hybrid light rail option. These options were narrowed down to the following three options:

- Option 1B: Light rail running at a 4 min headway between the airport and the City centre with street running sections through Mangere Town centre, Dominion Road and Queen Street;
- Option 2A: Light metro running at a 3 min headway between the airport and the City centre with tunnel sections through Mangere Town centre, underneath Sandringham Road and Wellesley Street.
- Option 3: Hybrid light rail running at 4 min headway between the airport and the city centre, with an overlay service (also at 4 min headway) between Mt Roskill and the city centre. It has street running sections through Mangere Town centre, and with tunnel sections through underneath Sandringham Road and Wellesley Street

The options all have different travel time and stop configurations responding to the alignment and environment in which they operate. Light metro provides the fastest end to end travel time (36 mins), followed by the Hybrid option (43 mins) with light rail providing a 57-minute travel time.

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All options enable faster public transport travel times from Mangere and Onehunga to the city centre when compared to the most viable alternative (car travel). Car travel remains slightly more competitive to the central city from Mt Roskill.

The option alignments, speed and headways result in expanded labour pool with 45 minutes access to the central city. The initial short list analyses showed Wynyard and the city universities to be key destinations for trips from the CC2M corridor.

The geographical analyses of the change in 45-minute catchment to these zones show clear differences for the light metro and hybrid over the light rail option, with the latter having limited reach into Mangere.

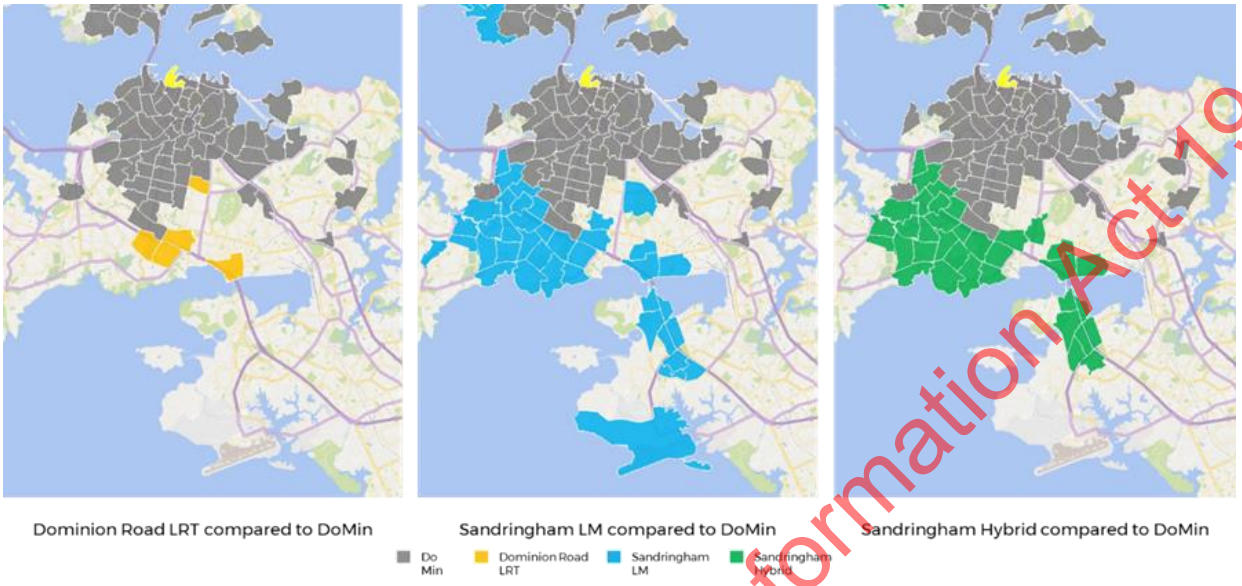


Figure 2: Zones within 45 min catchment from Wynyard (by 2051)

The demand profile along the corridor shows light metro and the hybrid attracts significantly higher demands than the light rail option, with the peak load point approximately 86% higher than light rail.

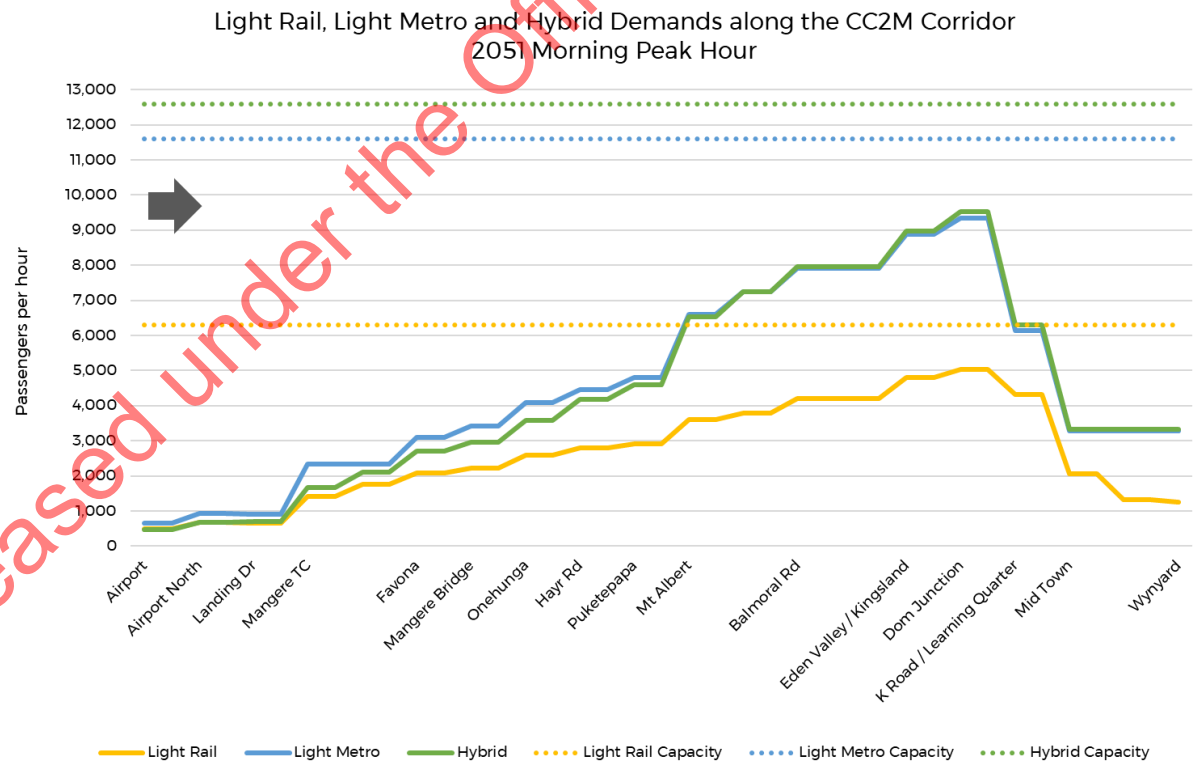


Figure 3: Demand profile along CC2M corridor (2051 AM 1hr)

The vehicle capacity, demand and travel time associated with each option result in nearly a quarter (26%) of all passengers standing for longer than 20 minutes on the light rail system during the morning peak. This compares to 8% and 7% of passengers standing on the light metro and hybrid options respectively.

The demand profile shows the light rail option is expected to reach 81% of the modelled capacity at its peak load point (between Dominion Junction and K-Road stops) by 2051. The ridership at the peak loading point is forecast to be 5,100 over the busiest 1hr period. Extrapolating demand (using the average annual growth rate between 2031 and 2051) signal the higher intensification land use scenario could generate peak hour demand on the light rail system that exceeds the modelled capacity by 2059.

Light metro demands are forecast to reach 82% of its modelled capacity by 2051. The ridership on the peak loading point is forecast to be 9,500 over the busiest 1hr period. This is 86% higher than the light rail option along Dominion Road. The option generates (extrapolated) demand that exceed its capacity by 2058.

The hybrid option is expected to reach 76% of its modelled capacity at the peak load point. The ridership at the peak loading point is forecast to be 9,500 over the busiest hour. This is similar to the Light Metro option. It is also 86% higher than light rail along Dominion Road.

The public transport share of all trip purposes within the CC2M corridor is forecast to increase from 12% (2018) to 26% by 2051 for all options. A summary of the key indicators is provided in the table below, with more detailed included within the report.

Table 1: Summary of key indicators

Key indicators	**2051 results (higher intensification land use scenario)**		
	Option 1B (LRT)	**Option 2A (Light metro)**	**Option 3 (Hybrid)**
Accessibility			
Number of jobs within 45 mins by PT from Mangere Town centre	247,207	452,773	344,317
Number of jobs within 45 mins by PT from Onehunga	405,544	463,881	437,561
Number of jobs within 45 mins by PT from Mt Roskill centre	414,691	423,047	401,431
Number of households within 45 min by PT from city centre	378,545	405,418	400,133
Number of households within 45 min by PT from airport	97,008	164,245	113,954
CC2M boardings			
AM peak (2hr)	16,505	28,822	27,706
Daily	72,605	125,252	114,174
Annual	20,256,851	34,945,169	31,854,462
PT Mode share within CC2M Corridor	26%	26%	26%
Regional PT boardings			
Total PT network	240,883,615	248,801,954	246,606,277
Total bus network	154,983,514	151,727,720	151,695,945
Total heavy rail network	61,669,356	59,905,763	60,498,231
CC2M modelled capacity and demands			
Modelled Maximum Capacity of CC2M (pax/hour/direction)	6,300	11,600	12,600
CC2M Demand at Peak Load Point (pax/hour/direction)	5,036	9,345	9,521

Sensitivity tests were done to test the impact on road pricing and the network expansion on the demand for the respective CC2M option. The purpose of these tests was to confirm adequate capacity in the system to accommodate future changes.

It shows road pricing will have a minimal impact on the CC2M demand, increasing demand on the options between 1% and 2%. This low shift to PT associated with pricing in the ALR scenario is most likely down to the inability of the wider PT system to accommodate extra passengers given capacity constraints (as a result of limited investment outside light rail assumed in the do minimum scenario).

Road pricing combined with an expanded CC2M network to the North Shore and north west will increase demands on the options by between 5% and 9%.

The results from the demand modelling were also benchmarked against global examples of major public transport infrastructure in similar cities to compare patronage characteristics with CC2M patronage forecasts. The report suggests the forecasts for CC2M are likely in the right range.

2. Demand modelling approach

2.1 MSM model

2.1.1 Description

The Auckland Forecasting Centre (AFC) Macro Strategic Model (MSM) was used to assess the likely impact various light rail alignments, station configuration and changes to the bus network would have on demand for travel and the outcomes sought in the business case.

The MSM Regional Transport Demand Model has 596 zones that contain projections about population, education and employment into the future.

Travel demands were forecast in MSM based on the population and employment forecasts provided in the Auckland Land Use Model. Council supplied data for 2018, 2031 and 2051 (for the medium growth Scenario - generally referred to as Scenario I-11.6).

2.1.2 Model constraints

The following constraints were identified and considered in the development of the short-listed options:

- Only two land use horizons were used; 2031 and 2051.
- The 2051 land use horizon is an extrapolation of the Stats NZ 2048 forecast for Auckland (based on growth leading up to 2048).
- No demands were modelled beyond 2051, and any analyses or interpretation in this report for periods beyond the 2051 horizon were derived through extrapolating the growth curve (either straight line or average annual compound growth) between the 2031 and 2051 forecast horizons.
- As a strategic, all modes model, MSM is ideal for providing information on the system wide assessment criteria set out in the business case. However, for public transport passenger demand forecasting, there are other, more robust modelling tools and these should be used in the detailed business case stage of the project to refine and confirm the passenger forecasts for the recommended option and the public transport networks that support it. Given the compressed time constraint, it was not possible to use these passenger demand forecasting tools.
- The strategic model does not have the ability to simulate detailed bus operations associated with high volumes of buses stopping for boarding and alighting at kerbside stops - especially in the city centre. The do minimum allows for 117 buses per hour (eastbound) and 123 buses per hour (westbound) along sections of Customs Street during the morning peak. The upper section of Symonds Street (where it crosses the motorway) will have 97 buses per hour (northbound). Wellesley Street will experience 113 buses per hour (westbound) in the PM peak.
- The bus speed curves were adjusted for these sections; however, in the next phase of the project, the do minimum would have to be reviewed and assessed to ensure that it realistically represents the likely bus network operation.

- The MSM model has no specific function estimating access to the light rail options (or other RTN stations) by demand responsive services or personal mobility modes (e.g. Lime or Flamingo scooters).
- Adjustments were made to station[1] access (in 2051 only) consistent with NZTA research project 674 Mode Shift to Micro Mobility; in particular the section on "first mile/last mile".

2.2 Approach

2.2.1 Process followed

The investment objectives, outcomes and supporting measures were defined through investment logic map workshops as part of the strategic case development workstream.

Several outputs and reports from the MSM model were identified[2] to provide quantitative data against the relative measures that informed the Multi Criteria Assessment (MCA) workshop for the short list options.

Do minimum land use and transport models were agreed with the urban development and economic case workstreams (for both the 2031 and 2051) and documented in the memorandum titled Do Minimum Assumptions – 5 July 2021.

Option specifications were development for each of the five short listed options. The initial outcomes were used to inform the change (when compared to the do minimum scenario) in accessibility and effective job densities.

This information (amongst others) were used by the urban development workstream to model the likely change in the spatial distribution of the growth over time. The adjusted spatial distribution was then applied to the 2051 model horizon and remodelled to determine the results against the agreed KPIs and measures. The process is illustrated in Figure 4.

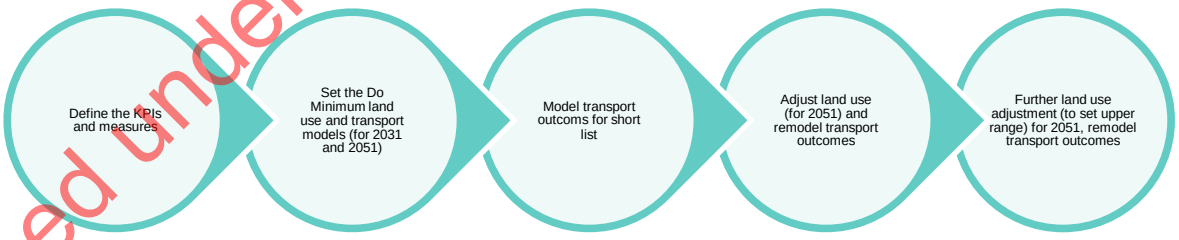


Figure 4: Process followed

A total of 5 short listed options were tested. Several reference cases were also developed to help inform sensitivity of the alignment to wider policy changes (road pricing) as well as future expansion of the light rail network to the North Shore and Auckland's North-west.

[1] Only stations that represent Mt Roskill, Onehunga and Mangere Town Centre

[2] Documented in "SR 1 - AFC_DataModelRequest_CC2M21 - 2021-07-21 - r5 - additional info"

Public Transport fares and other costs inputs such as parking are in real 2016 dollars in the MSM model. All PT fares were increased at 0.37% per annum for future year horizons based on GDP/capita growth of 1.5%

Auckland Transport's ticketing data (HOP) were analysed for the period between 2018 and 2019 to determine the peak hour factor for public transport demands on the entire PT network (excluding school buses) and the existing RTN network. The existing RTN included rail and NEX boardings only.

The data indicated the following peak hour factors to convert 2hr peak period demands to 1 hr demands in Auckland:

Table 2: PT boardings phf

Period	RTN boardings	All PT boardings
AM	0.61	0.60
IP	0.51	0.50
PM	0.55	0.54

2.2.2Defining the KPIs

Table 3: Agreed KPIs and measures below illustrates the measures obtained from the demand modelling to support the agreed investment objectives and KPIs.

Table 3: Agreed KPIs and measures

Investment Objectives	**KPIs**	**Measures supported by MSM demand modelling**
A rapid transit service that: Is attractive, reliable, frequent, safe and equitable Is integrated with the current and future active and public transport network Improves access to employment, education and other opportunities.	Improved access to major and growing employment areas, especially the city centre and Auckland Airport precinct;	No of employment opportunities accessible with 45 mins PT travel time from communities within the corridor (especially Mangere, Onehunga and Mt Roskill) and regionally. Effective Job Density
		No. of households within 45 mins travel time from City Centre and Airport
		PT mode share within the corridor
		Private VKT within the corridor.
	Improved access to education from communities along the corridor;	Number of education opportunities (tertiary education) within 45 mins travel time from communities within the corridor (especially Mangere, Onehunga and Mt Roskill) and regionally. Effective Job Density (adapted to education)
	Improved access to cultural, social, health, recreational and cultural facilities (including marae) from communities along the corridor	MSM model not used to inform this measure.
	Improved travel times for key journeys along the corridor	PT travel times between key centres along the route (including the City Centre, Airport, Mt Roskill, Onehunga and Mangere).

Investment Objectives	KPIs	Measures supported by MSM demand modelling
		PT travel times compared to car travel times between key centres along the corridor (including the City Centre, Airport, Mt Roskill, Onehunga and Mangere).
		Freight efficiency impact
	An attractive service that increases public transport mode share in the corridor and across Auckland.	Number of PT journeys within the corridor and regionally Corridor PT mode share. Mode share for education trips Maximum length of time standing (level of crowding)
	Increased walking and cycling mode share in the corridor.	MSM model not used to support this measure.
	Effective and efficient integration between the proposed service and the broader PT network.	Passenger km / service km Regional PT journeys Access measures (as above for access to employment, education and other opportunities)
	Effective and efficient integration between the proposed service and anticipated future rapid transit network.	Regional rapid transit boardings.
	Alleviation of current and forecast bus capacity constraints in the city centre;	Number of buses entering city Centre in AM peak
	Increased corridor capacity and utilisation of capacity;	Rapid Transit carrying capacity - AM peak and all day Rapid Transit pax capacity kms / RT pax kms
A transport intervention that embeds sustainable practice and that reduces Auckland's carbon footprint	Reduced CO2 emissions Reduced air pollution within the corridor Enabled Kaitiakitanga outcomes in the management of natural resources. Sustainable practice embedded in project design	CO2 emissions, total vehicle kilometres travelled, embedded carbon SOX, NOX, VOC emissions
Unlocking significant urban development potential, supporting a quality compact urban form and enabling integrated and healthy communities.	Additional feasible urban development capacity enabled within 1km of stations.	Effective job density (and other density measures)
	Redevelopment of major public landholdings enabled along the corridor within 1kmof stations.	MSM model not used to support this measure.

Investment Objectives	KPIs	Measures supported by MSM demand modelling
	Facilitation of quality transformation of areas around stations, improving community connectivity and delivering attractive, active and safe spaces.	MSM model not used to support this measure.

2.2.3Defining the Corridor

For reporting purposes, the MSM model zones shown in Figure 5Figure 5: MSM zones that represent 'the Corridor' below represent the 'Corridor' between the city centre and Mangere:

Figure 5: MSM zones that represent 'the Corridor'

The following specific zones represent key locations used within the reporting:

- Wynyard = zone 243;
- Downtown = zone 245;
- Mid-town = zone 248;
- Auckland universities = zone 249;
- Dominion Junction = zone 266
- Mt Roskill = zone 327;
- Onehunga = zone 347;
- Mangere = zone 472; and
- The airport = zone 478

3. The do minimum

3.1 The do minimum approach

Auckland Transport (AT) and the AFC provided the base 2018 model as well as the transport model for 2031 that reflect the approved Regional Land Transport programme (RLTP).

Only two planning horizons was developed for the analyses – 2031 and 2051. This allowed assessment of outcomes against a do minimum 'at opening' as well as an outcomes assessment 3-decades from 2021.

The approved and funded 2031 RLTP was adopted as the do minimum for the 2031 scenario. Key assumptions for the 2051 scenario are documented in a separate report, attached to Economic Case section of the business case.

The do minimum approach was agreed to by the peer reviewer. Refer to Appendix A for the Peer review note.

3.1.1 The do minimum land use

The do minimum land used assumed for 2031 reflects the totals and distribution contained within Scenario I-11.6 without any adjustments. For 2051: The do minimum land use was based on Scenario I-11.6 but with the following adjustments to remove growth allocated in anticipation of light rail:

- Households: households were reduced by 20,649 within the corridor zones and re-distributed to other zones in the region – in line with the previous Scenario I-11.3 forecast.
- Education roll was adjusted to match the revised household totals per zone.
- Employment: 4,000 jobs were redistributed away from the corridor (excluding city centre zones).

Table 4 shows population and employment forecasts for the 2031 and 2051 do minimum model horizons:

Table 4: Do minimum population and employment assumptions

Totals	Auckland Region			CC2M Corridor		
	2021	2031	2051	2021	2031	2051
Households	562,833	671,227	845,955	62,488	71,159	91,083
Population	1,666,599	1,930,490	2,331,170	185,224	212,517	259,688
Employment	705,461	809,803	960,521	169,973	203,612	251,144
Percentage increase from previous planning horizon						
Households		19%	26%		14%	28%
Population		16%	21%		15%	22%
Employment		15%	19%		20%	23%

3.1.2The do minimum transport patterns

Around 55% of all trips during the morning peak period in the do minimum 2051 scenario are forecast to be to destinations outside the CC2M corridor, including 56% of home to work trips and 49% of home to education trips.

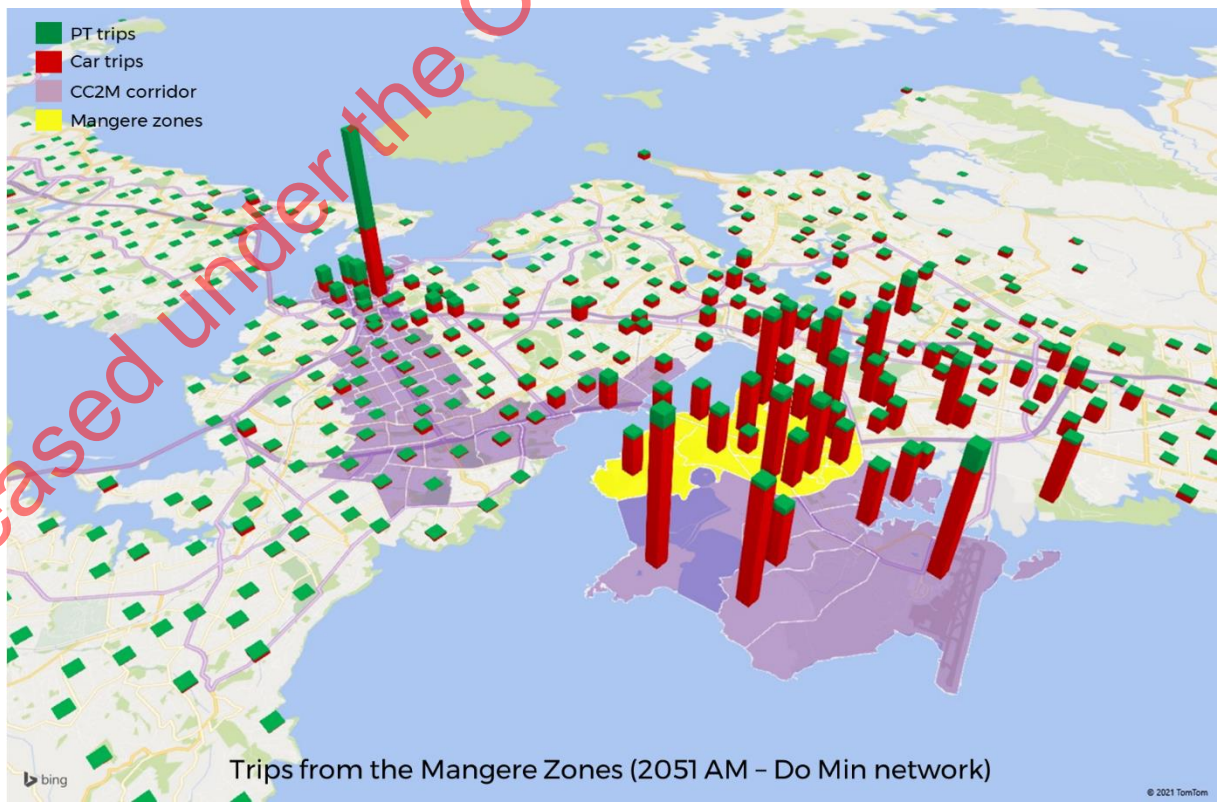
Popular work destinations outside the corridor include Penrose / Mount Wellington, New Lynn / Rosebank, East Tamaki and Manukau / Wiri.

Key education destinations outside the corridor include Unitech, North Shore campuses, Manukau and East Tamaki.

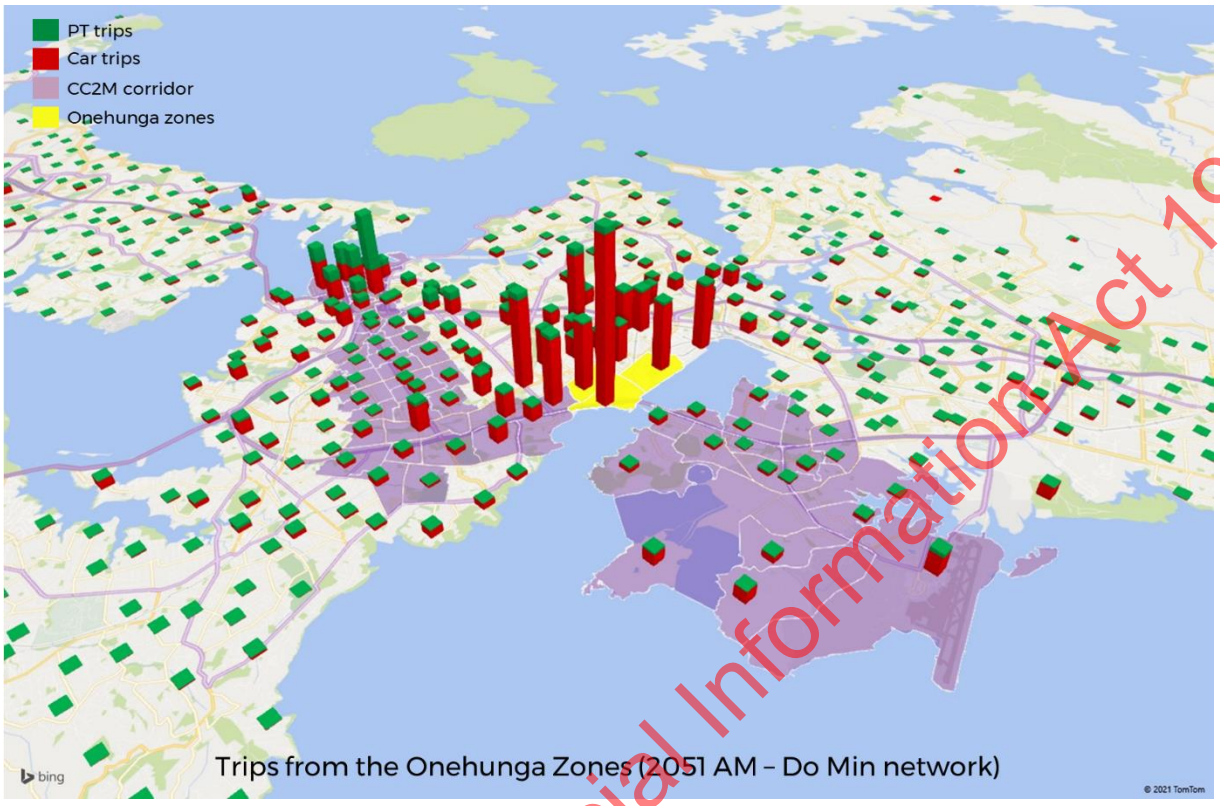
As can be seen from Figure 6, trips to CC2M destinations from the 3 communities have a much higher PT mode share than trips to external destinations – ranging between 30%-45% for trips to CC2M destinations vs 16%-30% PT mode share for trips to external destinations. Providing excellent interchange infrastructure and services for people to use the CC2M and transfer to connecting public transport services to get to external destinations will be essential to drive a higher PT mode share.

Around 22,000 short distance trips are forecast to be made between the residential communities along the CC2M corridor – i.e. not to the major City Centre and Airport employment hubs at either end of the CC2M corridor. Of these,20,000 (92%) are short distance trips are forecast to be by car. This is a key opportunity to increase PT and active mode share as being short distance trips they should be ideal for public transport, walking, cycling or personal mobility modes such as scooters.

To encourage as many of these trips as possible to shift from car to walking and cycling, excellent active mode facilities should be provided along the corridor to serve the dual purpose of proving good access to and from CC2M stations and also to encourage people to shift from car use for short distance trips.



Trips from the Mangere Zones (2051 AM – Do Min network)



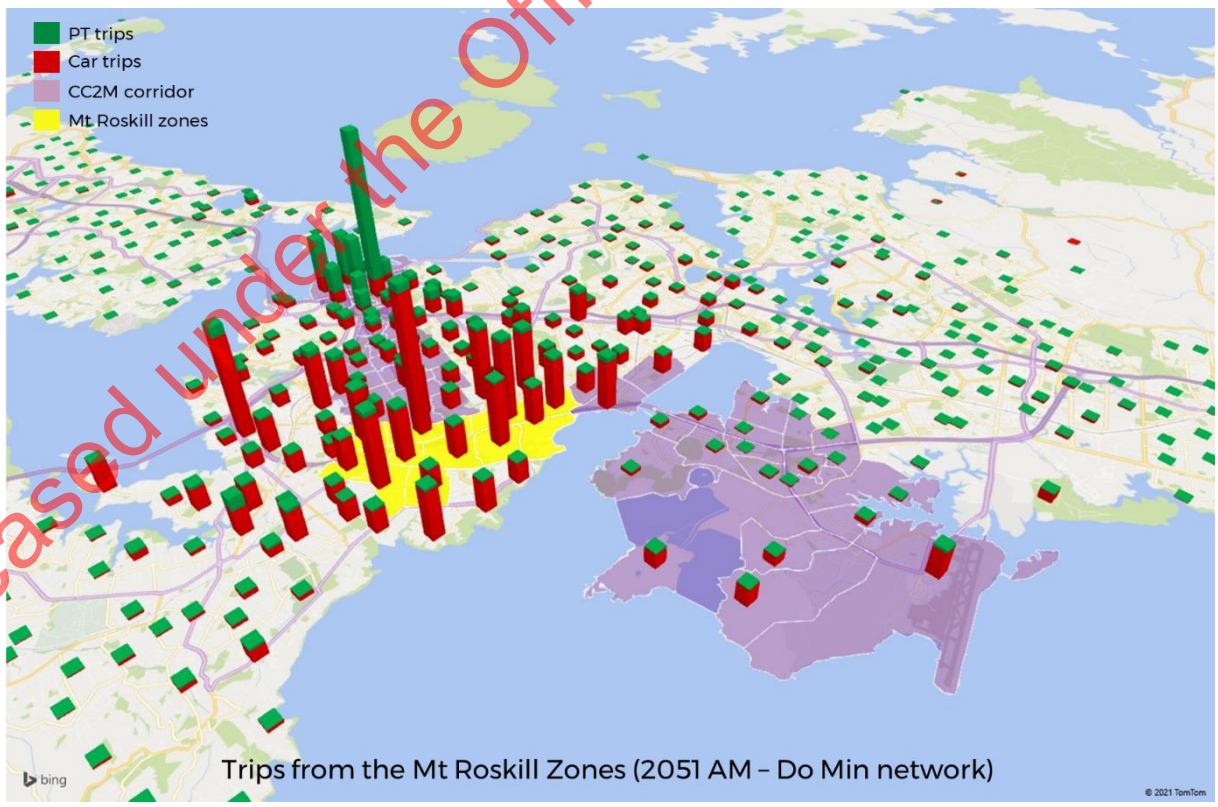


Figure 6: Trip patterns from Mangere, Onehunga and Mt Roskill

4. Initial short list – demand modelling

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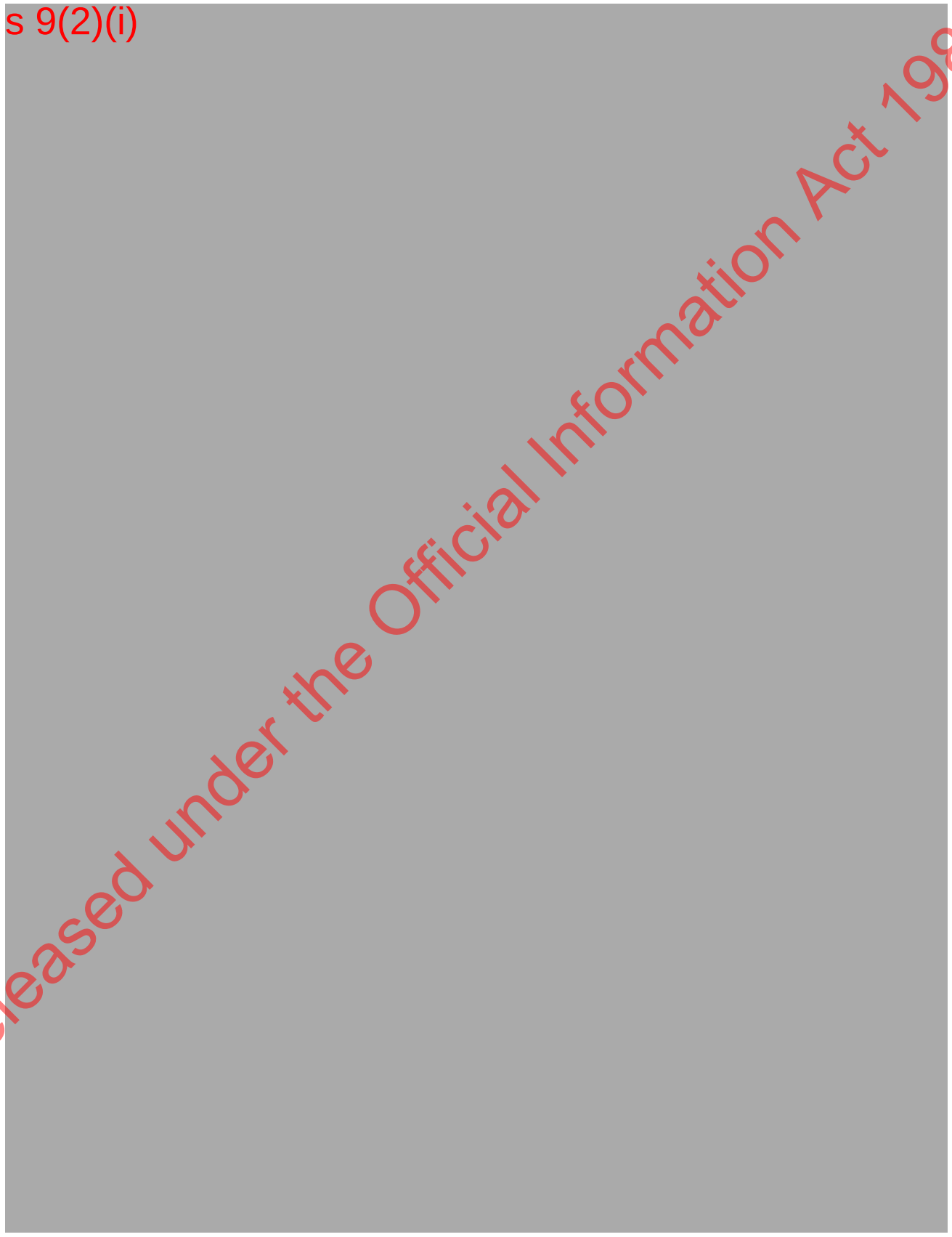

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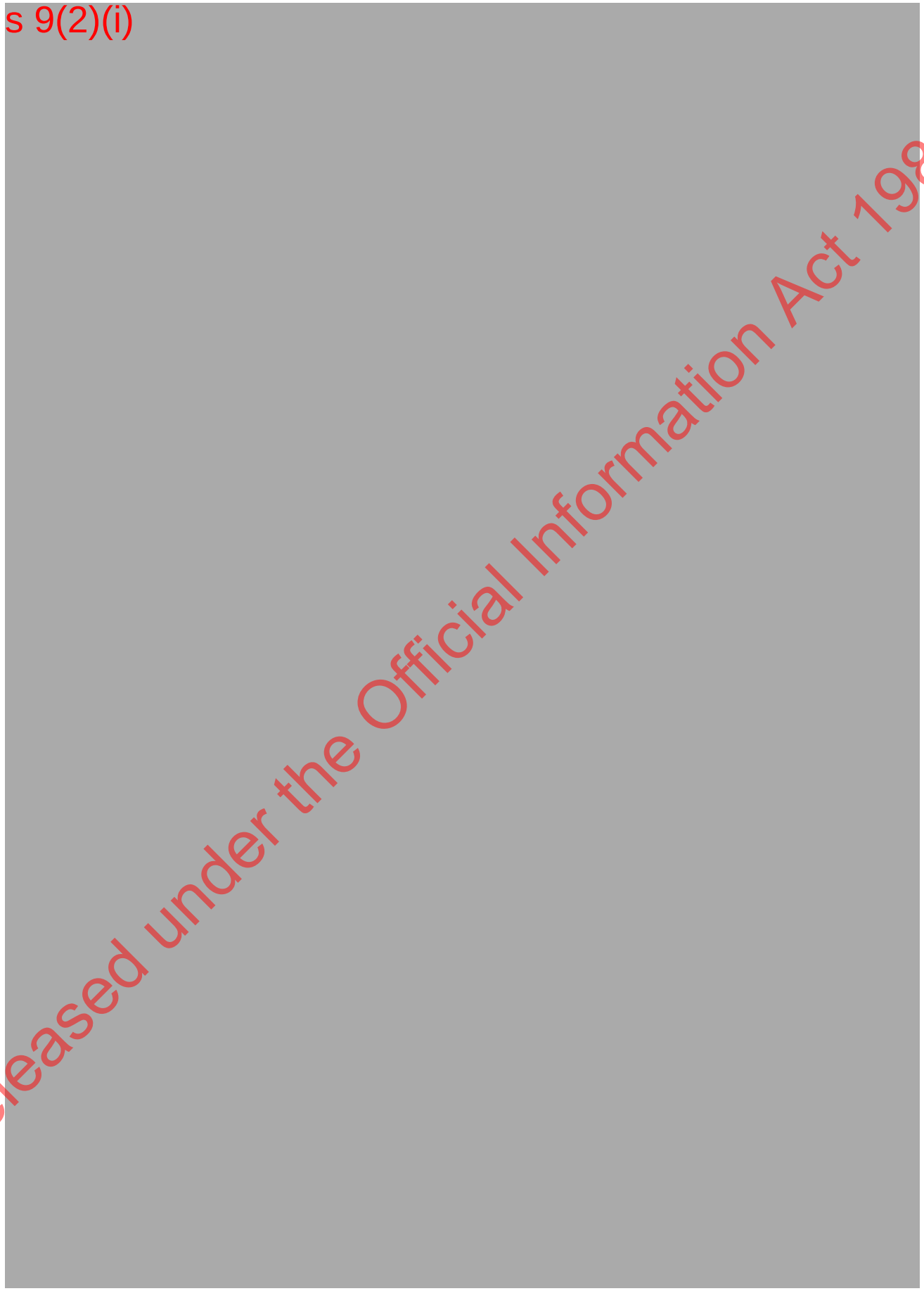

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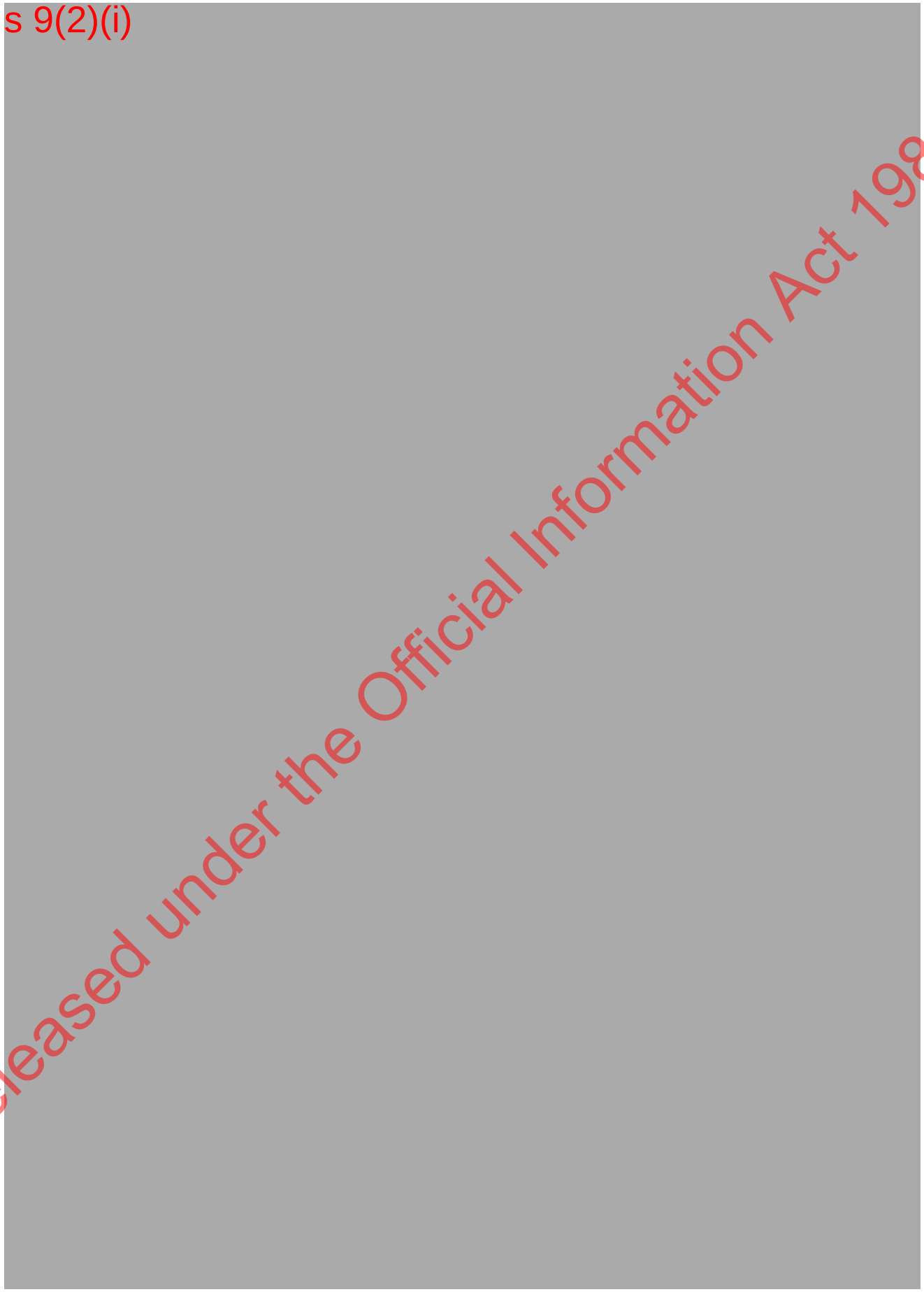

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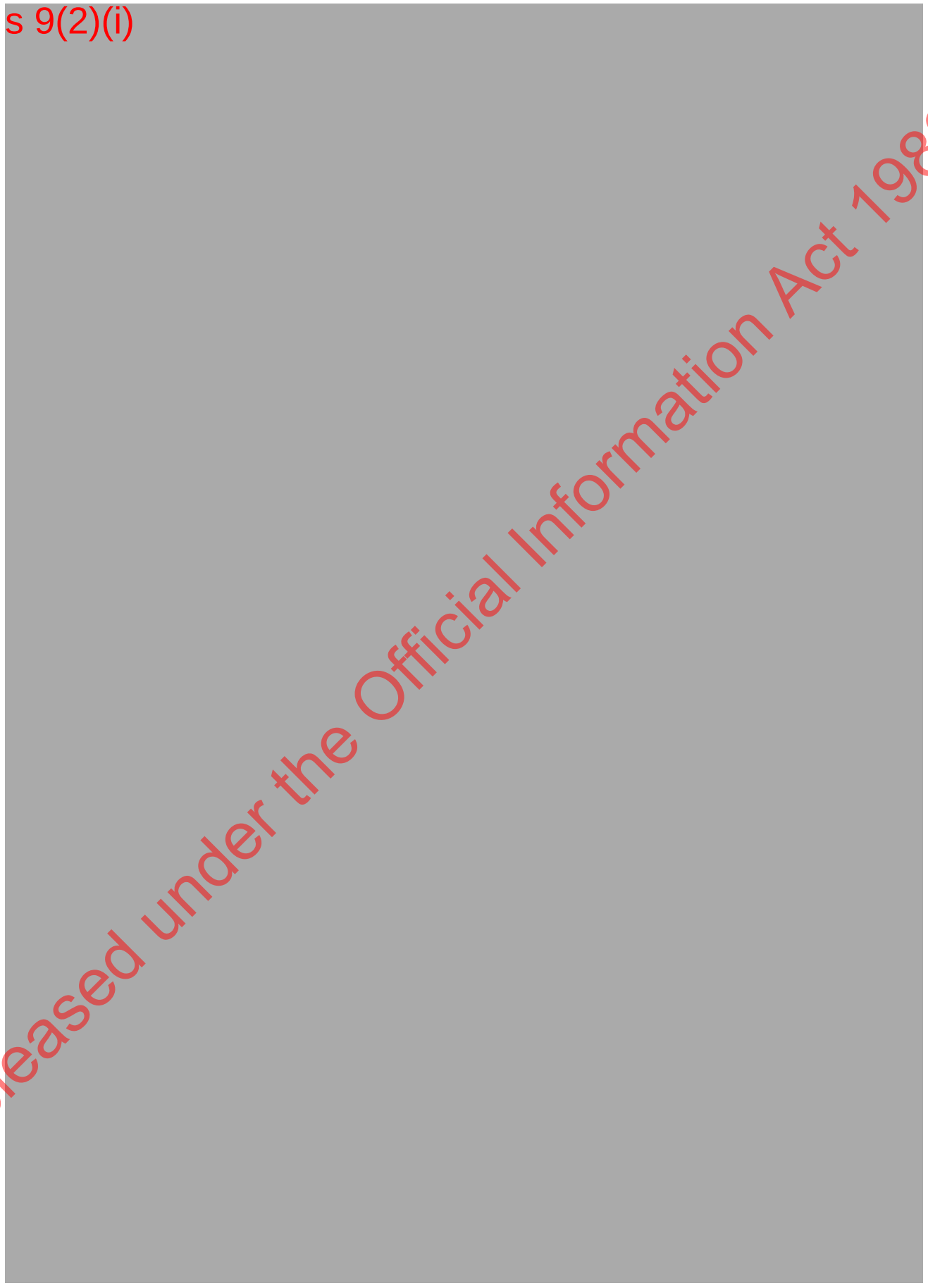

4.2 Outcomes against KPIs and measures

4.2.1 Initial run and land use adjustments

The five shortlisted options were modelled using MSM for both the 2031 and 2051 horizons.

The options were initially run on the do minimum land use, and accessibility and effective job density outputs were used to inform hedonic land use modelling (external to MSM) for the 2051 modelling horizon.

The hedonic modelling resulted in adjustments to the land use distribution in 2051 that reflect a slightly higher growth within the corridor. This adjusted growth pattern is referred to as the 'accessibility-based land use scenario'. Growth outside the corridor forecast to slow down to keep Auckland's 2051 regional forecast constant. The 2051 population in the CC2M Corridor was forecast to increase by between 5% and 6% and employment totals by between 1.2% and 1.7% as shown in Table 10: Adjustments to the 2051 land use forecast below.

Table 10: Adjustments to the 2051 land use forecast (accessibility-based land use scenario)

	Population in CC2M Corridor by 2051	**Increase over Do Minimum in CC2M Corridor**	**Percentage change in the C2M Corridor**
DM 2051	259,688		
Opt 1A 2051	272,969	13,281	5.1%
Opt 1B 2051	272,608	12,920	5.0%
Opt 2A 2051	275,408	15,720	6.1%
Opt 2B 2051	275,769	16,081	6.2%
Opt 3 2051	274,992	15,304	5.9%
	Employment in CC2M Corridor by 2051	**Increase over Do Minimum in CC2M Corridor**	**Percentage change in the C2M Corridor**
DM 2051	251,144		
Opt 1A 2051	254,253	3,109	1.2%
Opt 1B 2051	254,142	2,998	1.2%
Opt 2A 2051	255,341	4,197	1.7%
Opt 2B 2051	255,248	4,104	1.6%
Opt 3 2051	255,135	3,991	1.6%

4.2.2 Comparing the outcomes

The five shortlisted options were re-modelled in 2051 using MSM the adjusted land use distribution discussed above.

A summary version of the results for the 2051 model horizon is shown in Table 11: Key outcomes for the 5 shortlisted option at 2051 model horizon below, with a full set of results included in Appendix B.

Table 11: Key outcomes for the 5 shortlisted option at 2051 model horizon

Indicators	2018	2051 DM	1A	1B	2A	2B	3
	Existing land use	Do minimum land use scenario	Accessibility based land use scenario				
Number of Jobs within 45min by PT from origins in the AM Peak from:							
Mangere Town Centre	79,780	82,065	250,013	241,967	440,725	421,323	336,932
Onehunga	165,136	194,045	401,109	397,745	456,074	435,807	444,666
Mt Roskill	208,209	297,096	359,671	412,067	419,743	469,689	401,412
Number of Households within 45min by PT to destinations in the AM Peak from:							
City Centre	202,704	354,075	364,488	365,663	381,059	384,833	376,112
Airport	3,840	19,838	86,547	90,179	136,616	143,071	94,963
Number of Tertiary Education Opportunities within 45min by PT from origins in the AM Peak							
Mangere Town Centre	9,081	4,828	22,495	22,494	131,676	115,737	114,336
Onehunga	4,323	5,787	111,800	111,789	115,975	115,972	111,831
Mount Roskill	77,097	111,005	111,800	111,791	111,873	120,513	111,831
CC2M Travel times to Airport business from:							
Mangere			7.0	6.9	4.5	4.4	7.0
Onehunga			18.4	18.3	12.1	12.1	18.4
Mount Roskill			27.3	26.6	20.1	18.5	29.9
CC2M Travel times to Mid-Town from:							
Mangere			37.7	36.6	27.3	25.3	32.0
Onehunga			26.3	25.2	19.7	17.6	20.6
Mount Roskill			17.6	17.0	11.8	11.3	11.8
CC2M Travel times to Universities Station from:							
Mangere					25.0	23.0	29.7
Onehunga					17.4	15.3	18.3
Mount Roskill					9.5	9.0	9.5
CC2M Travel times to Wynyard from:							
Mangere			49.4	48.3	29.2	27.2	33.9
Onehunga			38.0	36.9	21.6	19.5	22.5
Mount Roskill			29.3	28.7	13.7	13.2	13.7
CC2M Boardings							
AM Peak			14,816	14,665	24,157	23,184	22,328
Daily			64,589	64,760	106,379	102,987	95,664
Annual			18,020,359	18,067,901	29,679,713	28,733,401	26,690,117
Percentage of Corridor separated from general traffic and pedestrianised areas			45%	42%	100%	100%	82%
Regional Rapid Transit (AM peak 2 hours):							
Boardings	22,735	84,669	96,789	96,298	105,338	103,755	103,637
CC2M Spare Capacity at Peak Load Point (maximum capacity - Peak Load Demand)							
Modelled Maximum Capacity of CC2M (pax/hour/direction)			6,300	6,300	11,600	11,600	8,400
Maximum Potential Capacity (pphpd)			8,400	8,400	23,200	23,200	12,600
CC2M Demand at Peak Load Point (pax/hour/direction)			4,412	4,528	7,799	7,121	7,337
% Utilisation (modelled capacity)			70%	72%	67%	61%	87%
Available capacity - modelled (pax/hour/direction)			1,888	1,772	3,801	4,479	1,063
Available Capacity Maximum (pphpd)			3,988	3,872	15,401	16,079	5,263

4.2.3Travel time comparison

The travel time comparisons of public transport and private vehicles at the 2051 model horizon show that:

- For Mangere all options will result in public transport options being competitive to the central city (midtown zone) when compared to private cars (refer to Figure 12: Travel times from zone 472 to zone 248) below);

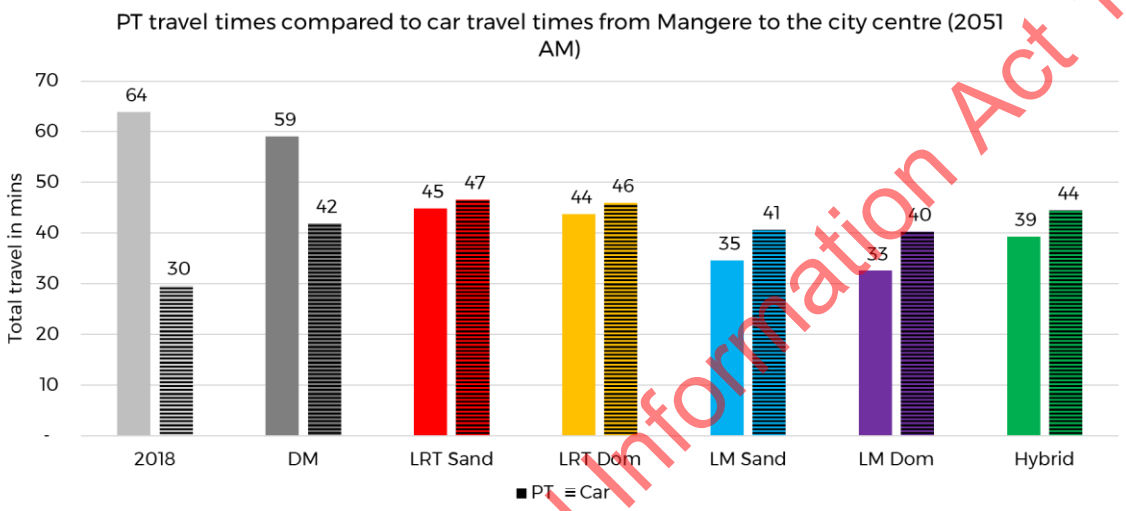

Figure 12: Travel times from zone 472 to zone 248)

- For Onehunga the light metro and hybrid options provide competitive travel times to the central city with the light rail options achieving parity with private cars (refer to Figure 13: Travel times from zone 347 to zone 248) below;

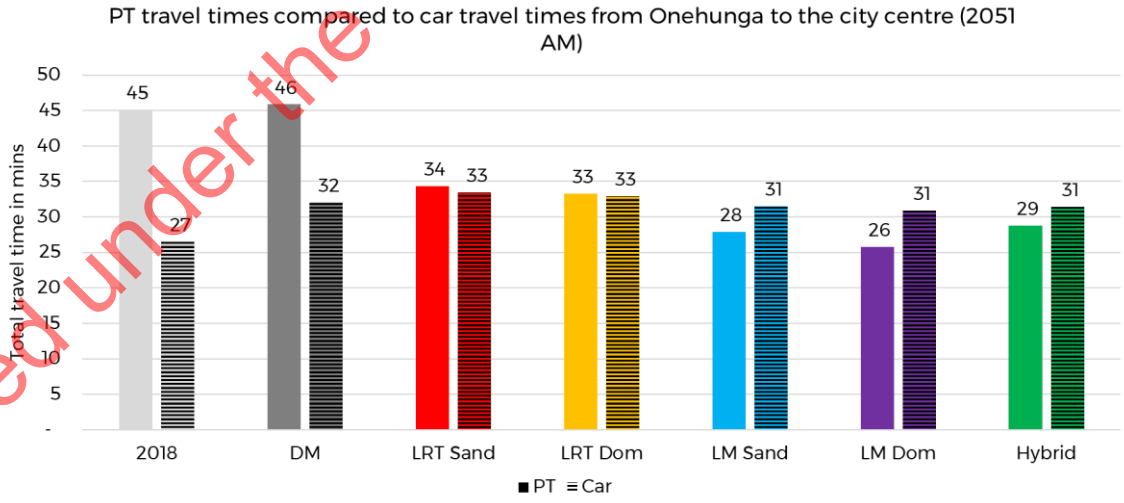

Figure 13: Travel times from zone 347 to zone 248)

- For Mt Roskill (zone 327) private cars will still be more competitive from a vehicle travel time perspective. Refer to Figure 14: Travel times from zone 327 to zone 248)

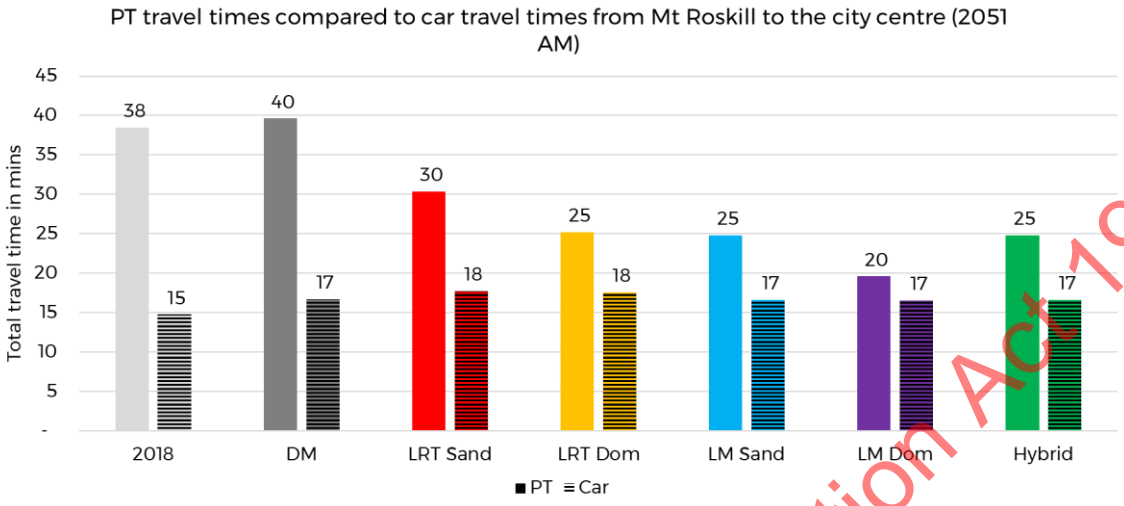

Figure 14: Travel times from zone 327 to zone 248)

4.2.4 Number of households within 45 minutes from city centre and airport

MSM analyses of the number of households that can access the midtown central city (represented by zone 248) within 45 minutes using public transport show that:

- Light metro increases the number of households that can access the central city in 45 minutes by 2051 between 8% and 9% when compared to the do minimum;
- The hybrid option increases the number of households that can access the central city in 45 minutes by 2051 by 6% when compared to the do minimum;
- Light rail increases the number of households that can access the central city in 45 minutes by 2051 by 3% when compared to the do minimum;

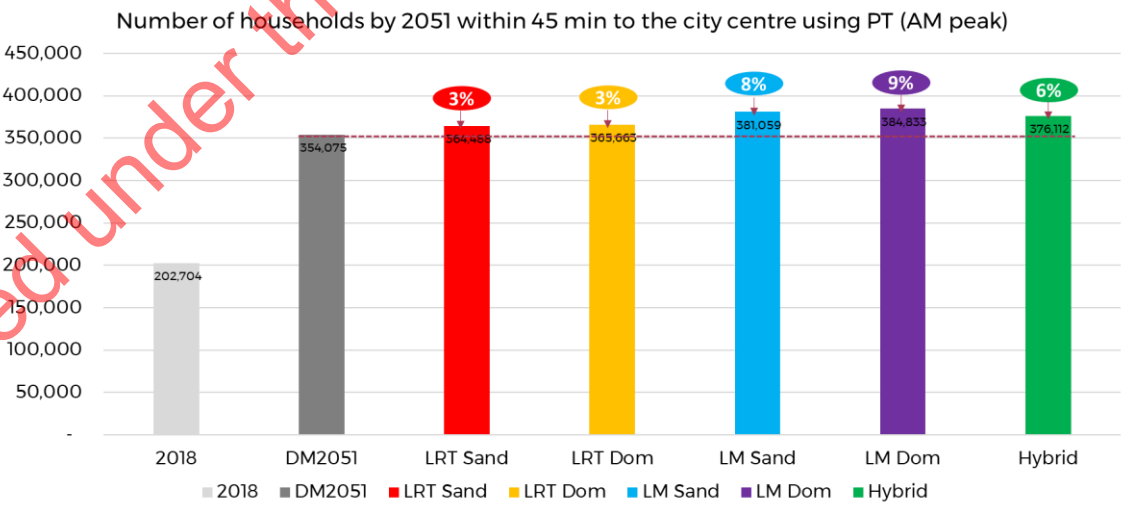

Figure 15: Households within 45 mins of central city (zone 248)

The options have a significant impact on the airport employment zone. MSM analyses shows that of the number of households that can access the airport employment area (represented by zone 478) within 45 minutes using public transport show that:

- Light metro increases the number of households that can access airport employment in 45 minutes by 2051 between 589% and 621% when compared to the do minimum;
- The hybrid option increases the number of households that can access airport employment in 45 minutes by 2051 by 379% when compared to the do minimum;
- Light rail increases the number of households that can access airport employment in 45 minutes by 2051 by between 336% and 355% when compared to the do minimum

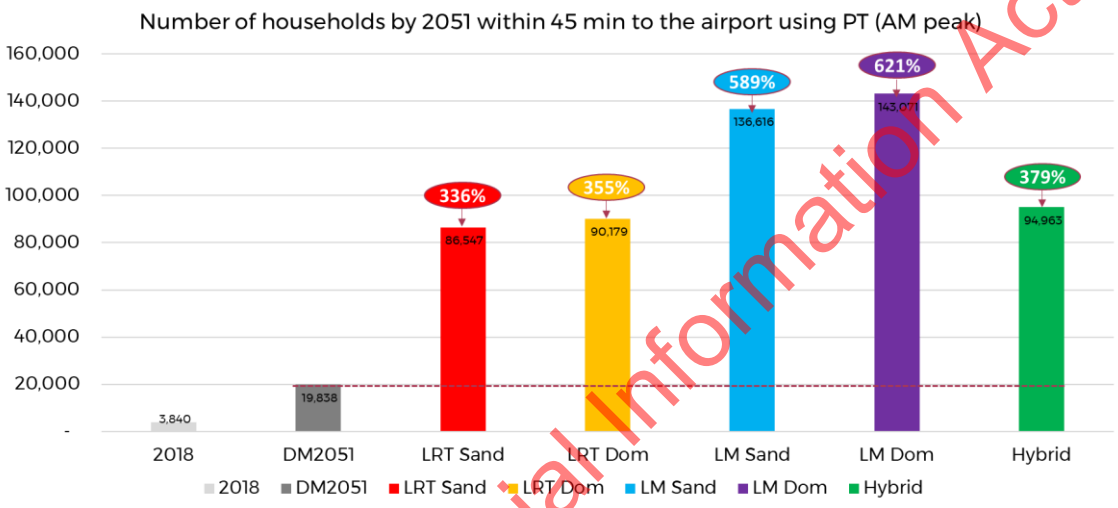

Figure 16: Households within 45 mins of airport employment (zone 478)

4.2.5Number of jobs from key areas

MSM analyses on the number of opportunities (jobs) available to residents from key areas of interest within 45 minutes using public transport show that:

- For Mangere residents (represented by zone 472) all options improve the number of jobs residents can access within 45 mins, with light metro options providing the highest improvement – a fivefold increase.

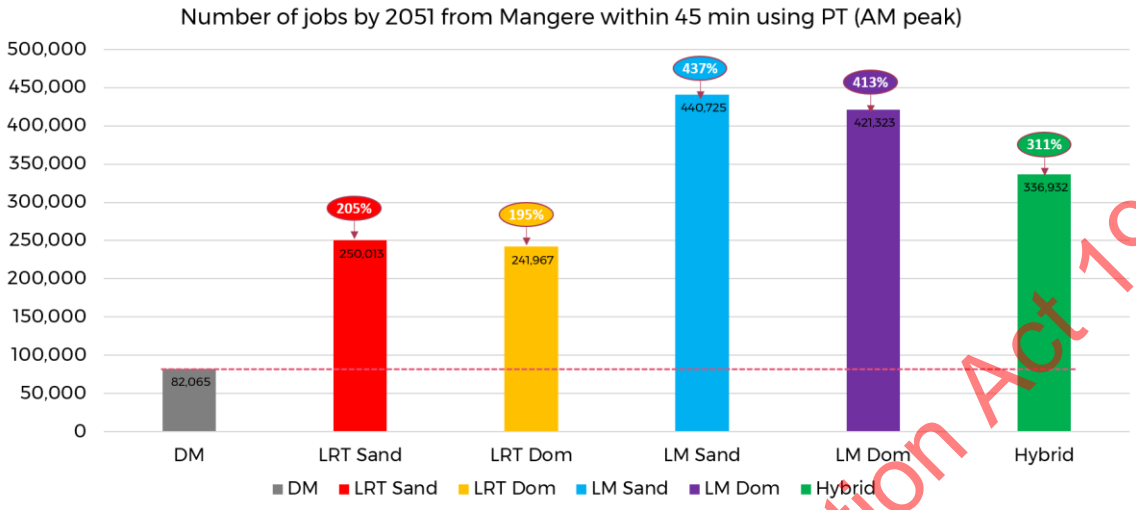

Figure 17: Improvement in job accessibility from Mangere (zone 472)

- For Onehunga residents (represented by zone 347) all options improve the number of jobs residents can access within 45 mins, with light metro option on Sandringham and the Hybrid options providing the highest improvement, doubling the number of jobs accessible – a 135% and 129% uplift respectively;

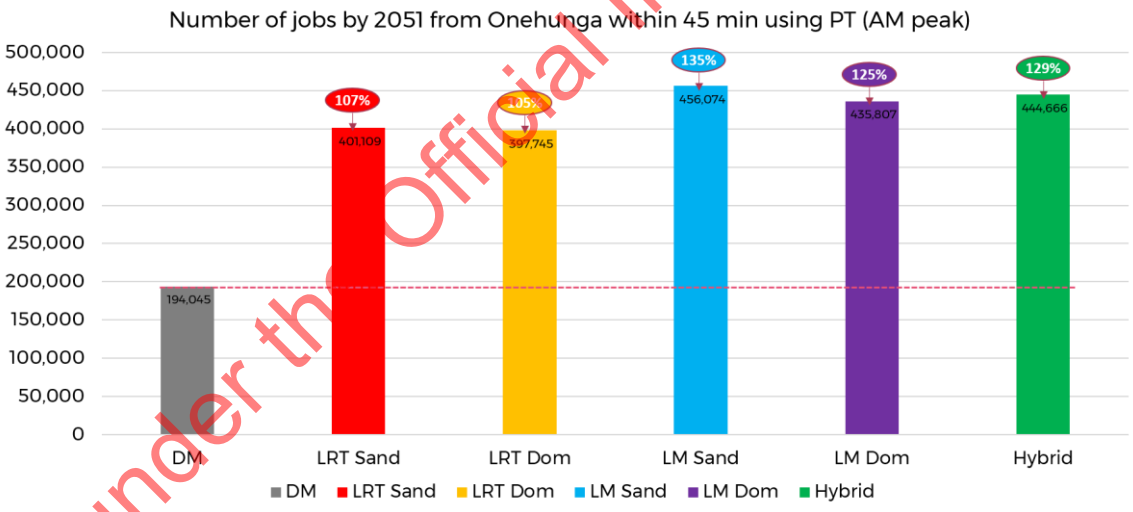

Figure 18: Improvement in job accessibility from Onehunga (zone 347)

- Mt Roskill (represented by zone 327) receive the lowest uplift of the three areas of interest – improving job accessibility between 21% and 58%, with light metro along Dominion Road providing the highest improvement over the do minimum (+58%).

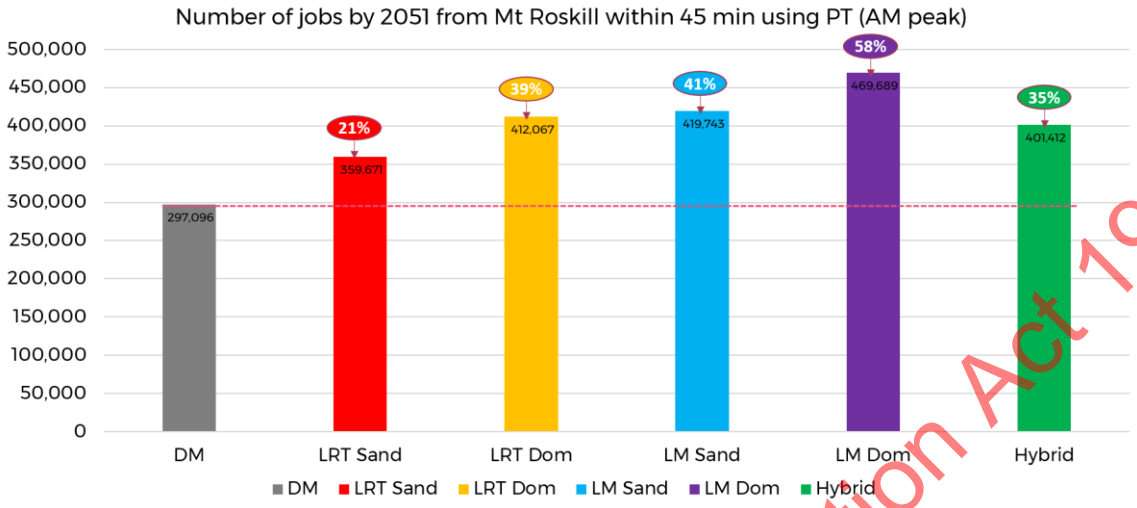

Figure 19: Improvement in job accessibility from Mt Roskill (zone 327)

4.2.6Number of tertiary education opportunities from key areas

The number of tertiary education opportunities available to residents from key areas of interest within a 45 minutes public transport journey estimated by the MSM model show that:

- For Mangere residents (represented by zone 472) all options improve access to education, with light metro and the hybrid options improving access significantly more than light rail options.
- For Onehunga all options improve access to similar level of improvement;
- Mt Roskill is forecast to achieve similar levels of access to education when compared to the do minimum – with light metro along Dominion Road the only option that provides notable improvements (+9%).

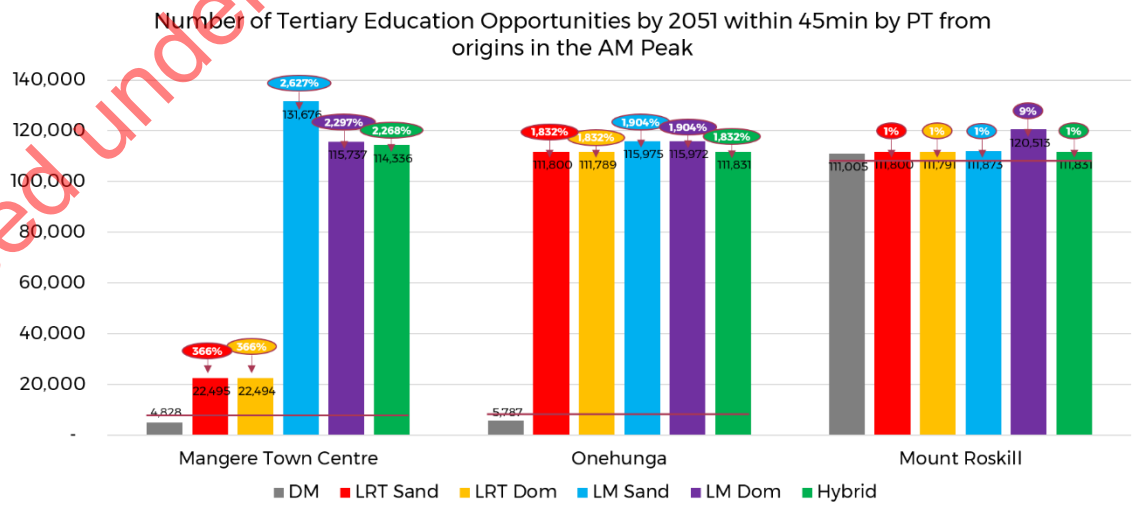

Figure 20: Improvements in tertiary education from all areas

4.2.7Light rail/light metro demands

The system and network configurations as discussed above are forecast to increase annual ridership on the entire public transport network by between 3% and 6%. The light metro solutions are forecast to contribute the highest - between 25.8M and 26.7M of the annual boardings. Light rail options forecast to attract approximately 16.2M annual boardings. Refer to Figure 21: Boardings – Region wide PT network below.

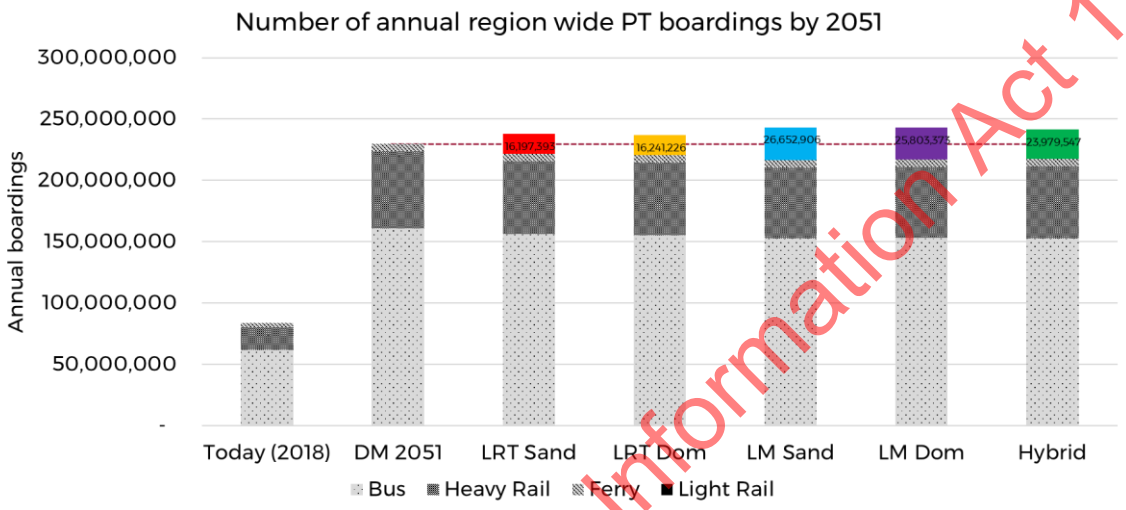

Figure 21: Boardings – Region wide PT network

s 9(2)(i)

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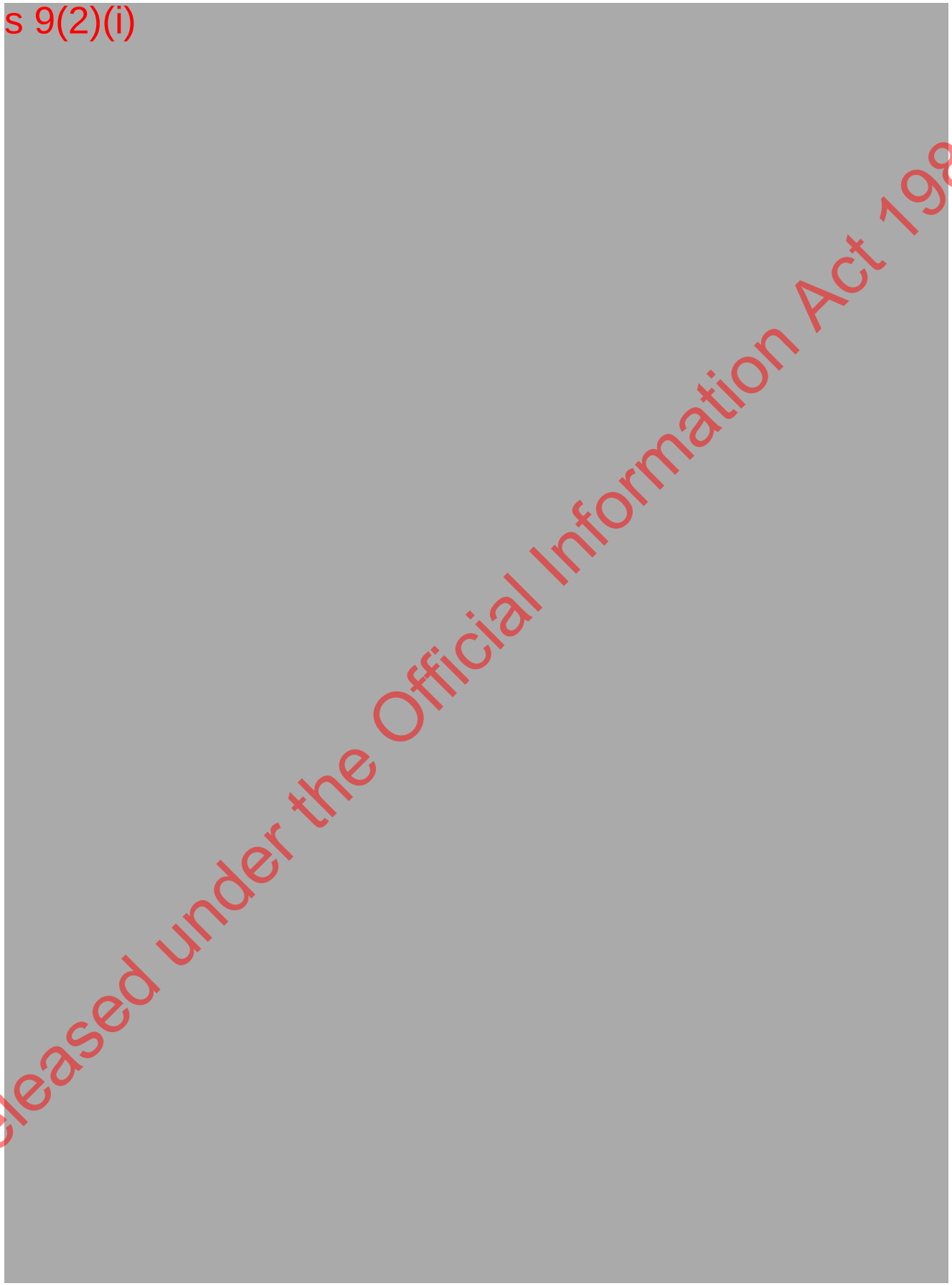

s 9(2)(i)

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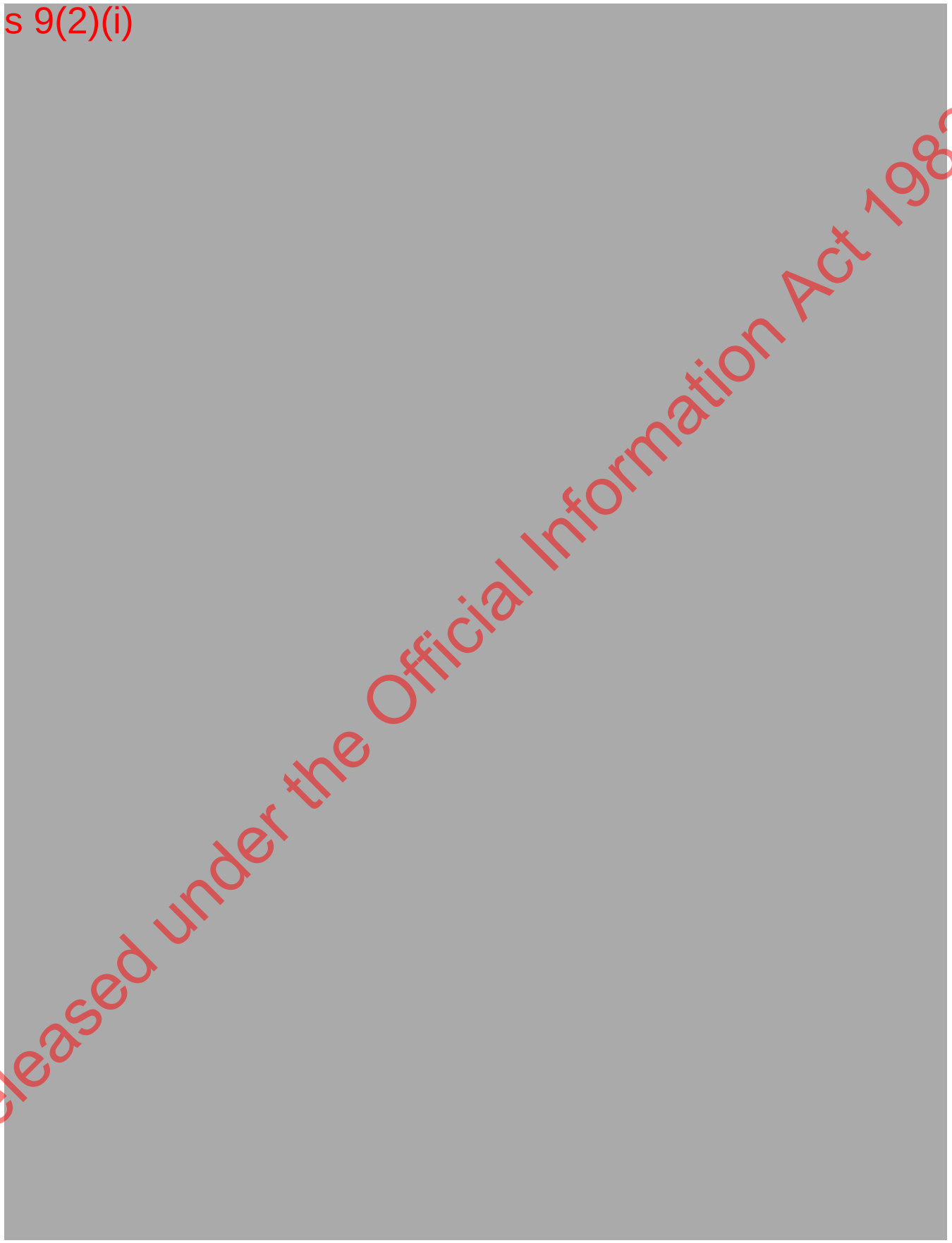

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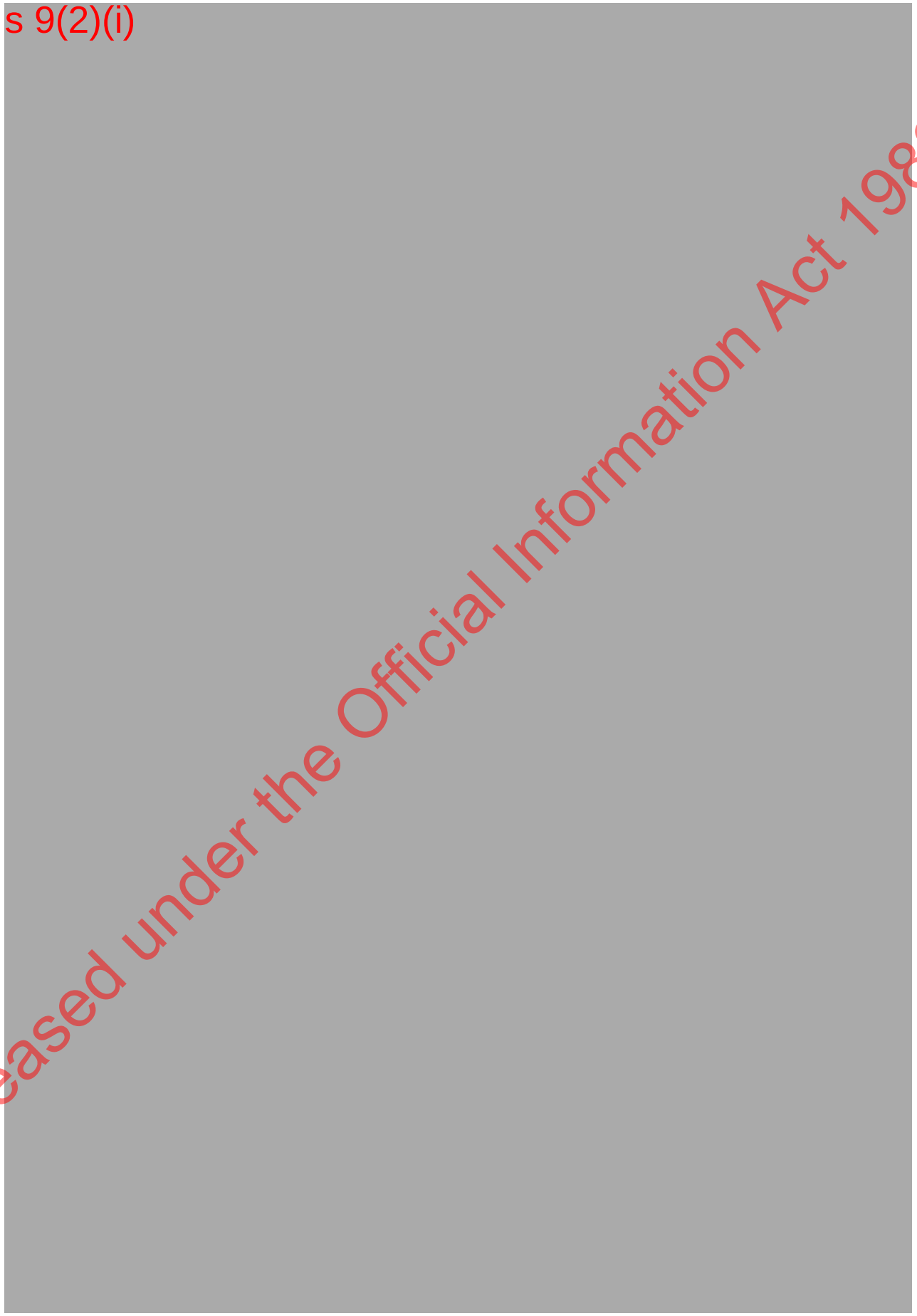

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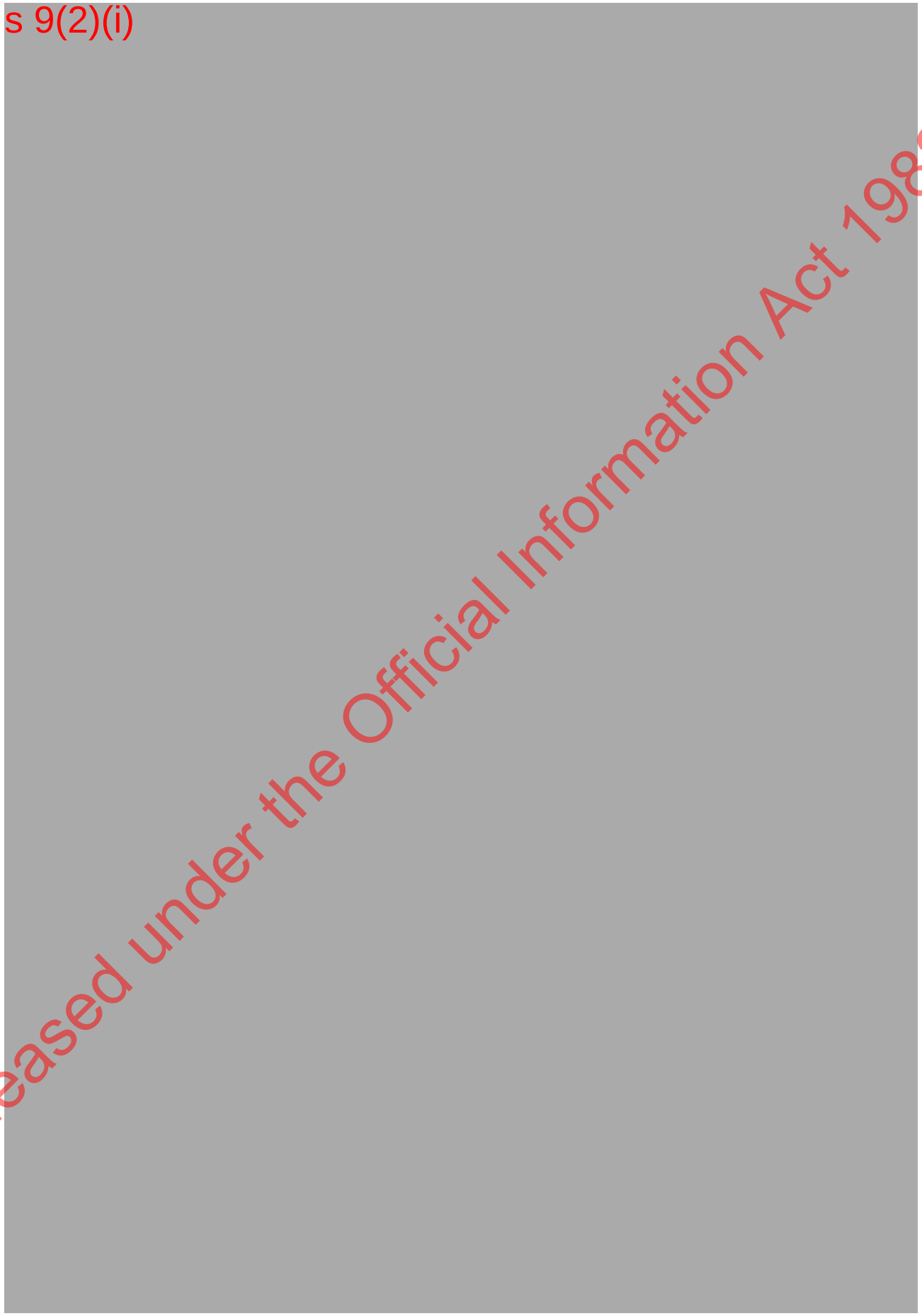

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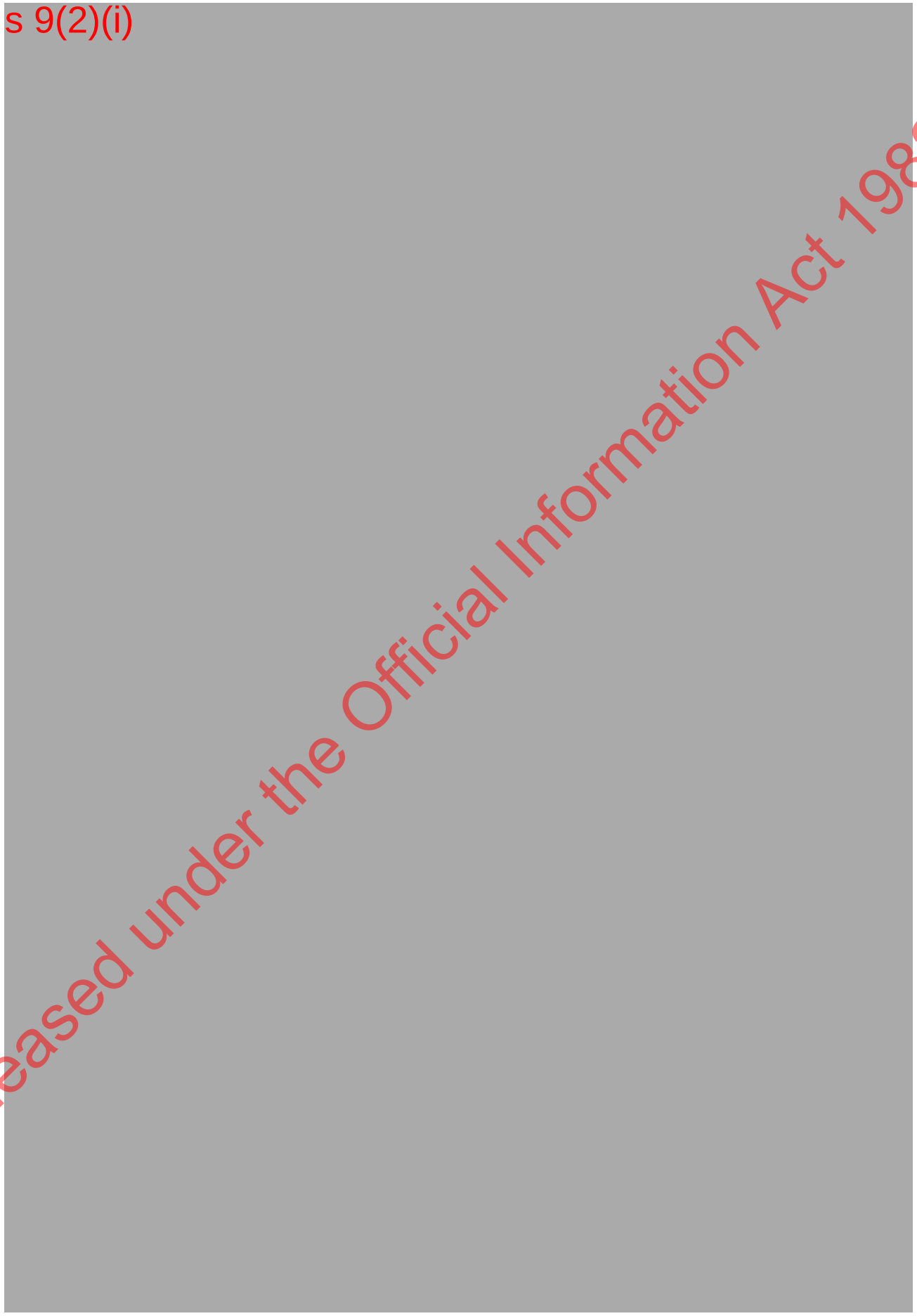


5. Final short list – demand modelling

5.1 Description of options and their land use

5.1.1Introduction

The three final shortlisted options were further analysed from a development capacity perspective resulting in further adjustments to the land use distribution in 2051 that reflect higher growth within the corridor.

The three options were

- Option 1B – Light Rail on Dominion Road
- Option 2A – Light metro on Sandringham Road
- Option 3 – Hybrid on Sandringham Road

5.1.2 Higher intensification land use scenario

The 2051 population in the CC2M Corridor under the higher intensification scenario was forecast to increase population in the corridor by between 18% and 31% This compares to a population of 5% to 6% under the accessibility-based land use scenario used during the initial short list phase, described earlier in the report. Employment totals were increased (over the do minimum) by between 5% and 6% under the higher intensification scenario, compared to an increase of between 1.2% and 1.7% for the accessibility-based scenario.

The changes are summarised in Table 12: Further adjustments to the 2051 land use forecast below.

Table 12: Further adjustments to the 2051 land use forecast (higher intensification scenario)

	Population in CC2M Corridor by 2051 after adjustment	Increase over Do Minimum in CC2M Corridor	Percentage change in the C2M Corridor
DM 2051	259,688		
Opt 1B 2051	306,227	46,539	17.9%
Opt 2A 2051	341,132	81,444	31.4%
Opt 3 2051	341,132	81,444	31.4%
	Employment in CC2M Corridor by 2051 after adjustment	**Increase over Do Minimum in CC2M Corridor**	**Percentage change in the C2M Corridor**
DM 2051	251,144		
Opt 1B 2051	263,144	12,000	4.8%
Opt 2A 2051	267,144	16,000	6.4%
Opt 3 2051	267,144	16,000	6.4%

Growth outside the corridor was forecast to slow down to keep Auckland's 2051 regional forecast constant. Growth in the greenfields areas of s 9(2)(i) were all reduced and re-allocated to the project corridor.

s 9(2)(i)

5.2 Outcomes against KPIs and measures

5.2.1 Comparing the outcomes

The three final shortlisted options were re-modelled in 2051 using MSM with the higher intensification land use scenario discussed above.

A summary version of the results for the 2051 model horizon is shown in Table 13: Key outcomes for the 3 final shortlisted option at 2051 model horizon below, with a full set of results included in Appendix C.

Table 13: Key outcomes for the 3 final shortlisted option at 2051 model horizon

Indicators	2018	2051 DM	1B (light rail)	2A (light metro)	3 (hybrid)
Number of Jobs within 45min by PT from origins in the AM Peak from:					
Mangere Town Centre	79,780	82,065	247,207	452,773	346,183
Onehunga	165,136	194,045	405,544	463,881	437,561
Mt Roskill	208,209	297,096	414,691	423,047	403,296
Number of Households within 45min by PT to destinations in the AM Peak from:					
City Centre	202,704	354,075	378,545	405,418	399,246
Airport	3,840	19,838	97,008	164,245	116,737
Number of Tertiary Education Opportunities within 45min by PT from origins in the AM Peak					
Mangere Town Centre	9,081	4,828	22,541	131,990	114,614
Onehunga	4,323	5,787	112,025	116,251	111,702
Mount Roskill	77,097	111,005	112,027	112,139	112,103
CC2M Travel times to Airport business from:					
Mangere			6.9	4.5	7.0
Onehunga			18.3	12.1	18.4
Mount Roskill			26.6	20.1	29.9
CC2M Travel times to Mid-Town from:					
Mangere			36.6	27.3	32.0
Onehunga			25.2	19.7	20.6
Mount Roskill			17.0	11.8	11.8
CC2M Travel times to Universities Station from:					
Mangere				25.0	29.7
Onehunga				17.4	18.3
Mount Roskill				9.5	9.5
CC2M Travel times to Wynyard from:					
Mangere			48.3	29.2	33.9
Onehunga			36.9	21.6	22.5
Mount Roskill			28.7	13.7	13.7
CC2M Boardings					
AM Peak			16,505	28,822	26,411
Daily			72,605	125,252	111,724
Annual			20,256,851	34,945,169	31,170,996
PT Mode share					
CC2M corridor	12%	21%	26%	26%	26%

Indicators	2018	2051 DM	1B (light rail)	2A (light metro)	3 (hybrid)
Percentage of Corridor Separated from General Traffic and Pedestrianised Areas			42%	100%	82%
CC2M Spare Capacity at Peak Load Point (maximum capacity - Peak Load Demand)					
Modelled Maximum Capacity of CC2M (pax/hour/direction)			6,300	11,600	8,400
Maximum Potential Capacity (pphpd)			8,400	23,200	12,600
CC2M Demand at Peak Load Point (pax/hour/direction)			5,036	9,345	8,193
% Utilisation (modelled capacity)			80%	81%	98%
Available capacity - modelled (pax/hour/direction)			1,264	2,255	207
Available Capacity Maximum (pax/hour/direction)			3,364	13,855	4,407

5.2.2Travel time comparison

5.2.2.1 Short list options compared to car alternative

The travel time comparisons of public transport and private vehicles at the 2051 model horizon show that:

- For Mangere all 3 options will result in public transport options being competitive to the central city (midtown zone) when compared to private cars (refer to Figure 35: Travel times from zone 472 to zone 248 below);

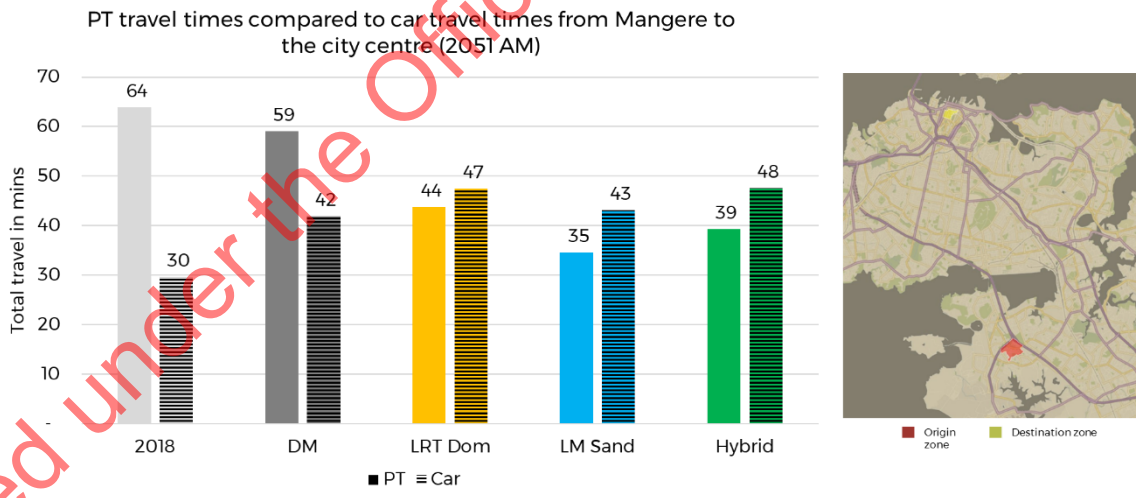


Figure 35: Travel times from zone 472 to zone 248

- For Onehunga all 3 options will result in public transport options being competitive to the central city (midtown zone) when compared to private cars (refer to Figure 36: Travel times from zone 347 to zone 248 below;

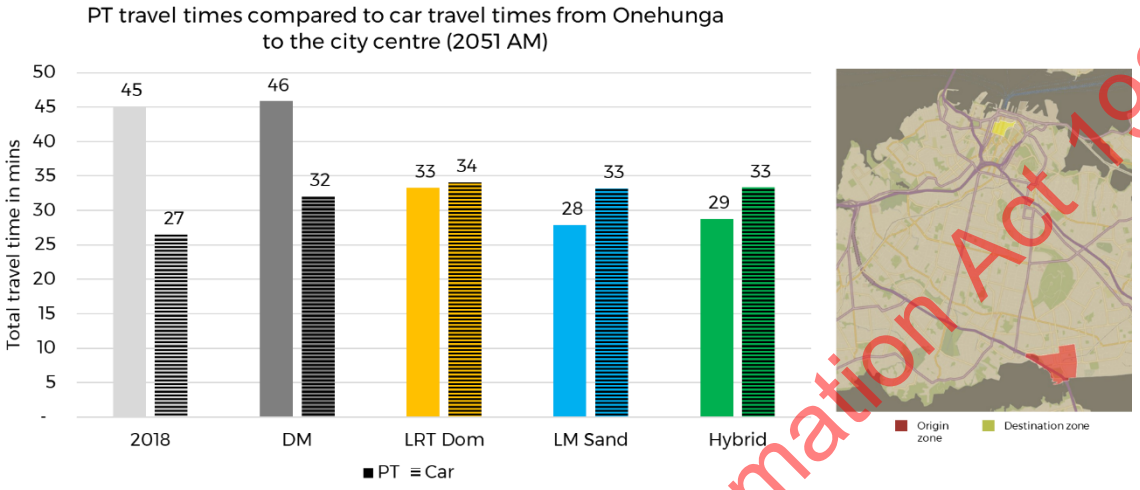


Figure 36: Travel times from zone 347 to zone 248

- For Mt Roskill (zone 327) private cars will still be more competitive from a vehicle travel time perspective for options along Sandringham Road. Refer to Figure 37: Travel times from zone 327 to zone 248

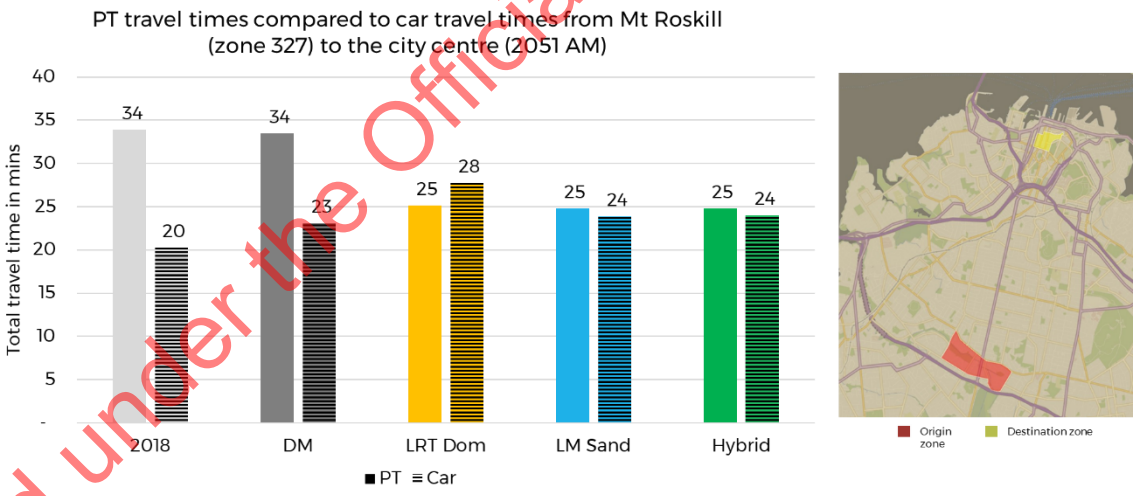


Figure 37: Travel times from zone 327 to zone 248

- A large part of the Kainga Ora development is located to the west of the Mt Roskill zone adopted for the analyses, zone 327. Further travel time comparisons were therefore made from this zone (zone 320) to the central city.
- This show that the two options along Sandringham Road will result in public transport being competitive to private cars from the development area within zone

320. The Dominion Road LRT option will not impact this area significantly, and hence no significant improvement over the do minimum is forecast.

- Refer to Figure 38: Travel times from zone 320 to zone 248

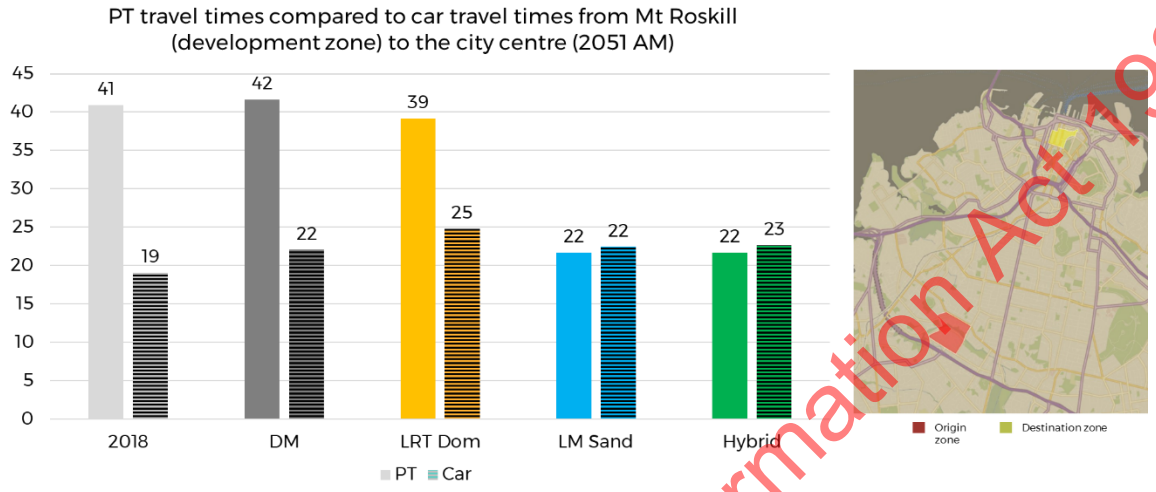


Figure 38: Travel times from zone 320 to zone 248

s 9(2)(i)

5.2.3 Number of households within 45 minutes from city centre and airport

5.2.3.1 **Changes in accessibility to the central city**

MSM analyses of the number of households that can access the midtown central city (represented by zone 248) within 45 minutes using public transport show that:

- Light metro increases the number of households that can access the central city in 45 minutes by 2051 by 15% compared to the do minimum;
- The hybrid option increases the number of households within the catchment by 13% and the light rail option increases it by 7%.

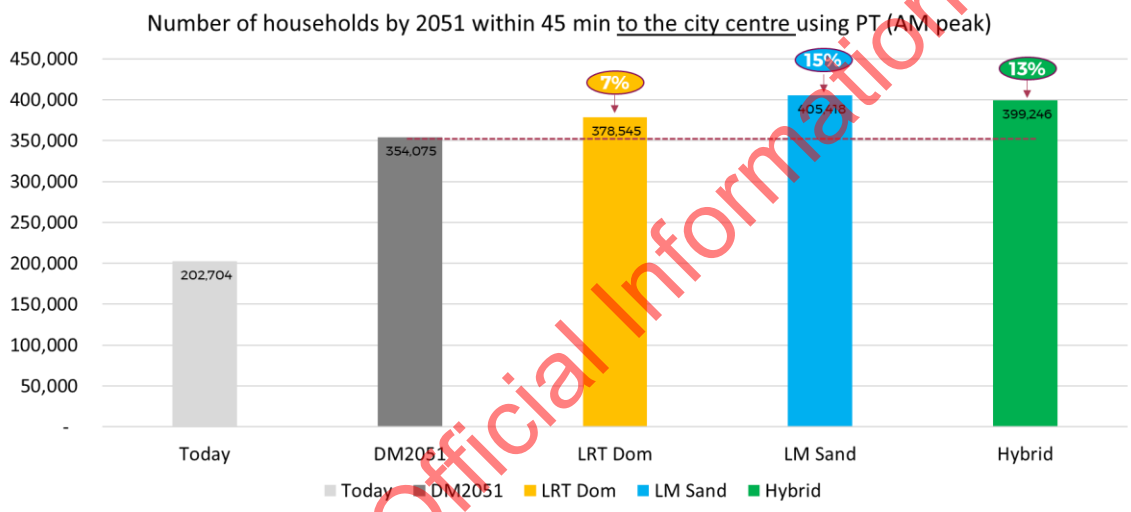


Figure 40: Households within 45 mins of central city (zone 248)

- The options largely enhance the 45-minute catchment in various degrees to include the areas of Mt Roskill south of SH20 as well as more of Onehunga and Mangere. Figure 41 below shows the geographical extend of a 45-minute catchment to midtown associated with each option.

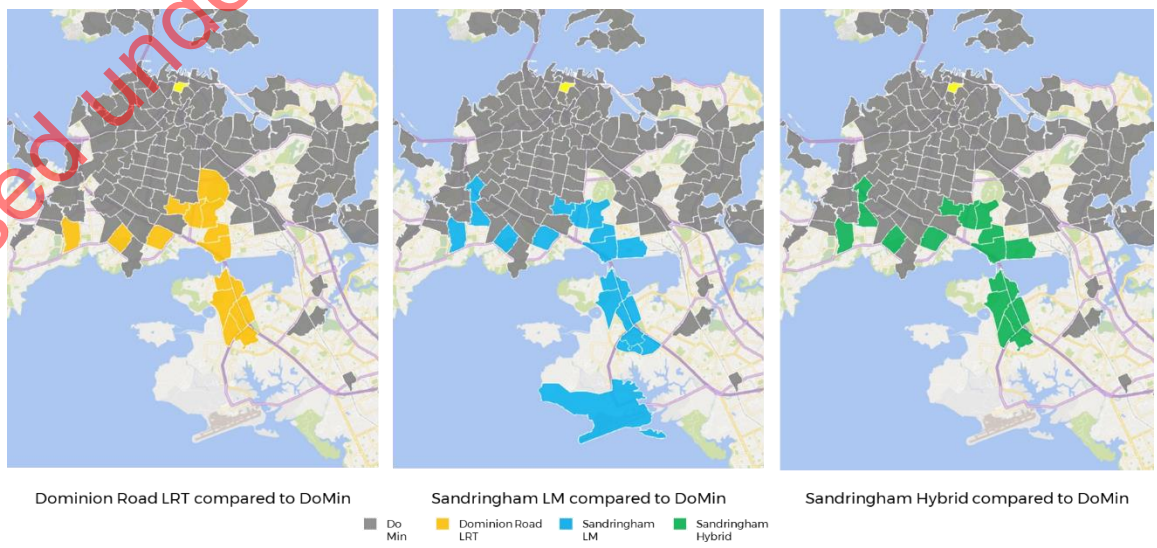


Figure 41: Zones that reach city centre (midtown zone 248) within 45 min on PT – 2051 AM

- The initial short list analyses showed Wynyard to be a key destination for trips from the CC2M corridor. The geographical analyses of the change in 45-minute catchment to Wynyard shows clear differences for the light metro and hybrid over the light rail option, with the latter having limited reach into Mangere. Refer to Figure 42 below.

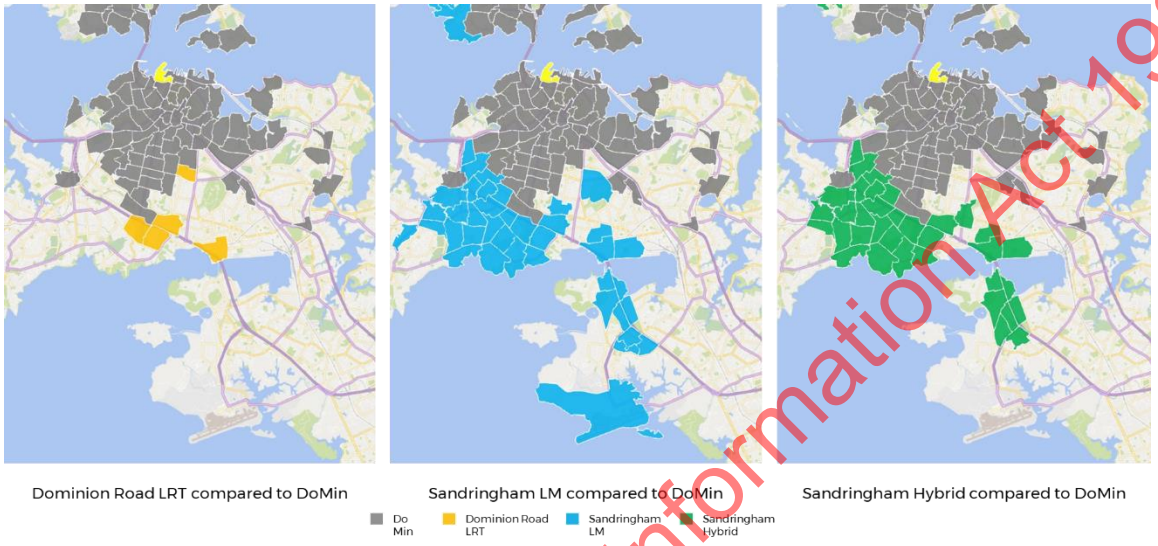


Figure 42: Zones that reach city centre (Wynyard zone 243) within 45 mins on PT - 2051 AM

- The city universities are also an important destination from all areas within the corridor. The geographical analysis of the change in 45-minute catchment to the university zone shows the catchment expands further into Mangere for the faster options (light metro and hybrid) when compared to light rail.

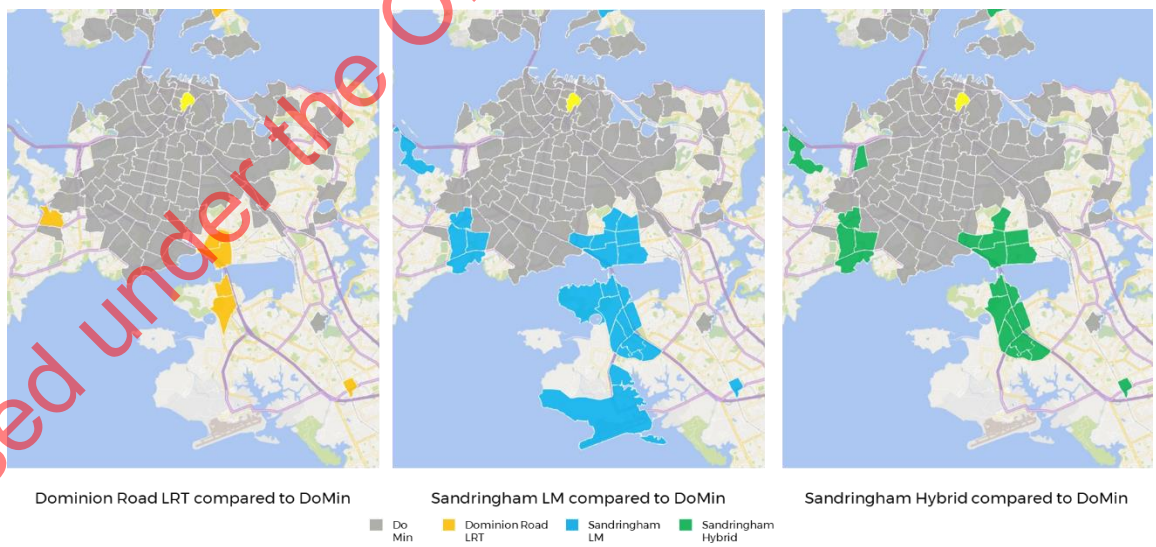


Figure 43: Zones that reach city centre (university zone 249) within 45 mins on PT - 2051 AM

5.2.3.2 **Changes in accessibility to the airport**

The three options have a significant impact on the airport employment zone. MSM analyses shows that of the number of households that can access the airport employment area (represented by zone 478) within 45 minutes using public transport show that:

- Light metro increases the number of households that can access airport employment in 45 minutes by 2051 between 728% when compared to the do minimum; the hybrid option increases the number of households by 488% and light rail increases it by 389%. Refer to Figure 44: Households within 45 mins of airport employment (zone 478) below.

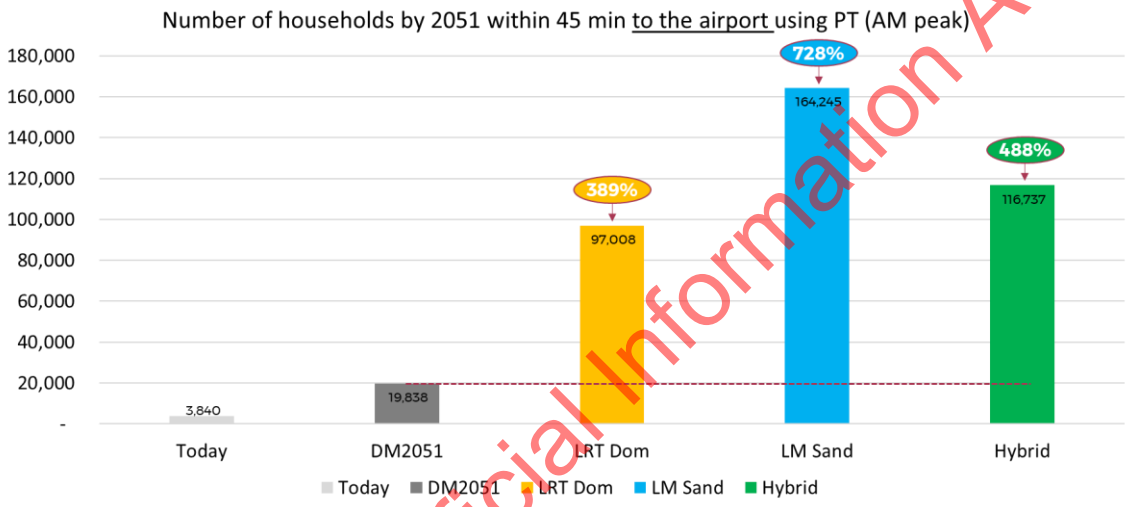


Figure 44: Households within 45 mins of airport employment (zone 478)

- All options extend the 45 minute PT catchment into the isthmus when compared to the do minimum. The light metro option extends the 45 minute catchment as far north as the centre city, with hybrid and light rail options extending the catchment to the Dominion Junction area. Refer to Figure 45 below.

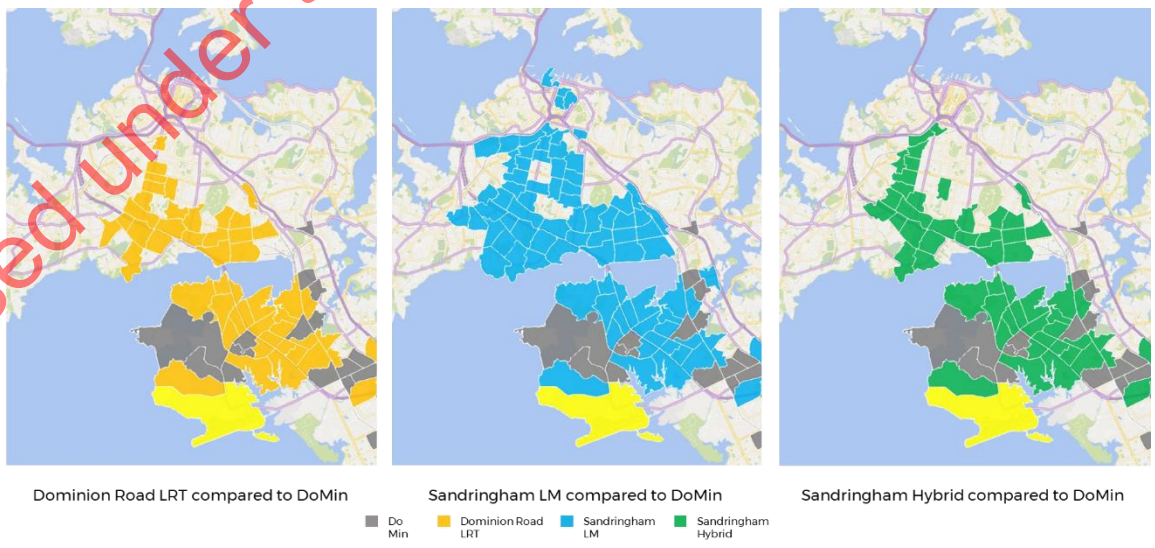


Figure 45: Zones that reach the airport (zone 478) within 45 mins on PT - 2051 AM

5.2.4Number of jobs from key areas

MSM analyses on the number of opportunities (jobs) available to residents from key areas of interest within 45 minutes using public transport show the following for each area.

5.2.4.1 **Opportunities accessible to Mangere residents**

- For Mangere (represented by zone 472) all three options improve the number of jobs residents can access within 45 mins, with light metro providing the highest improvement – a 452% increase.

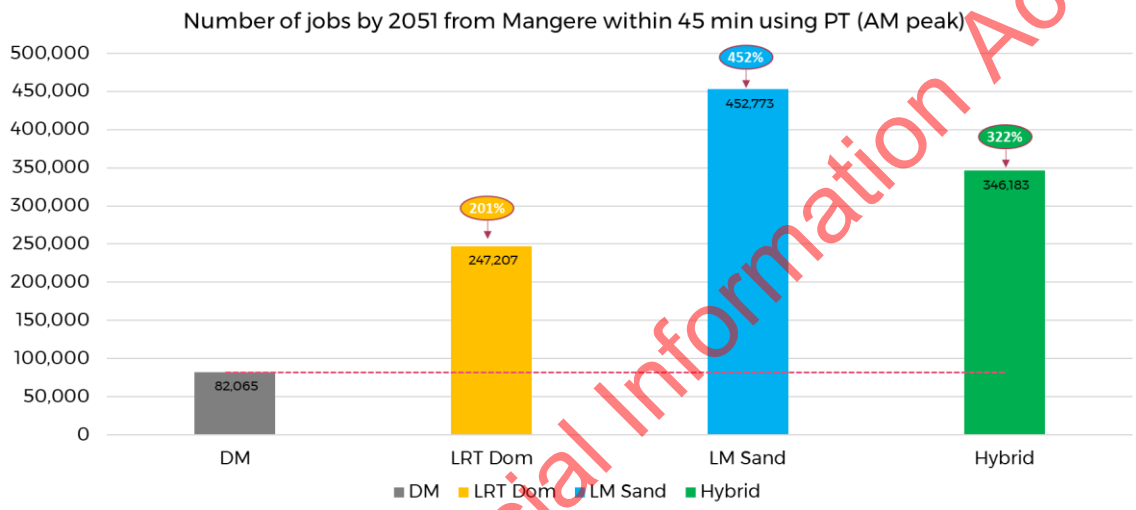


Figure 46: Improvement in job accessibility from Mangere (zone 472)

- The spatial expansion of the 45-minute catchment for each option is shown in Figure 47 below.
- It shows both light metro and hybrid options include significant parts of the central city within its 45-minute catchment area.

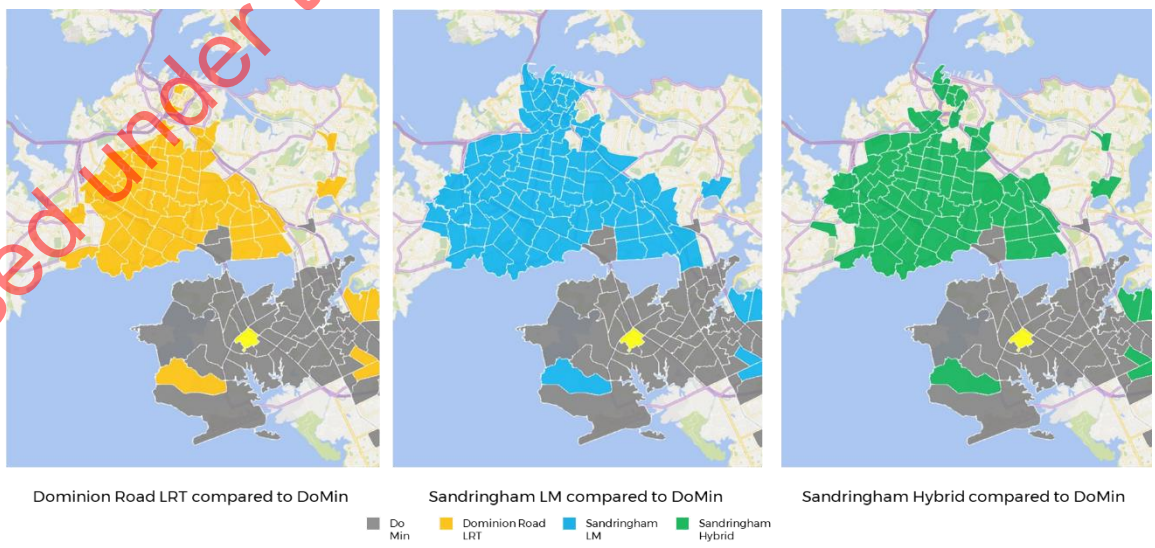


Figure 47: Zones within 45 min PT trip from Mangere Town Centre (zone 472) - 2051 AM

- Further analyses were done to test the sensitivity of the 45-minute catchment on accessibility to employment opportunities to Mangere residents. The analyses show that light metro will provide more job opportunities than light rail within a range of catchment isochrones, from 30 minutes to 60 minutes. The largest differences occur within the 38 – 48 minute range.
- The hybrid option will achieve accessibility parity with light metro for accessibility thresholds of more than 55 minutes.

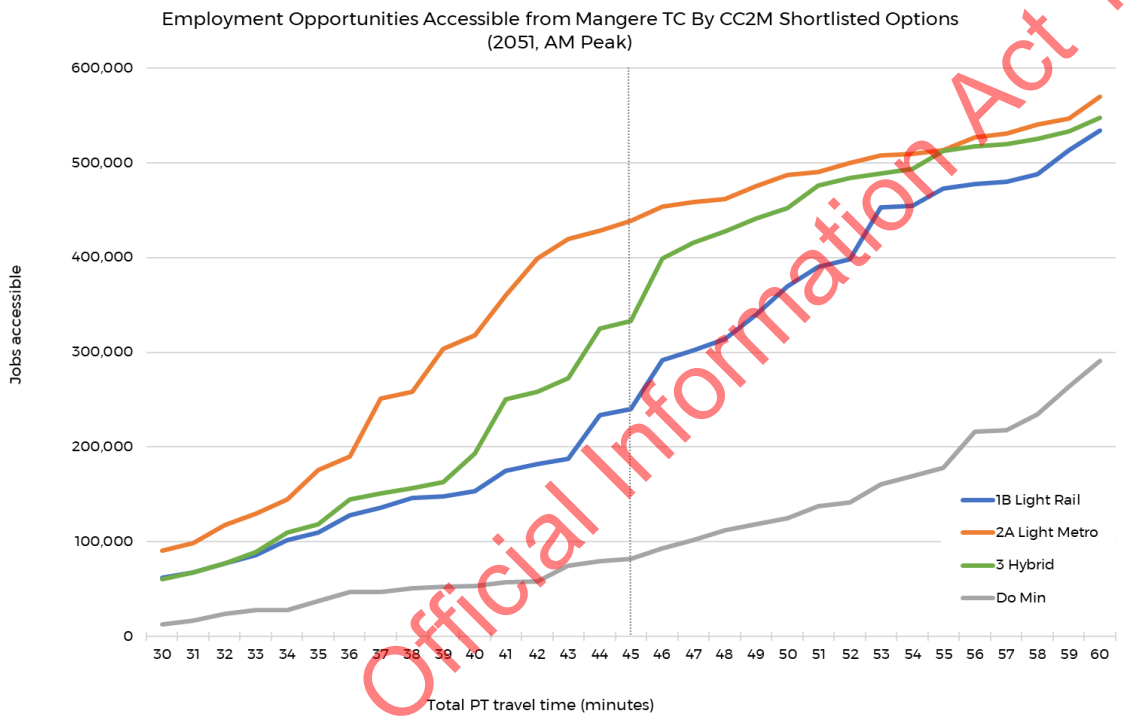
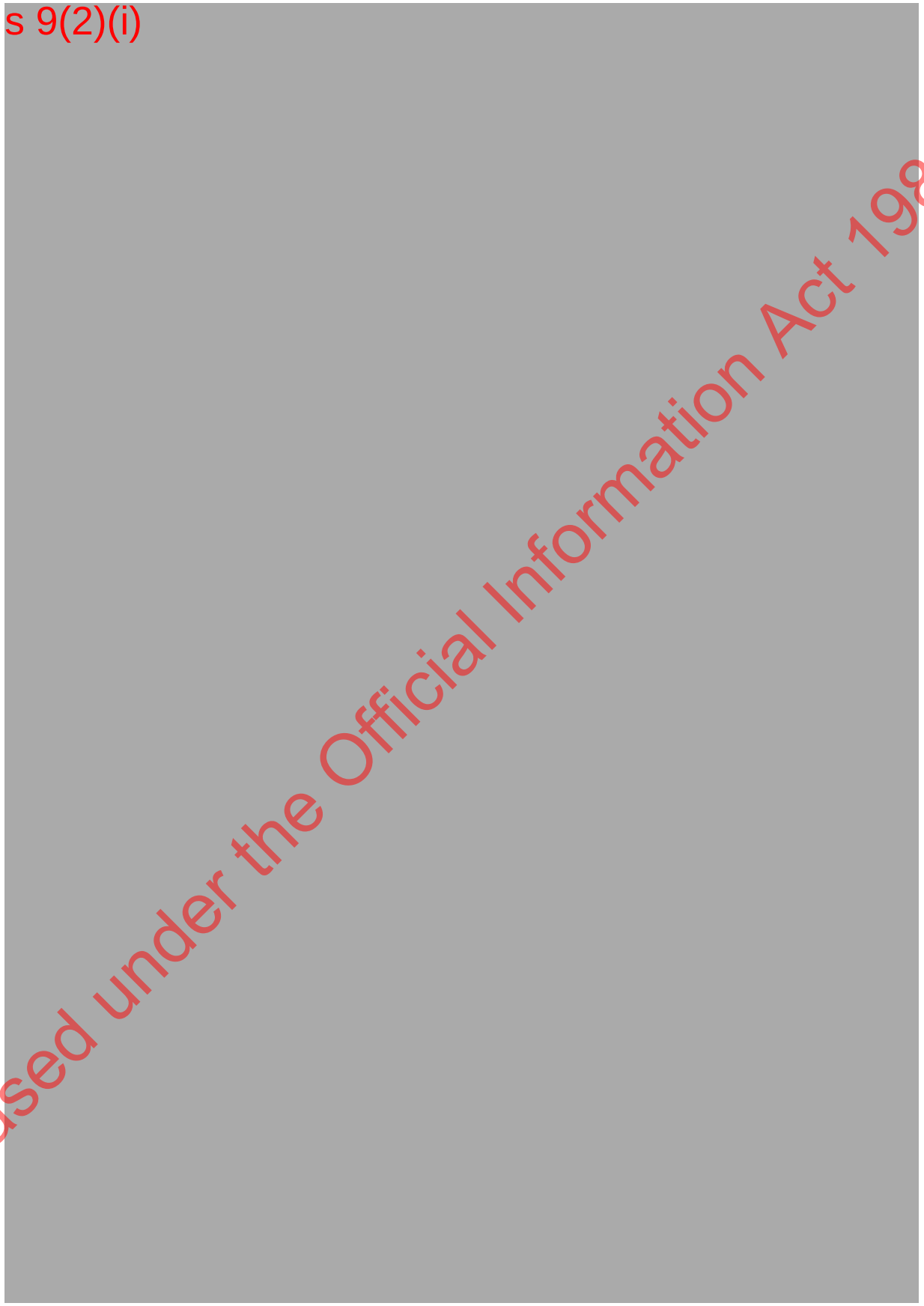


Figure 48: Sensitivity analysis of employment accessibility from Mangere for various travel time isochrones

- Origin-destination analyses for trips on the CC2M line during the AM peak show a significant number of people use the CC2M system to go to the City Centre, including Wynyard for work and Education purposes from Mangere, Favona and Mangere Bridge. Refer to Figure 49. More detailed breakdown is provided in Appendix E.
- Education related trips are an important component for Mangere trips to the central city, with light rail using the Civic stop as the main alighting station. Light metro and the hybrid have a more direct connection to the education precinct through the university station.
- Midtown, Wynyard and the airport are the top three alighting destinations for work related trips.

s 9(2)(i)



5.2.4.2 **Opportunities accessible to Onehunga residents**

- For Onehunga (represented by zone 347) all options improve the number of jobs residents can access within 45 mins.

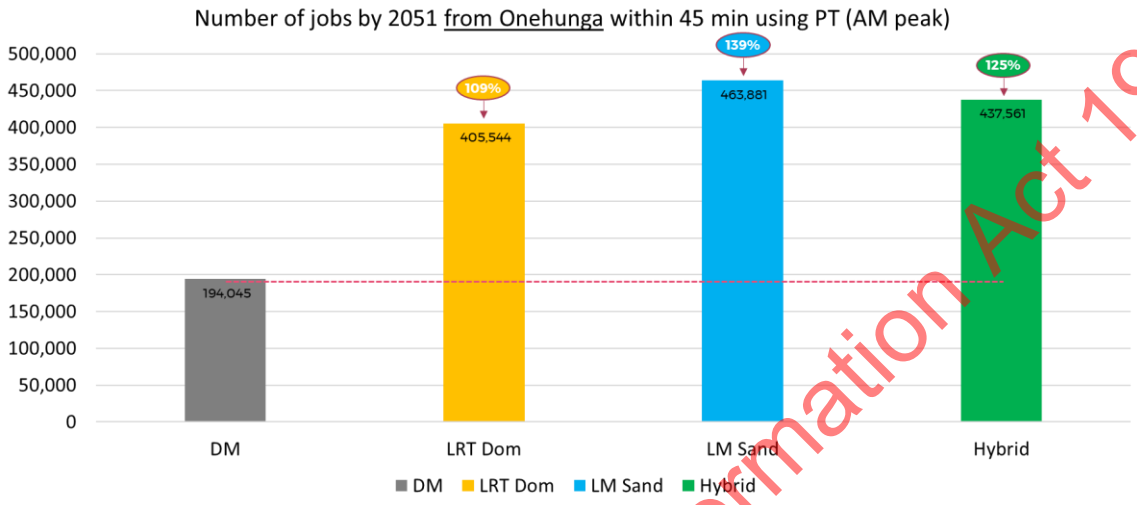


Figure 50: Improvement in job accessibility from Onehunga (zone 347)

- The light metro option increases accessibility by 139% over the do minimum, the hybrid option increases it by 125% and the light rail by 109%.
- The spatial analysis below (Figure 51) shows very similar coverage provided by each option within a 45 minute catchment of the two key employment areas, the central city and the airport employment zone.

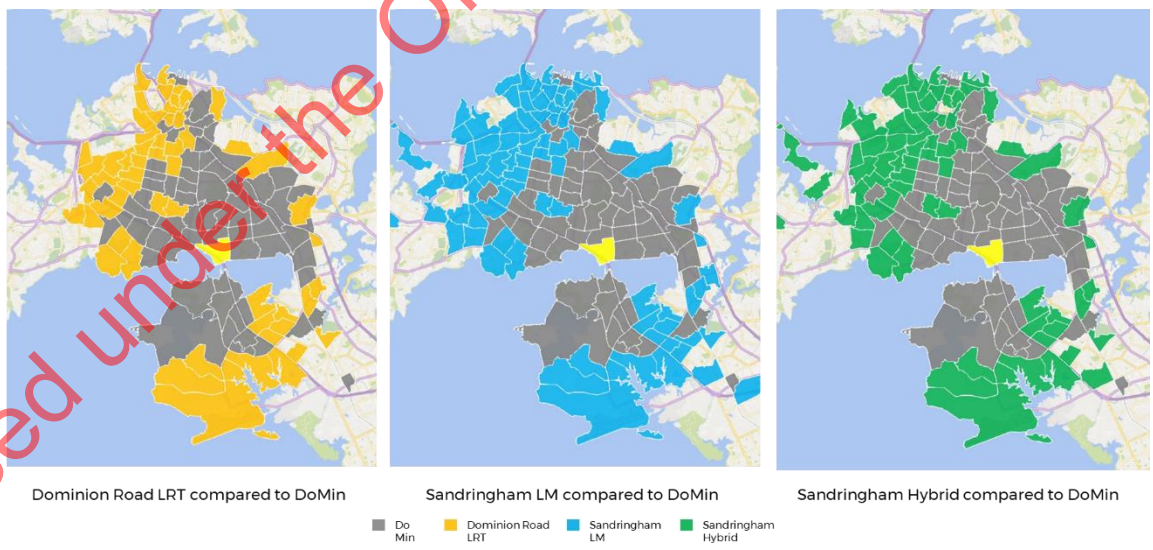


Figure 51: Zones within 45 min PT trip from Onehunga (zone 347) – 2051 AM

- The travel time sensitivity analyses (Figure 52) on accessibility to employment opportunities show the difference between the options are not sensitive to the value of the travel time isochrone.
- Light metro will provide more job opportunities than hybrid and light rail within a range of catchment isochrones.

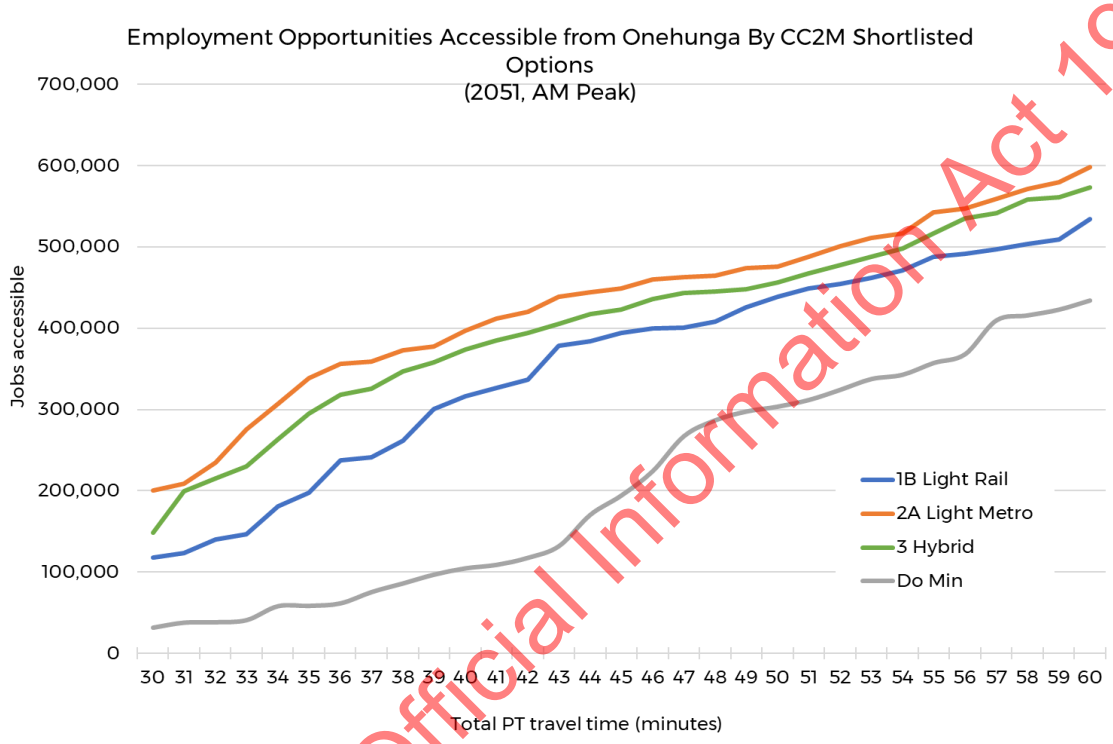


Figure 52: Sensitivity analysis of employment accessibility from Onehunga for various travel time isochrones

- Origin-destination analyses for trips on the CC2M line during the AM peak show Onehunga residents (people boarding the CC2M system at the Onehunga station) predominately use the CC2M to access work and education opportunities in the city centre and the airport. Refer to Figure 53. A more detailed breakdown is provided in Appendix E.
- Education related trips are an important component for Onehunga trips to the central city, with light rail using the Civic stop as the main alighting station. Light metro and the hybrid have a more direct connection to the education precinct through the university station.
- Midtown, Wynyard and the airport are the top three alighting destinations for work related trips.

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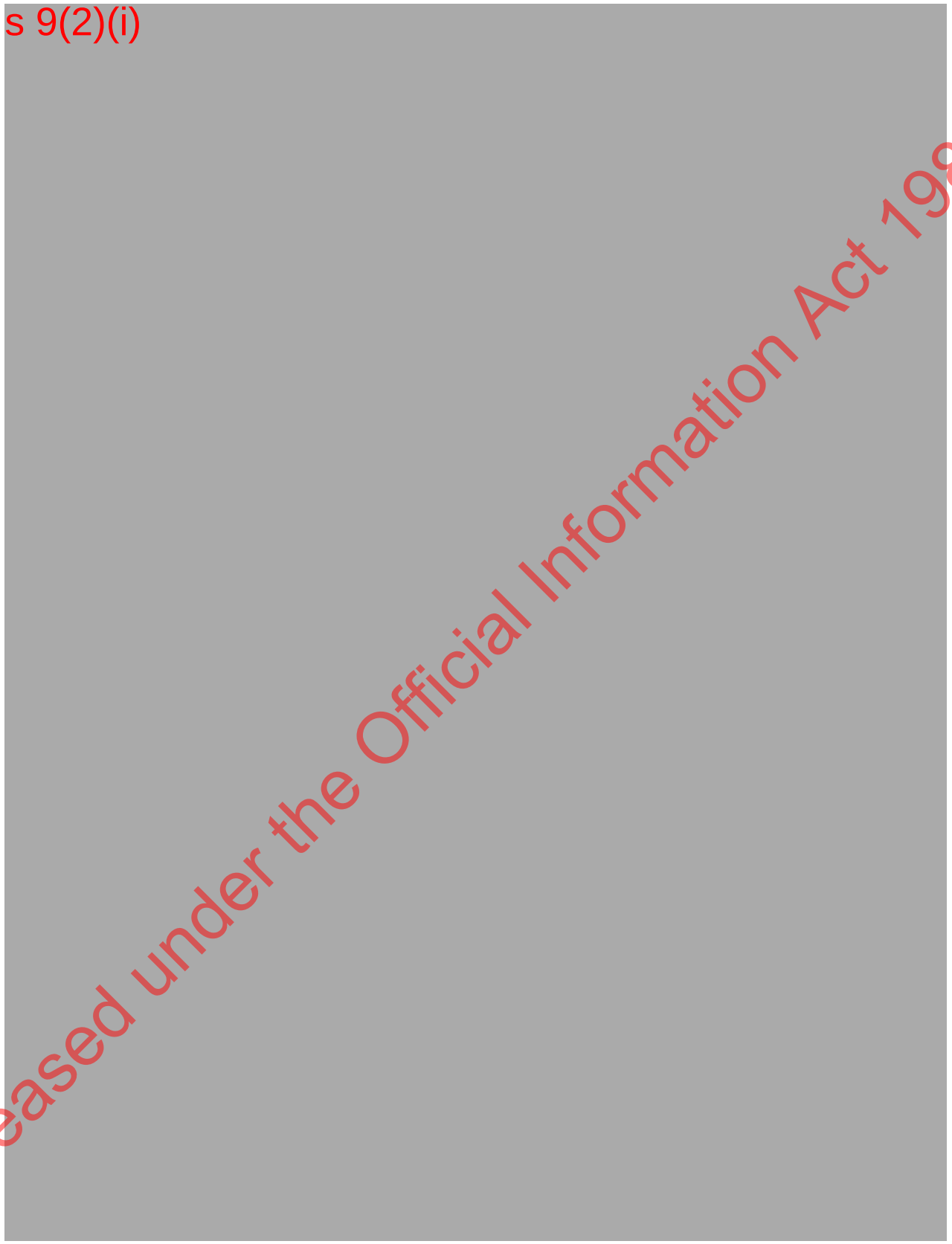


5.2.4.3 **Opportunities accessible to Mt Roskill residents**

- Mt Roskill (represented by zone 327) receive a similar magnitude of improvement in accessibility from the all 3 short list option options, with the lowest uplift (36%) provided by the hybrid option. Light metro provided the highest improvement at 42%. Refer to Figure 54 below.

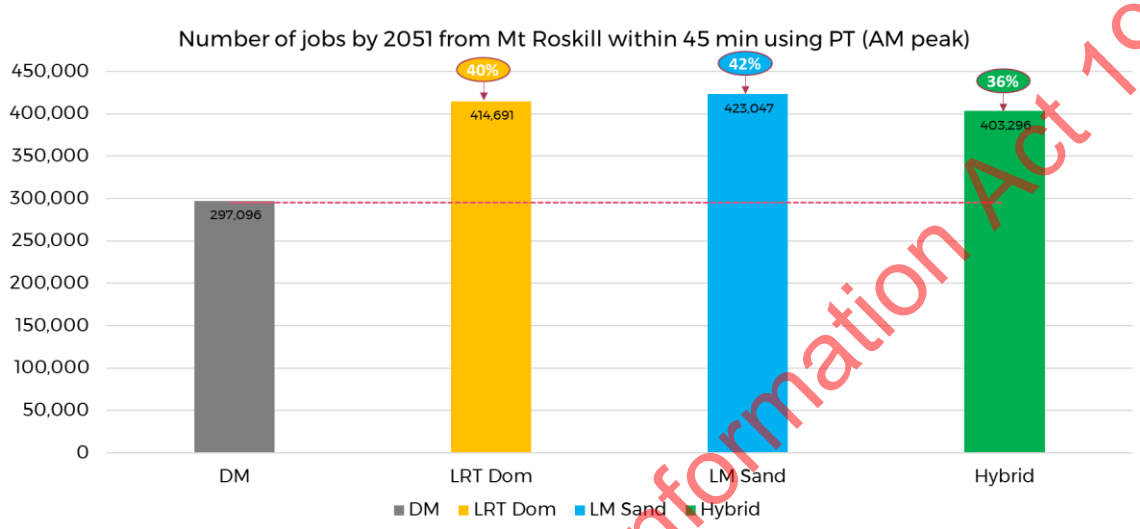


Figure 54: Improvement in job accessibility from Mt Roskill (zone 327)

- The spatial analysis below (Figure 55) shows the do minimum already provide coverage of large parts of the central city within 45-minute isochrone. The options impact accessibility more significantly towards the airport over the do minimum.

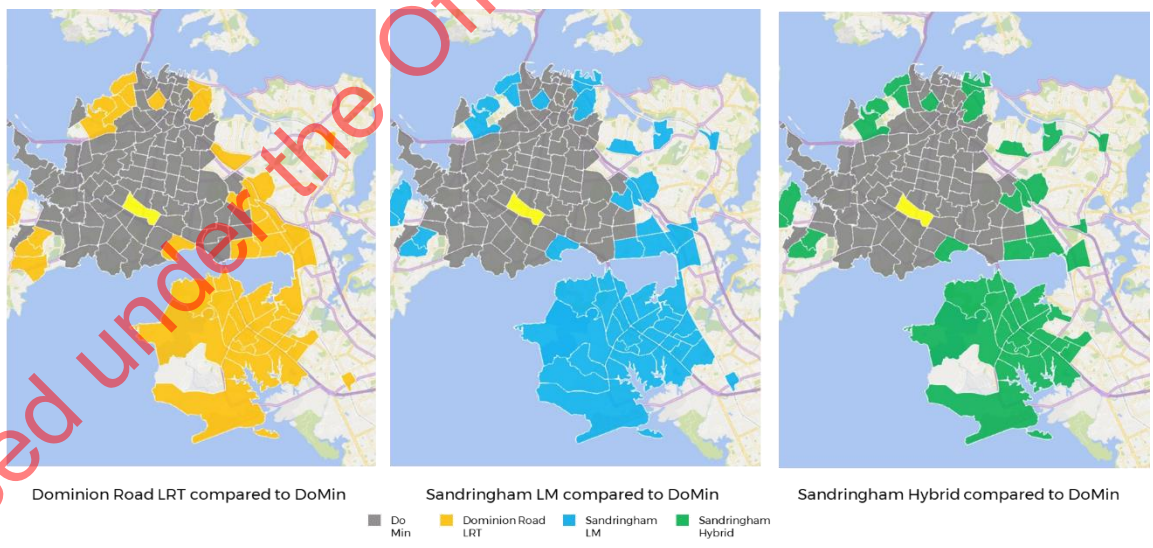


Figure 55: Zones within 45 min PT trip from Mt Roskill development area (zone 327) - 2051 AM

- The travel time sensitivity analyses (Figure 56) on accessibility to employment opportunities show the difference between the options are not sensitive to the value of the travel time isochrone.
- It also shows very little difference in accessibility when comparing the options with each other, with all providing an incremental improvement over the do minimum.

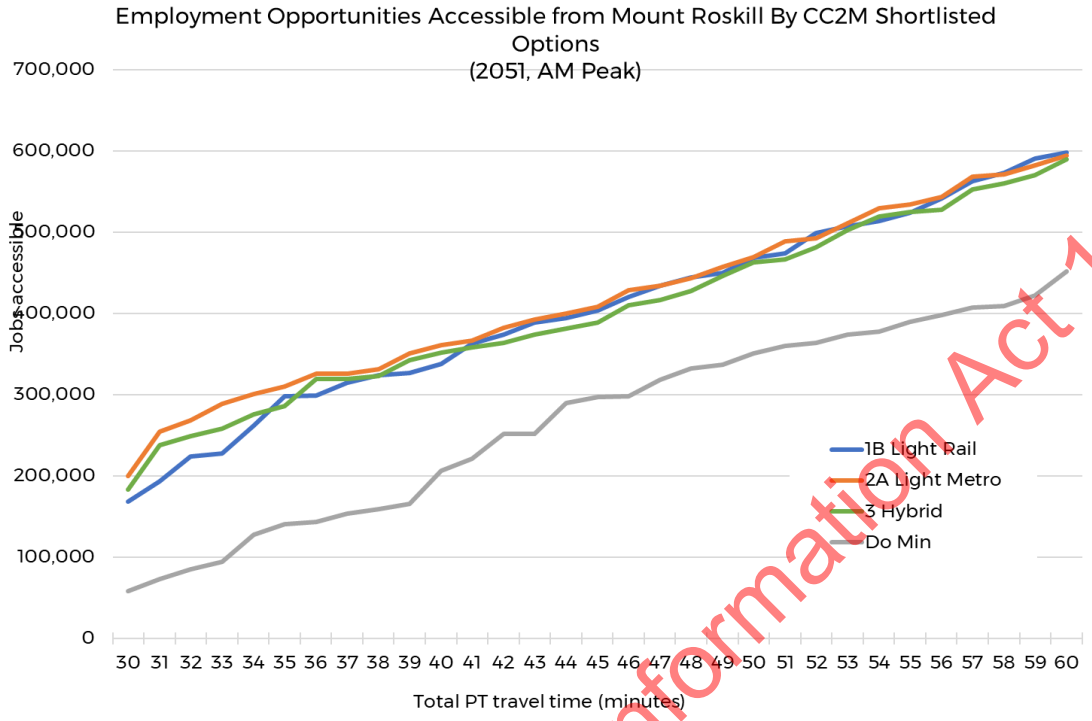
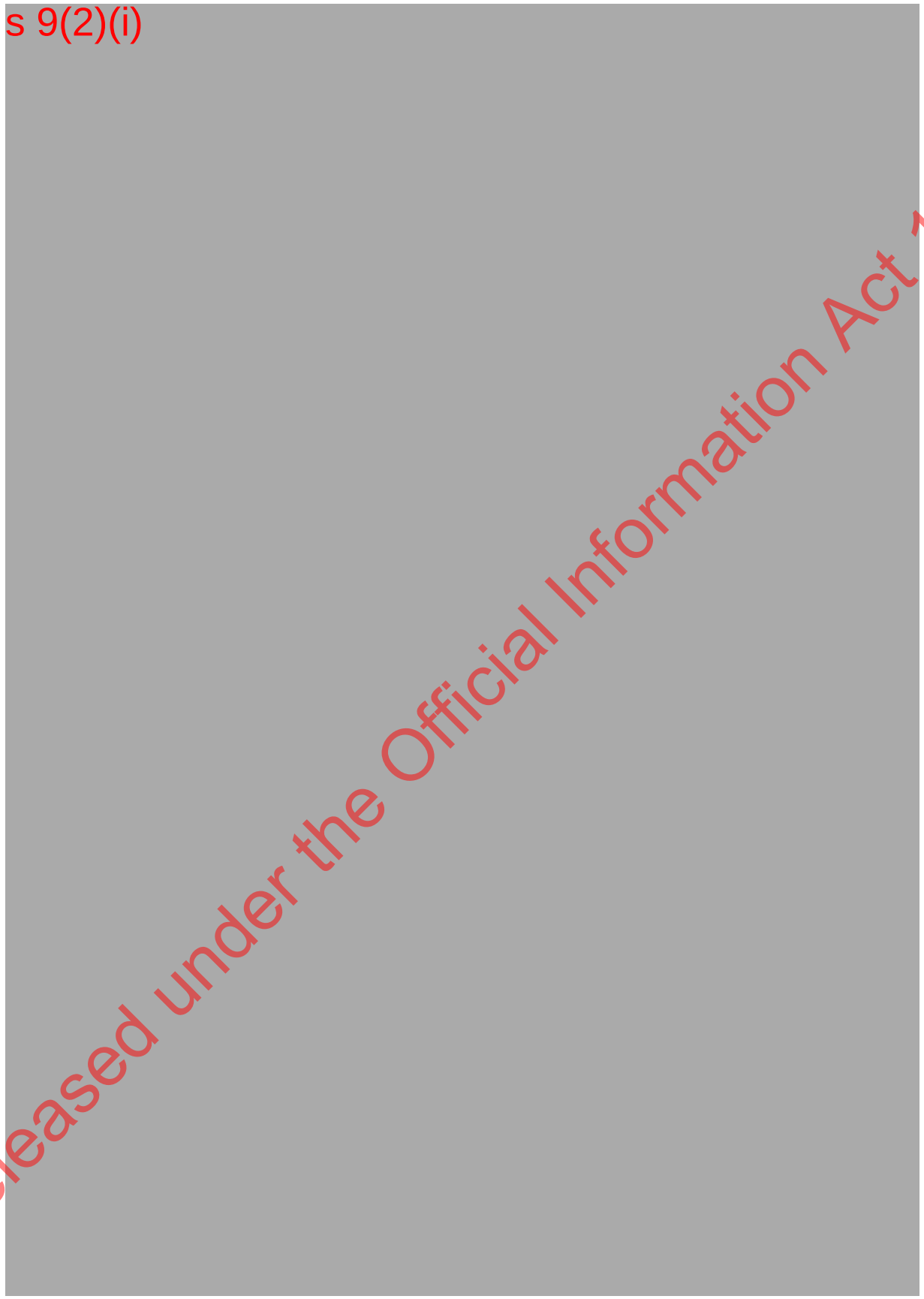


Figure 56: Sensitivity analysis of employment accessibility from Mt Roskill for various travel time isochrones

- Origin-destination analyses for trips on the CC2M line during the AM peak show Mt Roskill residents (people boarding the CC2M system in the Mt Roskill area) predominately use the CC2M to access work and education opportunities in the city centre. The airport is of lesser relative importance for this area compared to Onehunga and Mangere boardings. It is still the largest destination station outside the city centre. Refer to Figure 57. Refer to Appendix E. for more detailed breakdown.
- Education related trips are an important component for Mt Roskill trips to the central city, with light rail used to a lesser extend compared to light metro and the hybrid. Light metro and the hybrid have a more direct connection to the education precinct through the university station.
- Midtown and Wynyard are large alighting destinations for work related trips.



5.2.5 Number of tertiary education opportunities from key areas

The MSM analyses on the number of opportunities (tertiary education) available to residents from key areas of interest within 45 minutes using public transport are shown in Figure 58 below:

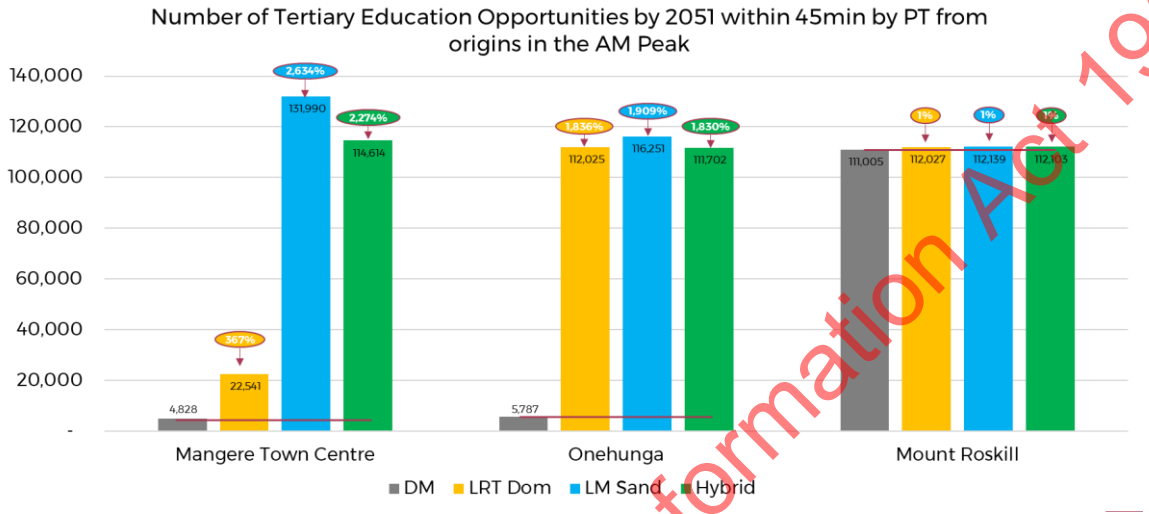


Figure 58: Improvements in tertiary education from all areas

- Mangere residents (represented by zone 472) will receive significantly more benefit under the light metro and hybrid options when compared to light rail. All options provide significant improvement over the do minimum.
- Onehunga residents receive a similar magnitude of benefit from all options, with light metro providing slightly more benefit than the other options. All options provide significant improvement over the do minimum.
- Mt Roskill residents will not receive any significant benefit over the do minimum under all options.

5.2.6 Light rail/light metro demands

The three short listed options are all forecast to increase annual ridership on the entire public transport network by between 5% and 8%. Refer to Figure 59 below.

The light rail option will represent 8% (20.3M) of all boarding on the public transport network by 2051; light metro 14% (35.0M) and the hybrid option 13% (31.2M).

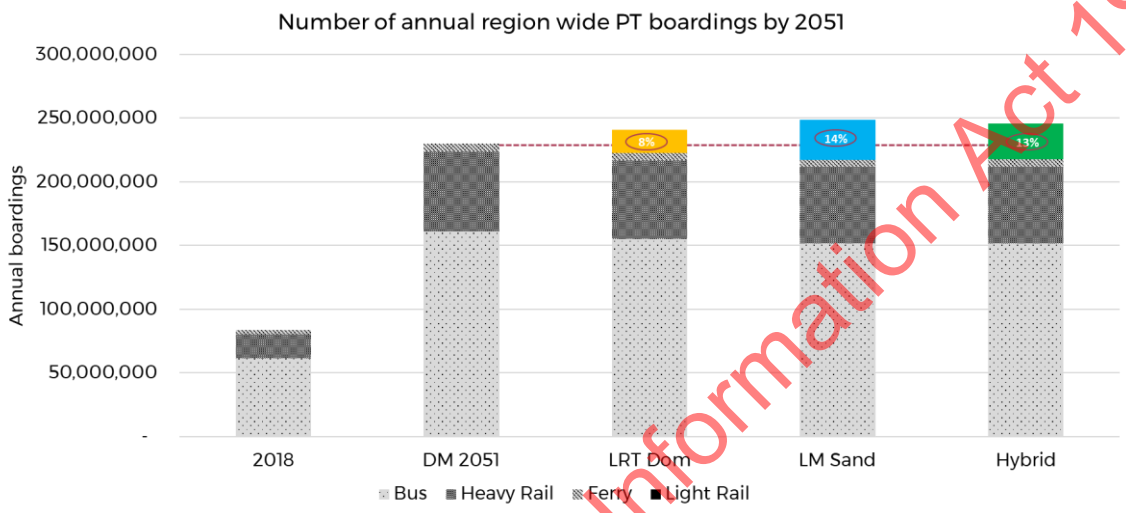


Figure 59: Annual boardings – Region wide PT network by 2051

Light metro and the hybrid option will also represent almost a quarter of all boardings on the rapid transit network included within the MSM for the 2051 model horizon.

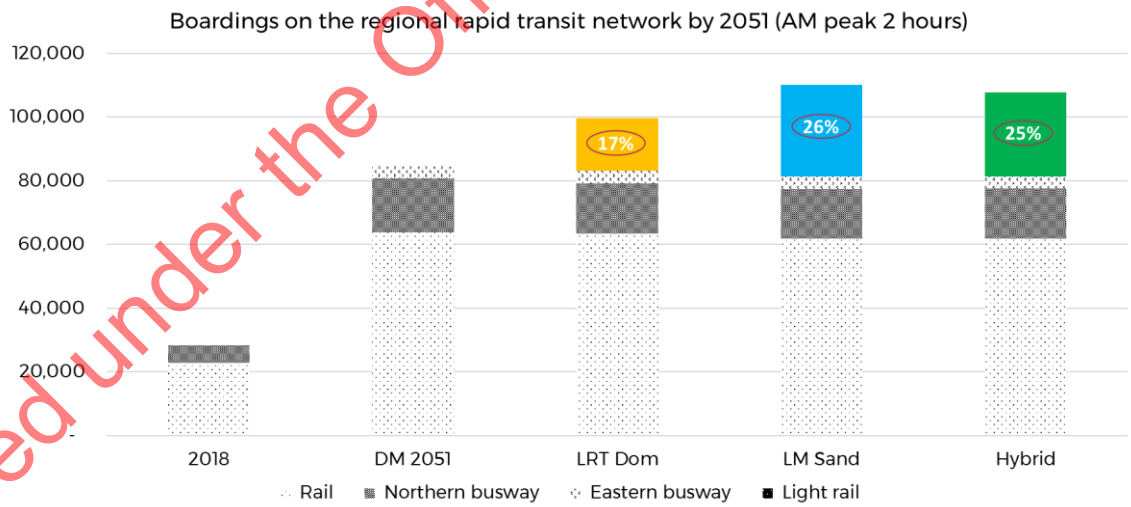


Figure 60: AM peak period (2hr) boardings on the regional rapid transit network - 2051

The regional rapid transit network consists of:

- the heavy rail network, inclusive of CRL and Papakura to Drury electrification,
- the northern busway including its expansion to Albany; and
- the eastern busway between Panmure and Botany.

A summary of the annual, daily and peak period boardings are provided in the table below.

The data shows light metro will generate 72% more demand, based on annual boardings by 2051, when compared to light rail. The hybrid will attract 10% less than the light metro option.

Table 14: CC2M boardings by 2051

Option	2051 Boardings by option		
	AM 2hr peak	Daily	Annual
Opt 1B 2051	16,505	72,605	20,256,851
Opt 2A 2051	28,822	125,252	34,945,169
Opt 3 2051	26,411	111,724	31,170,966

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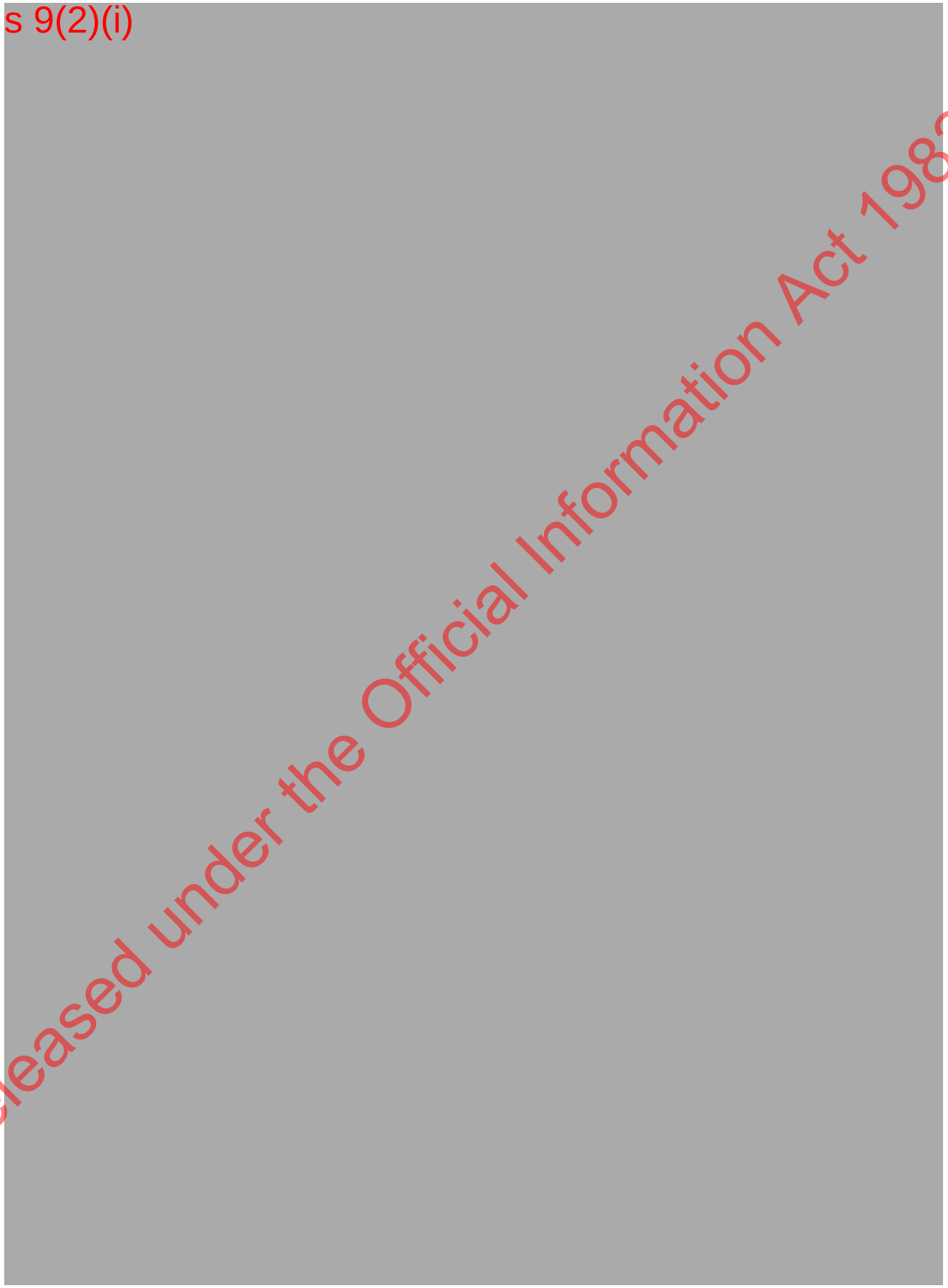

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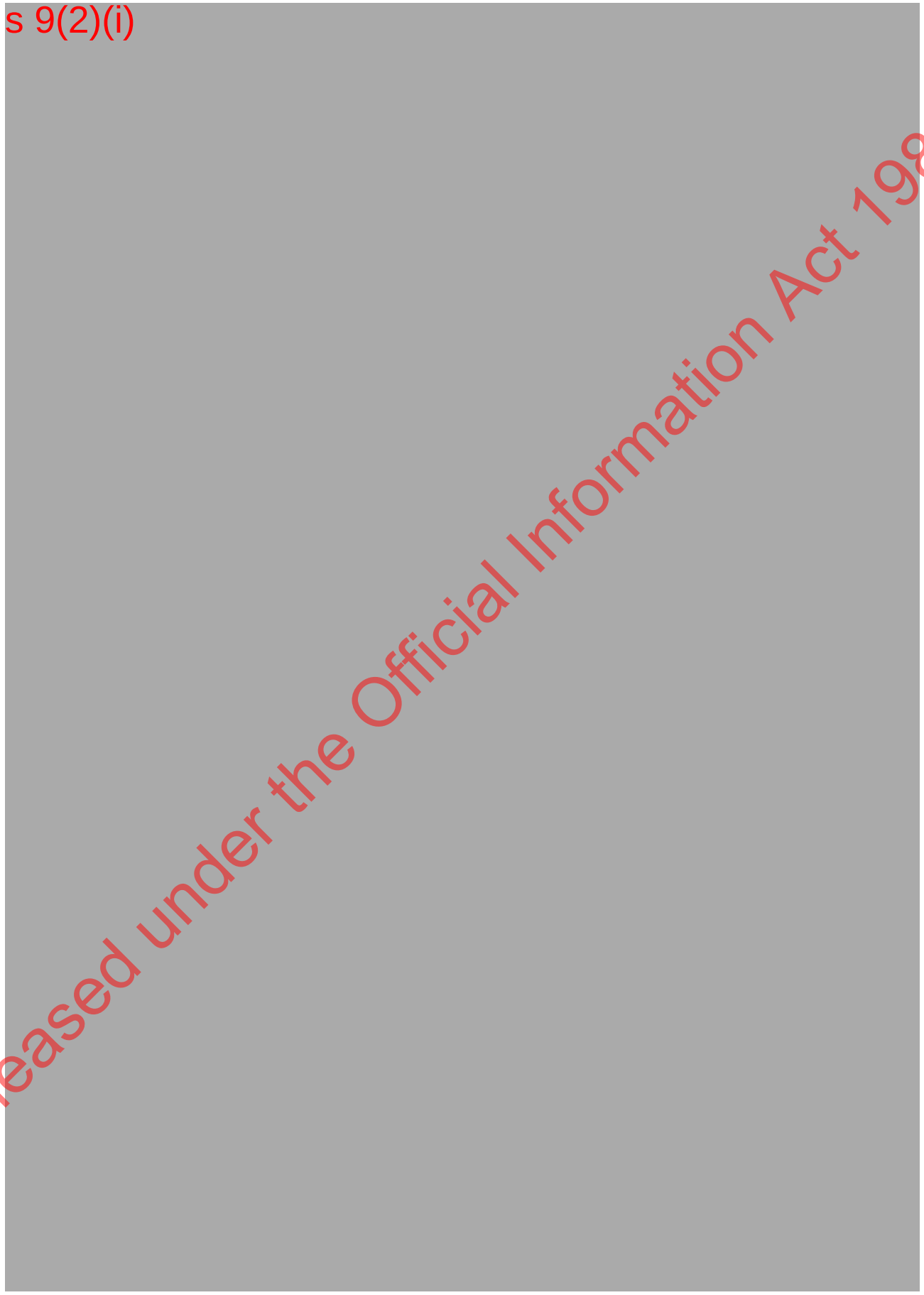

5.2.8Demands along the route

The MSM model was used to generate demand profiles along the corridor for the 2hr morning and evening peak, as well as the 2hr midday interpeak. These two hour peaks were then converted to 1 hr peak flows by suing the peak hour factors listed in Table 2: PT boardings phf.

5.2.8.1 **Option1B: Dominion Road LRT**

- Option 1B's 2051 AM peak period demand profile is shown below in Figure 64: .
- The demand profile shows the option is expected to reach 81% of the modelled capacity at its peak load point (between Dominion Junction and K-Road stops). The ridership at the peak loading point is forecast to be 5,100 over the busiest 1hr period.
- Inbound patronage is forecast to exceed the total seated capacity from the Miller Road stop up to the Britomart stop. The maximum standing time on this system is approximately 36 minutes (for passengers boarding at Miller Road and travelling all the way to the Britomart stop).
- Most of the passengers get off at the Civic stop.

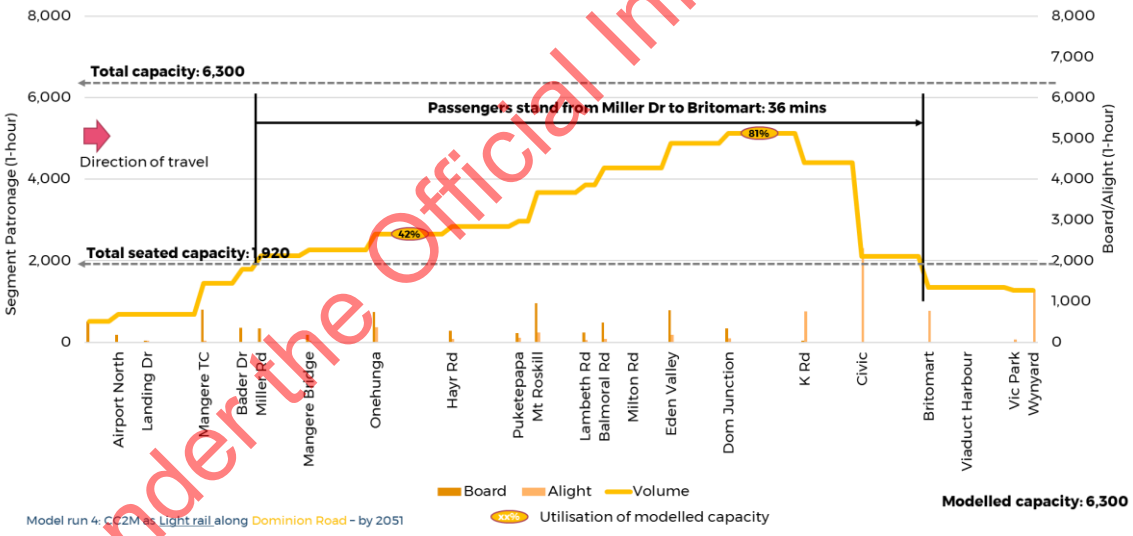

Figure 64: CC2M ridership (AM1hr): LRT Dominion Road (phf 0.61)

- Option 1B's 2051 IP peak period demand profile is shown below in Figure 65: .
- The demand profile shows the option is expected to reach 52% of the modelled capacity at its peak load point (between Dominion Junction and K-Road stops). The ridership at the peak loading point is forecast to be 1,600 over the busiest hour in the inter-peak.
- Inbound patronage is forecast to exceed the total seated capacity from the Bader Drive stop up to the Civic stop. The maximum standing time on this system is approximately 32 minutes (for passengers boarding at Bader Drive and travelling all the way to the Civic stop).
- Most of the passengers get off at the Civic stop.

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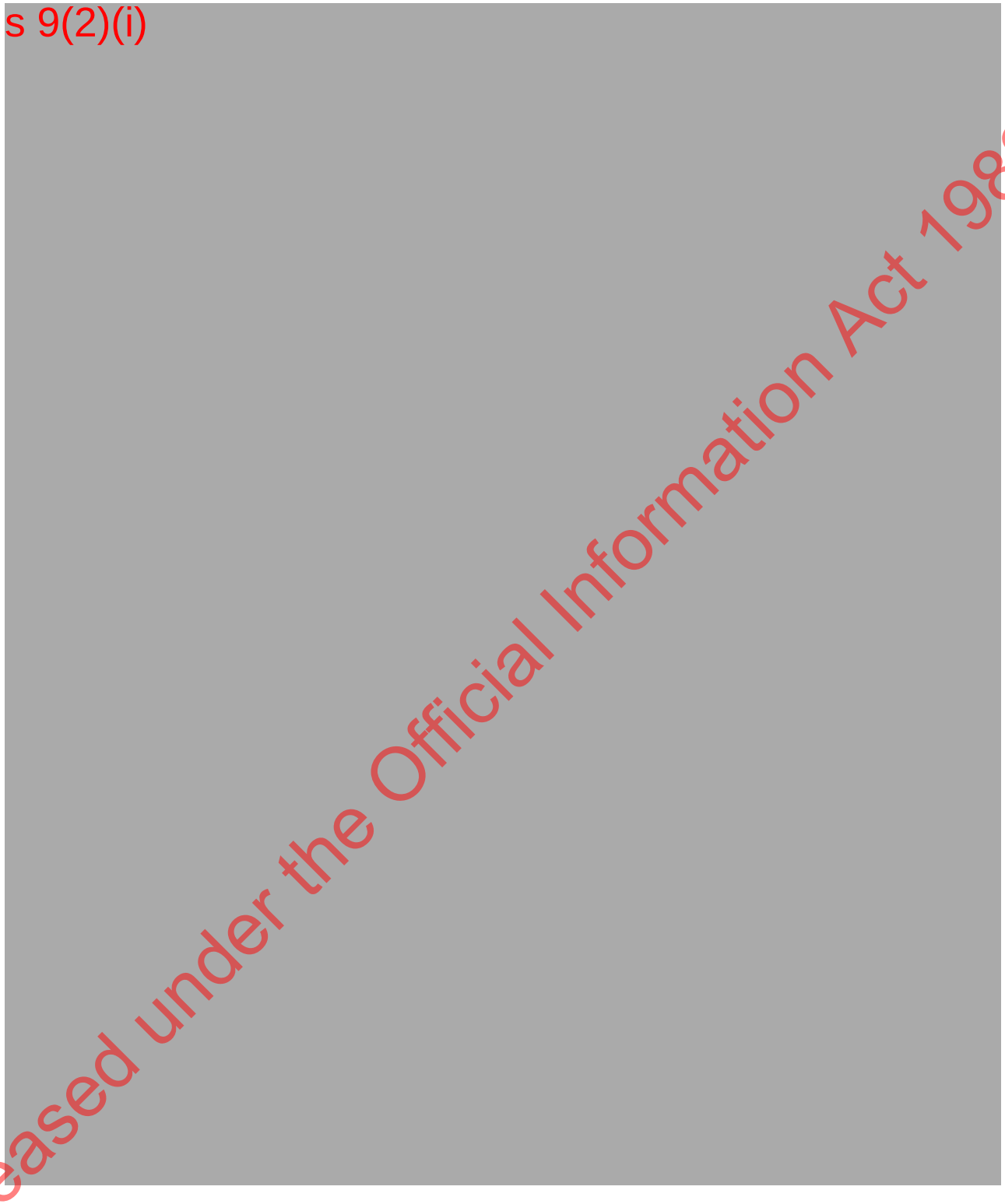

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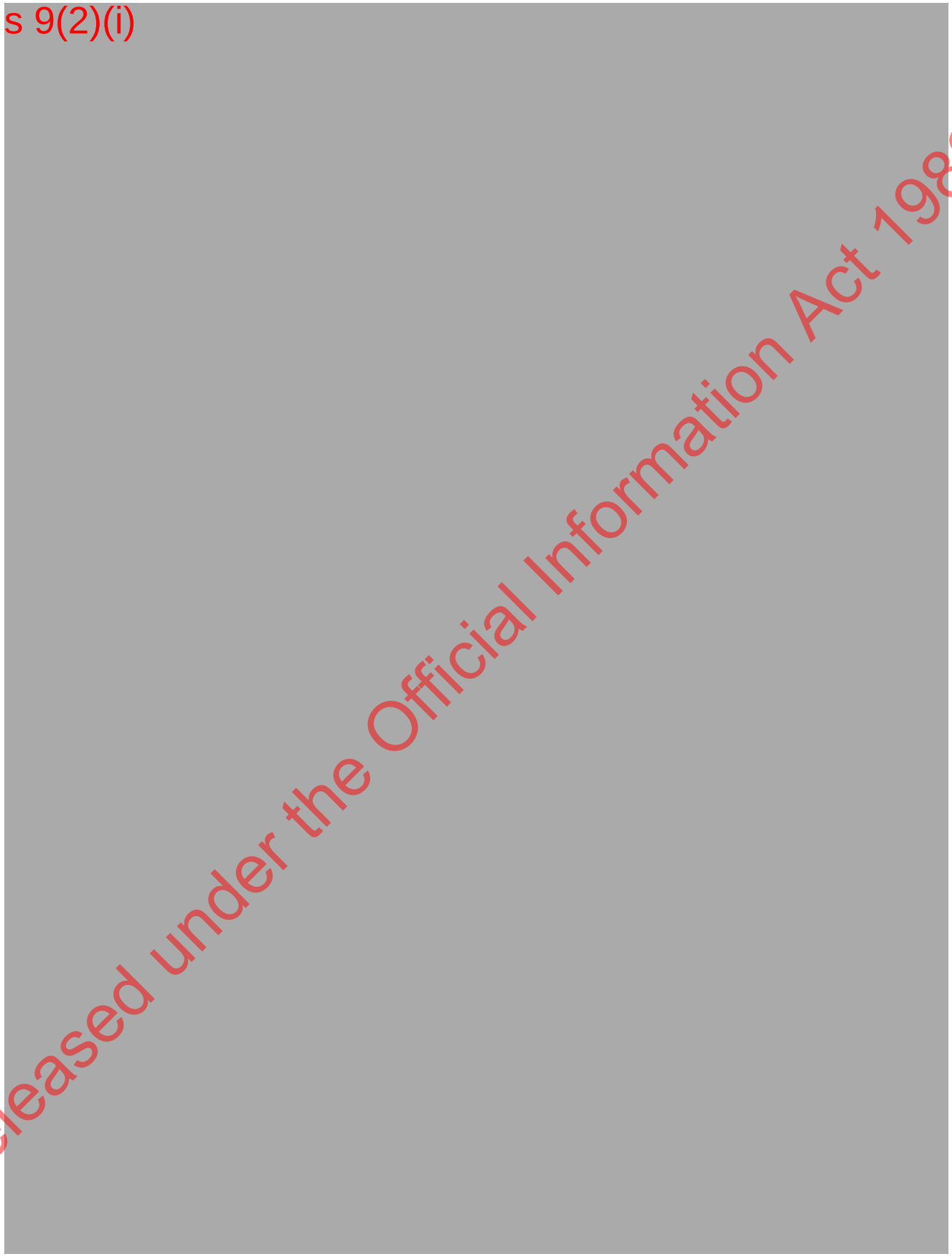

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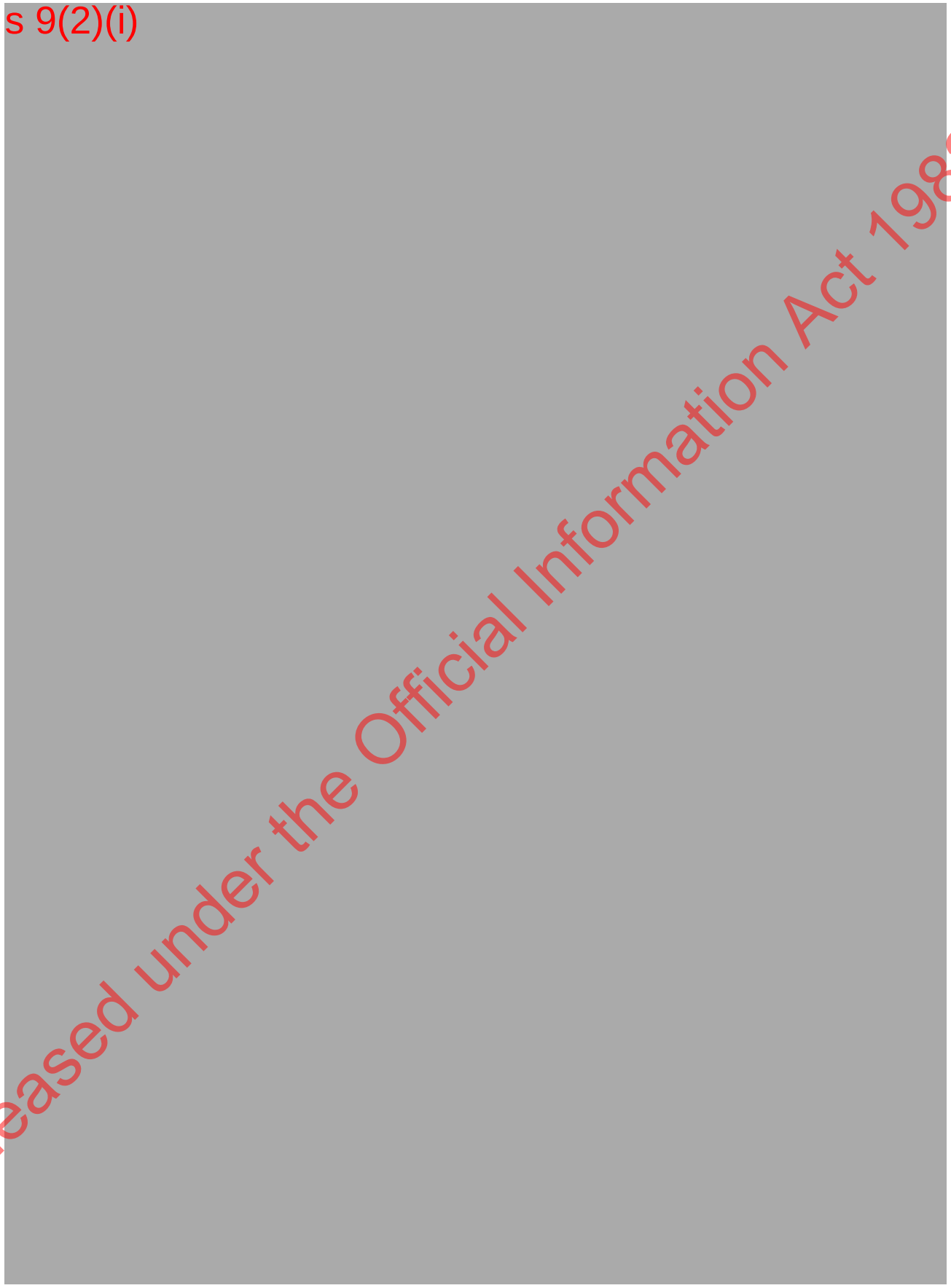

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5.2.8.4 **Overview of short list demand**

A visual representation of the 2-hour morning peak demand flows from the MSM model - including the wider public transport network - is illustrated in Figure 73 below for on each of the short listed options:

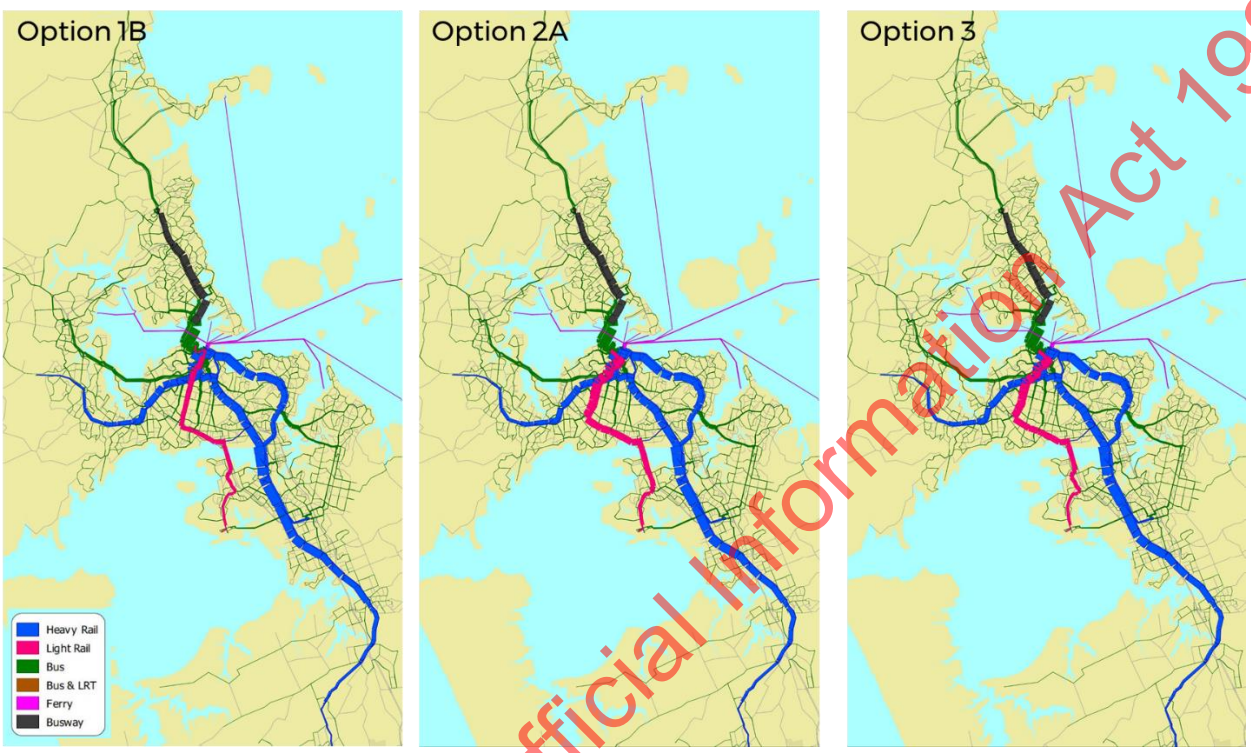

Figure 73: Visual representation of the 2hr AM peak demand along the CC2M corridor

A comparison of the 2051 1hr morning peak demand is illustrated for the three short listed option in Figure 74 below.

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Figure 74: CC2M ridership (2051 AM 1hr):3 shortlisted options

5.3 Refinement of Option 3

The demand modelling shows Option 3 would reach its modelling capacity (within the peak 1 hour) by 2051, limiting its ability to accommodate growth (at the key load point) beyond this date.

The hybrid option envisages a tunnel through the city centre and isthmus, allowing for more capacity to be allocated through this section compared to the modelled capacity.

A further model test was therefore performed to test the impact on demand by introducing a short run service at a 4 min headway (15 trains per hr) between Hayr Road and the city centre. The headways for services from the city centre to the airport were increased to 4 minutes, effectively lowering the level of service for Mangere residents. (from 3 mins to 4 mins). This test still assumes the same vehicle configuration (66m LRVs), with the same seating and standing capacity per vehicle.

This operating plan results in 30 trains per hour (2 min headways) through the isthmus and increases the capacity at the peak load point (from 8,400 to 12,600 per hour per direction).

The refined Option 3 test assumes the same land use growth and distribution used for Option 3.

The key changes to CC2M demands when comparing Option 3 with its refinement are shown in Table 15 below. It shows capacity will have the following impacts:

- Access to employment: The Mangere and Mt Roskill areas will experience a slight decrease (-0.5%) in accessibility (Mangere decreasing from 346 thousand to 344 thousand).
- PT Boarding's: The regional total PT boardings experience a marginal increase of 0.4%.
- CC2M Boarding: Boardings on the hybrid system increase by 4.9% in AM and 2.2% annually from 31.2 million to 31.9 million.
- The largest increase in demand is forecast at the Peak Load Point (between Dominion Junction and University stops). This section of the route experienced capacity pressure under option 3. The additional capacity increases demand by

16.2% from 8,200 to 9,500 persons per hour per direction. This demand is now higher than light metro along the comparative section.

Table 15: Impact of additional capacity on Option 3 demands

Key Indicators by 2051	Results based on higher intensification scenario by 2051		Percentage change as a result of additional capacity	
	Option 3	Option 3 (refined)		Option 3 (refined)
Accessibility				
Number of jobs within 45 mins by PT from Mangere Town centre	346,183	344,317		-0.5%
Number of jobs within 45 mins by PT from Mt Roskill centre	403,296	401,431		-0.5%
Number of households within 45 min by PT from city centre	399,246	400,133		+0.2%
Number of households within 45 min by PT from airport	116,737	113,954		-2.4%
CC2M Boardings				
AM peak (2hr)	26,411	27,706		+4.9%
Daily	111,724	114,174		+2.2%
Annual	31,170,996	31,854,462		+2.2%
Regional PT Boardings (annual)				
Total PT network	245,711,233	246,606,277		+0.4%
Total bus network	151,519,602	151,695,945		+0.1%
Total heavy rail network	60,369,499	60,498,231		+0.2%
CC2M capacity and demands				
Modelled Maximum Capacity of CC2M (pax/hour/direction)	8,400	12,600		+50%
CC2M Demand at Peak Load Point (pax/hour/direction)	8,193	9,521		+16.2%

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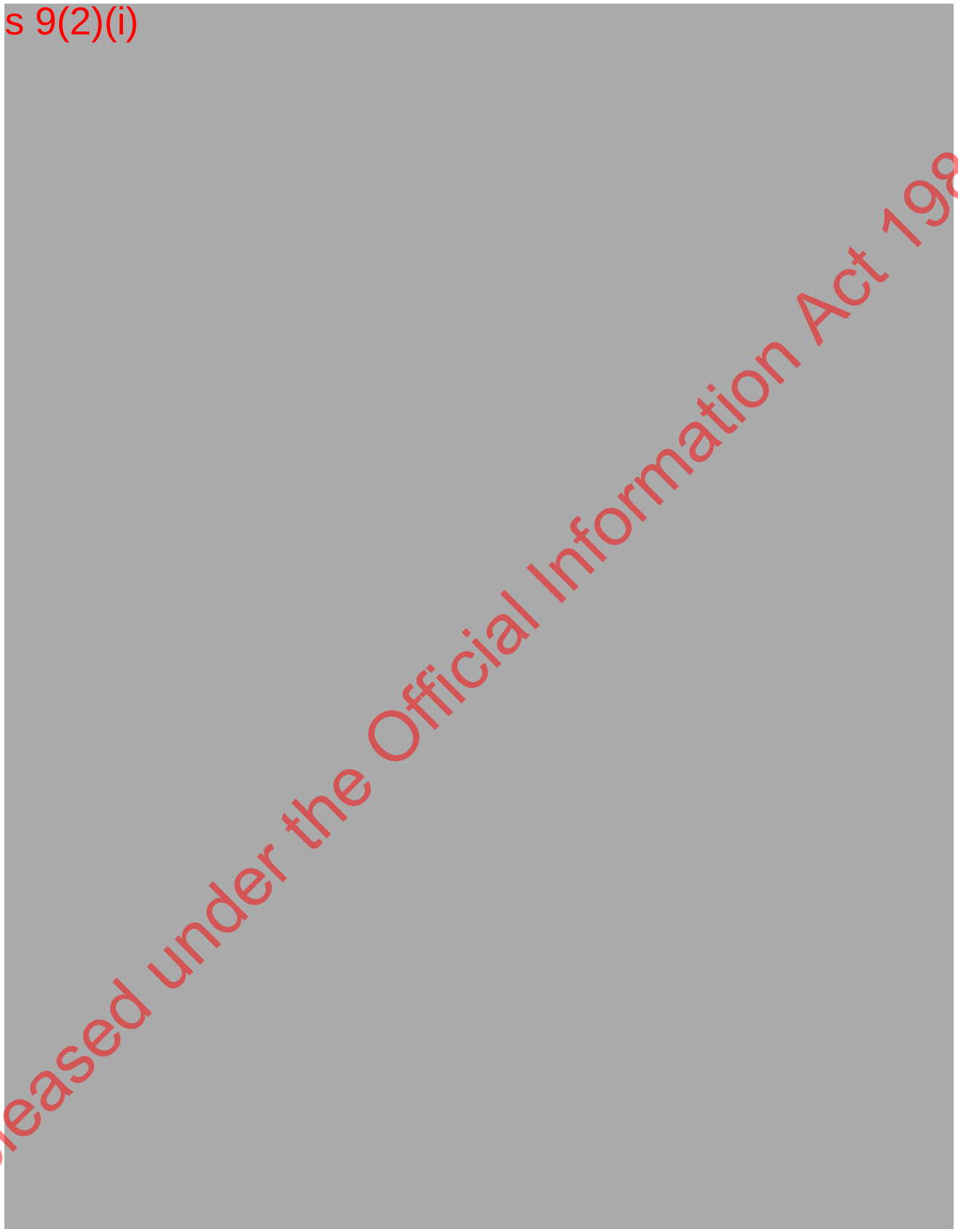

Extending demand profile:

- Extrapolating demand generated by the higher intensification land use scenario illustrates the refined hybrid option could extend option 3's capacity headroom by approximately a decade (from 2050 to between 2060 and 2065). (Compare higher intensification profiles of Figure 78 below with Figure 72).

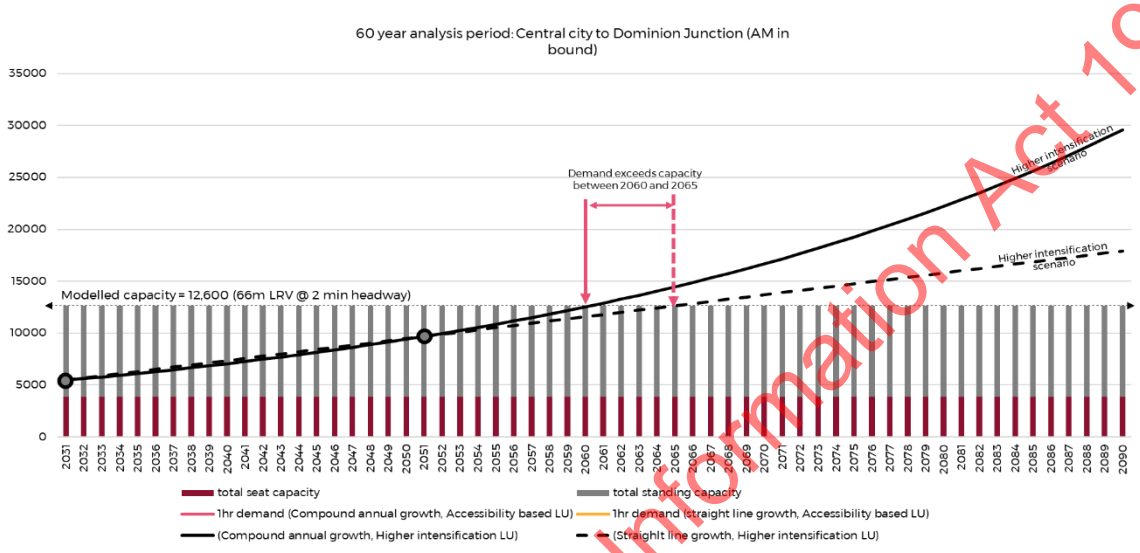

Figure 78: Refined Hybrid– inbound AM peak 1hr demand vs capacity

5.4 Customer level of service

Analyses[3] of the station to station matrix within MSM (for the 2051 AM 2hr peak) shows:

- 4% of the light metro passengers travel longer than 30 mins
- 7% of the hybrid passengers travel longer than 30 mins
- 23% of light rail passengers travel longer than 30 mins

The seat capacity, journey time and trips patterns result in the following passenger level of service, as it relates to standing time (refer to Table 16: Level of service by option):

Table 16: Level of service by option

Passenger LoS (2051 AM inbound)	Option 1B (LRT)	Option 2A (Light metro)	Option 3 (Refined Hybrid)
Portion of passengers that stand 20 minutes or more	26%	8%	7%
Portion of passengers that will have a seat	29%	21%	23%

For annotated matrices refer to Appendix E.

[3] Note the station to station matrix excludes rail to rail transfers.

6. Conclusion

6.1 Summary

The final short-listed options (light rail, light metro, and hybrid) all deliver enhanced outcomes against the agreed measures for the CC2M project when compared to both the current conditions (represented by 2018 data) and the do minimums for 2031 and 2051.

The light rail was modelled with a land use that stimulates growth that results in approximately 46,000 additional residents along the corridor by 2051 when compared to the do minimum land use. The light metro and hybrid options were modelled with a growth patterns that result in an additional 81,000 residents along the corridor (when compared to the do minimum).

Light metro services are significantly faster than light rail, and travel time comparison shows that when light metro from the airport arrives at the Wynyard Station,

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Fast travel times are especially important to Mangere Residents for whom the City Centre is an important destination for work, education and other purposes, and the Wynyard station is the 4th highest destination station.

All options enable faster public transport travel times from Mangere and Onehunga to the city centre when compared to the most viable alternative (car travel). Car travel remains slightly more competitive to the central city from Mt Roskill.

The option alignments, speed and headways result in expanded labour pool with 45 minutes access to the central city. The initial short list analyses showed Wynyard and the city universities to be key destinations for trips from the CC2M corridor. The geographical analyses of the change in 45-minute catchment to these zones show clear differences for the light metro and hybrid over the light rail option, with the latter having limited reach into Mangere.

The three options deliver very similar accessibility outcomes for the isthmus residents, with no significant differences between the options. The accessibility differences for the options become more pronounced for areas within the corridor located further away from the central city. For Mangere (represented by zone 472) all three options improve the number of jobs residents can access within 45 mins over the do minimum. Light metro does however provide significant more opportunities than both the hybrid and light rail. Sensitivity tests were done with shorter and longer travel isochrones, ranging from 30 mins to 1 hr. The tests show the light rail option will always delivers lowest accessibility of the three short listed options, with the hybrid achieving parity with light metro for travel times between 55 mins and 1 hr.

The demand modelling shows light metro will generate 72% more demand, based on annual boardings by 2051, when compared to light rail. The hybrid will attract 10% less than the light metro option.

The demand profile shows the light rail option is expected to reach 81% of the modelled capacity at its peak load point (between Dominion Junction and K-Road stops) by 2051. The ridership at the peak loading point is forecast to be 5,100 over the busiest 1hr period. Extrapolating demand (based on growth rates between 2031 and 2051) signals that the

higher land use scenario could generate peak hour demand on the light rail system that exceeds the modelled capacity between 2060 and 2070.

Light metro demands are forecast to reach 82% of its modelled capacity by 2051. The ridership on the peak loading point is forecast to be 9,500 over the busiest 1hr period. This is 86% higher than the light rail option along Dominion Road. The option generates (extrapolated) demand that exceed its modelled capacity between 2060 and 2080.

The hybrid option generates demands that reach its modelled capacity by 2051. The ridership on the peak loading point is forecast to be 8,300 over the busiest 1hr period. This is 12% lower than the light metro option on Sandringham Road, but still 63% higher than light rail along Dominion Road.

A further modelling test was done on the hybrid option that introduces an overlay service through the isthmus. The service plan for this option increases that capacity of the hybrid system through the high demand section of the corridor (the isthmus) with a minor decrease in capacity through Mangere.

The demand profile for this refinement of the hybrid option is expected to reach 76% of its modelled capacity at the peak load point. The ridership at the peak loading point is forecast to be 9,500 over the busiest hour. The refined option delivers an 16% higher ridership at the peak loading point to bring it to similar peak load demand when compared to the light metro option. It is also 86% higher than light rail along Dominion Road.

Further sensitivity tests were done to test the impact on road pricing and the public transport network expansion on the demand for the respective CC2M option. The purpose of these tests was to confirm adequate capacity in the system to accommodate future changes.

It shows road pricing will have a minimal impact on the CC2M demand, increasing demand on the options between 1% and 2%. Road pricing combined with an expanded CC2M network to the north shore and north west will increase demands on the options by between 5% and 9%. Appendix F summarises these tests and their results.

The results from the demand modelling were also benchmarked against global examples of major public transport infrastructure in similar cities to compare patronage characteristics with CC2M patronage forecasts. Refer to Appendix H for more detail. The report suggests the forecasts for CC2M are likely in the right range.

7. Glossary of Terms

7.1 Table 2: Terms and Description

Term	Description
AFC	Auckland Forecasting Centre
AM Peak	Morning peak period (7-9)
CC2M	City Centre to Mangere
Corridor	The CC2M zones that define the corridor from the city centre to the airport
CRL	City Rail Link
KPI	Key Performance Measure
K Road	Karangahape Road
LM	Light Metro
LRT	Light Rail Transit
MSM	Macro Strategic Model
NEX	Northern Express Bus Service
Opt	Option
Pax /pas	passengers
phf	Peak Hour Factor
PM Peak	Afternoon peak period (4 to 6)
pphpd	Passengers per hour per direction
PT	Public Transport
tph	Trains per Hour
veh	vehicle