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Technical Note

To	**Auckland Transport**	From	[redacted]
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Subject	**Airport to Botany Heavy Rail Option Summary (September 2020 modelling update)**		

1 Introduction

This technical note outlines how the heavy rail options have been considered for the Airport to Botany (A2B) Single Stage Business Case (SSBC).

1.1 Scope of this document

At the time of writing this Technical Note, the A2B SSBC project has completed its assessment of a long list of options. This note details the process followed and outcomes of the long list assessment of the heavy rail spur option *as part of the A2B SSBC*. It communicates why no heavy rail options progressed to the more comprehensive short list assessment stage for this corridor. It is important to note that as part of the A2B SSBC, the heavy rail option was considered with regard to its effectiveness in delivering on the specific objectives for the Airport to Botany connection. It is also important to note that the City Centre to Mangere Light Rail proposal is assumed to be implemented in A2B's planning as per the 2018 ATAP programme.

1.2 Airport to Botany MRT project problem definition

The purpose of the Airport to Botany MRT project and the options assessment is defined in response to the following problem definitions:

i) Costly, unreliable, long & complicated trips severely limit people's ability to meet daily needs for work, learning & socialising, reinforcing ongoing deprivation
ii) Poor east-west travel choices in southern area constrain current & future growth, undermining prosperity for Aucklanders
iii) Current transport system does not recognise cultural identity and taonga diminishing the Mauri of the area
iv) Perceptions of poor personal safety limit uptake of public transport & active modes

In summary, the problem definition identifies the need to improve transport access, choice and effectiveness across South Auckland, with a focus on east-west travel and identifies deficiencies in user engagement and experience with the current transport system. Of note, the A2B corridor is long and covers a large portion of the southern Auckland area. Analysis of evidence to support these problems illustrated that deficiencies and opportunities for improvement in the transport system included access to the airport and its employment zones, but also wider connectivity issues in Manukau, Ormiston, Otara and Botany as well as links to growth areas to the south.

2 Overview of the Airport to Botany corridor

2.1 Background

The A2B SSBC has its origins in a range of strategies and studies, however of particular importance are the Auckland Transport Alignment Project (ATAP) and the Airport Access Programme Business Case.

Completed in 2017, the Airport Access Programme Business Case (PBC) recommends a suite of initiatives across all modes of transport for implementation by NZTA, Auckland Transport and Auckland International Airport Ltd. The PBC was endorsed by the NZTA and AT Boards in 2017. The approach was one of optimisation of the current network and driving behaviour change, underpinned by an acknowledgement that the airport cannot grow to its potential without a major shift to public transport.

The PBC confirmed that in order to provide the required travel capacity to the airport and to enable the behaviour change, two rapid transit lines should be connected to the airport, supported by a suite of improvements such as:

- Additional bus services, including an express route to New Lynn Interchange
- Park and ride facilities
- Remote meet and greet provision
- Bus priority measures and route optimisation

The rapid transit lines included AT and NZTA's preferred light rail proposal from the City Centre via Dominion Road and SH20A and an additional link connecting Puhinui Station, Manukau and Botany from the east. This latter link would provide catchments from Manukau, Flat Bush and Botany with a single seat journey to the airport and catchments on the southern and eastern rail lines (including the large greenfield growth areas proposed south of Papakura) a fast, reliable journey with a single, high quality transfer at a specifically designed Puhinui Station.

ATAP 1.1 conceives the A2B corridor as a crosstown rapid transit link, serving core trips within the wider southeast of Auckland directly, and functioning as an integral element of the regional public transit system by allowing connections to local buses at a range of interchange stations along the route, including at Botany, Manukau and the Airport itself. It also supports this through connections to other major radial rapid transit corridors in the southeast, specifically the Southern and Eastern rail lines at Puhinui, the Eastern Busway at Botany, and the City Centre to Māngere LRT line at the Airport.

2.2 Scope of the Airport to Botany MRT assessment

The A2B SSBC project assessed an initial long list of public transport options that contained various modes, alignments and service options; including standard bus, bus rapid transit, advanced bus, cable-liner, people mover, gondola, light rail, light metro, heavy rail, and heavy metro. Included in this was a range of heavy rail options.

2.3 Forecast demand levels

2.3.1 Projected passenger transit demand on the Airport to Botany corridor

Overall, Auckland Transport Alignment Project modelling, including the A2B MRT corridor, plus the City to Airport LRT corridor and other programmed projects updated in 2019 (MSM i11 v5), indicates around 3,400 passengers per direction on the Puhinui to Airport section across the two-hour morning peak in 2048. This translates into a peak direction demand of approximately 2,000 people per hour between Puhinui and the Airport (refer Figure 1).

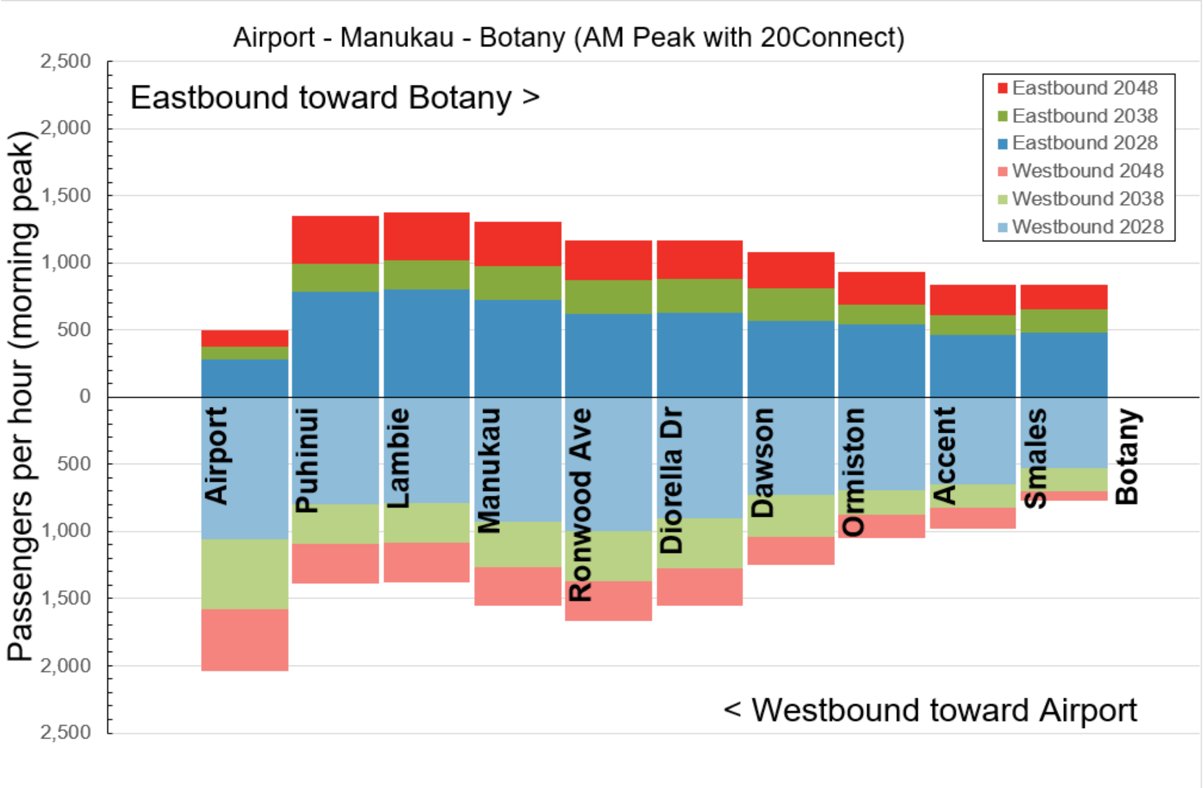

Figure 1: A2B directional pax forecasts, AM peak hour (ATAP 2 MSM i11)

As this figure shows, the A2B corridor is a long route that connects a number of key origins and destinations with a relatively even spread of demand along the length of the route, and similar demands in both directions at peak times.

Taking the airport access routes alone, Table 1 compares the sources of predicted demand for public transport access to the airport in 2048 (MSM, i11-5 land use, ATAP 2 update [August 2019] base network, A2B scenario 48168). These estimates are rounded to three significant figures.

Table 1: Modelled public transport patronage to Auckland Airport precinct by service type, 2048 AM Peak (ATAP 12 i11)

Corridor	2-hour am peak, peak direction	1-hour peak, peak direction (@ 60% of 2-hour)
Rapid transit via Mangere (SH20A)	3,300	2,000
Rapid transit via Puhinui (SH20B)	3,400	2,000
Local buses from adjacent suburbs	500	300
Total	**7,200**	**4,300**

These data show that a total of 4,300 passengers per hour are predicted to arrive at the airport by public transport during weekday morning peaks in 2048. This is comprised of 2,000 passengers using the rapid transit corridor via Māngere and the north (i.e. the proposed City Centre to Māngere light rail line), and 2,000 passengers per hour using the rapid transit corridor via Puhinui and the east (i.e. the proposed Airport to Botany lines), with direct bus services from the adjacent suburbs of Māngere, Favona and Māngere East supplying the remaining 300 passengers per hour.

2.4 Peak load point and capacity requirements

While Table 1 shows that the projected demand *for public transport trips to the airport* is very similar across both the proposed rapid transit corridors serving the airport, it is important to note that the peak demands across the other destinations served by each line are considerably different.

On the Airport to Botany corridor via Puhinui, the access to the airport is also the peak load point, the busiest point on the line that determines the maximum capacity required. However, on the Airport to City corridor via Mangere, the peak load point is located approaching the Auckland City Centre, not the airport. As Table 2 shows, the peak load and required peak capacity of the corridor via Mangere is 5,400 passengers per hour in 2048, approximately two and half times higher than that of the A2B corridor via Puhinui. This indicates that the capacity, mode and service plan for the city corridor needs to be significantly different from the Airport to Botany corridor.

Table 2: Comparison of public transport patronage at the peak load point, 2048 AM peak (ATAP 2 i11-5)

Corridor	Peak load point and direction	2-hour am peak, peak direction	1-hour peak, peak direction (@ 60% of 2-hour)
Rapid transit via Mangere (SH20A)	City Centre, inbound (Ian McKinnon Drive approaching Karangahape Road)	9,000	5,400
Rapid transit via Puhinui (SH20B)	Airport, approaching airport precinct (Puhinui Road/SH20B at Tom Pearce Drive)	3,400	2,000

3 Option assessment to date

At the time of writing this Technical Note, the A2B project has completed assessment of a long list. To get to this stage, a pre-long list sieve was carried out to ensure that a wide range of options was considered and a robust long lost assessed.

3.1 Pre-long list sieve

In this sieve, five heavy rail options were considered across four heavy rail alignments including one option re-used the corridor from a previous option, with different operational choices.

3.1.1 Sieving process

Prior to the finalisation of the long list, a 'sieving framework' was utilised to eliminate some options with clear deficiencies before the long list option assessment. During the sieving process, options were scored against four evaluation criteria. Options that scored the highest were retained for the long list, and lower scoring options were discarded. The evaluation criteria used were:

- Potential to provide the benefits established during Investment Logic Mapping;
- Potential to provide the required capacity (i.e. not insufficient or markedly superfluous capacity);

- Major environmental risks; and
- Costs, impacts and feasibility of delivery.

Professional judgement was used to progress or discard options that presented extraordinarily strong benefits or fundamental flaws not captured adequately by the scoring.

Table 3: Heavy rail options that were eliminated in the sieving process

Code	Name	Description	Reasons for exclusion
I3	Heavy Rail loop via Onehunga	Heavy rail Onehunga line extended: Onehunga to Puhinui via Airport (as per SMART full loop).	Very high cost. Duplication of transport infrastructure with heavy rail parallel to the City to Māngere LRT alignment south of Onehunga, including across the Māngere Inlet. Forced transfer at Puhinui for passengers from east of Puhinui. Likely to be inconsistent with planned City Rail Link network operating plan: limited capacity or impacts on other lines.
I4	Heavy Rail loop via Ōtāhuhu	Heavy rail Eastern line extension: Ōtāhuhu to Puhinui via Airport (SMART full loop but from Ōtāhuhu via Māngere East).	Very high cost. High environmental and social impacts of a new heavy rail line along southern shore of Māngere Inlet and through established residential and commercial areas. Forced transfer at Puhinui for passengers from east of Puhinui. Likely to be inconsistent with planned City Rail Link network operating plan: limited capacity or impacts on other lines.
I6	Heavy Rail Airport Shuttle Line	Heavy Rail, spur line: Puhinui to Airport (via new Wiri junction) with rail shuttle service Puhinui to Airport.	Relatively high cost of operating a rail shuttle service over a short distance. Forced transfer at Puhinui for all users. Excessive capacity (10,000+ pax/hour[1]) on rail shuttle section.
I7	Airport to Botany Heavy Rail Crosstown	Heavy rail, new dedicated alignment: Botany to Manukau (Te Irirangi Dr grade separation + tunnel Clover Park to Manukau Station) and Puhinui to Airport. Manukau branch becomes part of the new crosstown heavy rail alignment, Eastern Line runs to Papakura.	High cost, particularly for grade separated sections. High environmental and social impacts of a new heavy rail line through established residential and commercial areas. Excessive capacity (10,000+ pax/hour[2]).

[1] Capacity calculation assumes 4 minutes (desirable) headway for double EMU (6-car set)
[2] Capacity calculation assumes 4 minutes (desirable) headway for double EMU (6-car set)

3.2 The long list assessment

3.2.1 Selected heavy rail alignment

Although several heavy rail alignments were identified, all but one was removed at the sieving stage, refer to Initial Options and Sieving process technical note (502334-6000-TEC-KK-0011). The heavy rail option that was considered to be the most appropriate was option I5 (renumbered to A6 for the Long List MCA); a spur line from Puhinui to the Airport with services operating between Britomart and the Airport via Puhinui and the Southern line. This preferred option is shown in Figure 2 It was considered appropriate for progressing to the MCA for the following reasons:

- Direct connection to the Southern line,
- Aligned with project objectives,
- Lowest cost of the heavy rail options, and
- Most likely heavy rail option to be feasible (in terms of engineering and construction).

The alignment of this option is the best-performing heavy rail option from the SMART SAR. The A2B SSBC used the engineering design and constructability information from the SMART SAR to inform its assessment.

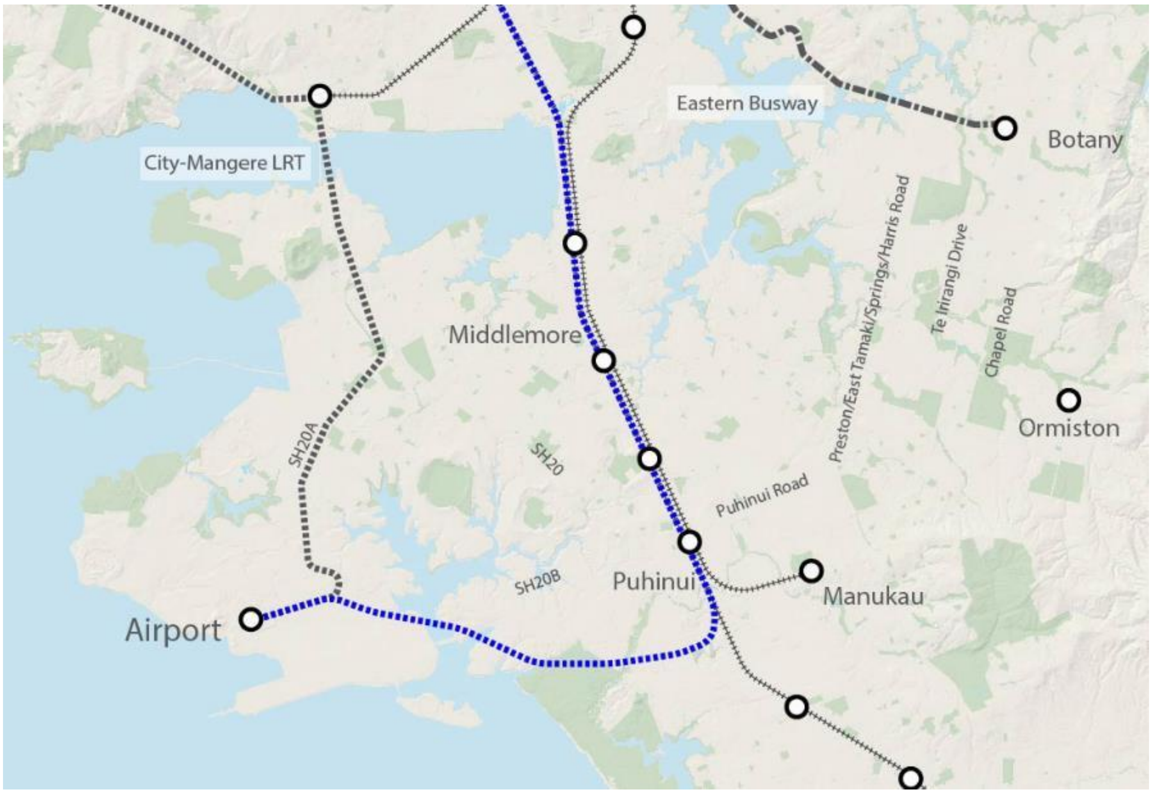

Figure 2: Heavy rail option A6

The assumed physical characteristics alignment, shown in Figure 3 assessed consists of three distinct section and involves the following:

- A 300m cut and cover box containing the airport station
- A 3.4km tunnelled section from airport station to Puhinui Road
- A 1.1km drive structure transitioning from the tunnel to the at-grade section
- A 1.4km at-grade section from Puhinui Road to McLaughlins Road
- A 2.33km elevated section from McLaughlins Road NIMT

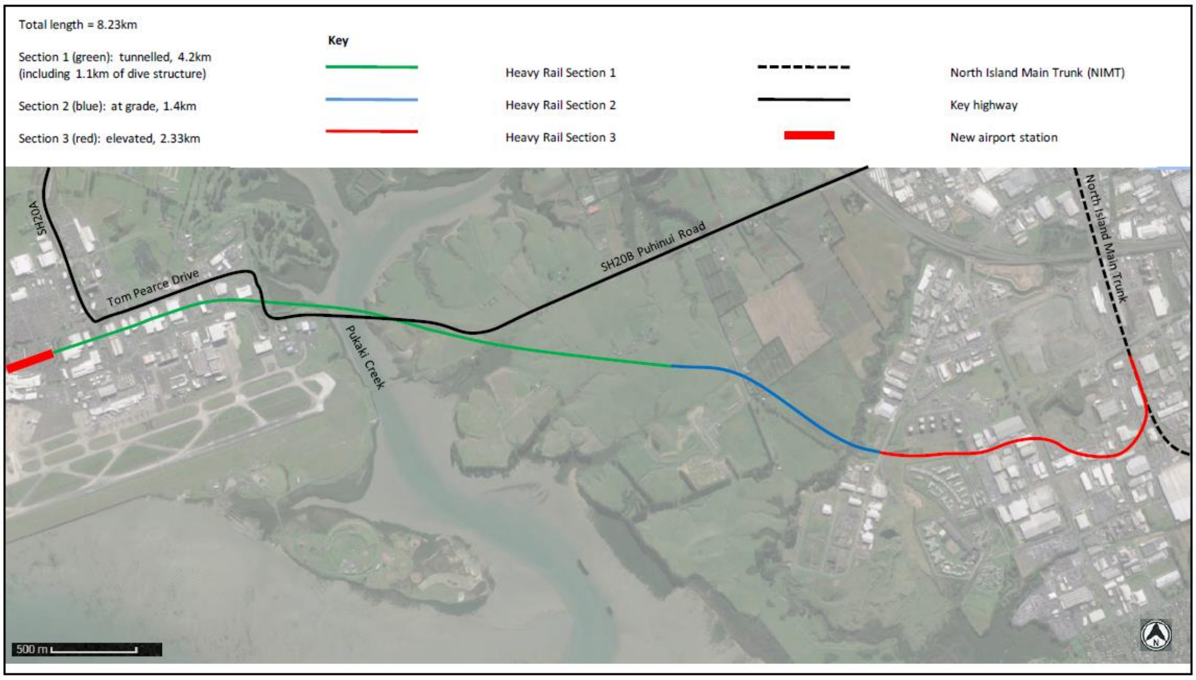

Figure 3: Summary of heavy rail alignment (SMART SAR)

3.2.2 Inclusion of heavy rail into A2B options

The A2B corridor was broken into segments for the assessment so that various modes and corridors could be tested in varying combinations. This was done by selecting a 'base' alignment for each segment, and testing variations to one segment at a time. Figure 4 shows all of the components for the A2B SSBC and the options that were considered for each segment. Note that the heavy rail option discussed as I5 above was renumbered to A6 for the MCA. For the section of the corridor between Puhinui and the Airport (annotated section 'A'), three options were considered. This included a northern LRT or BRT option using SH20 and SH20A (A2), a LRT or BRT option using SH20B (A1) and the abovementioned heavy rail option (A6).

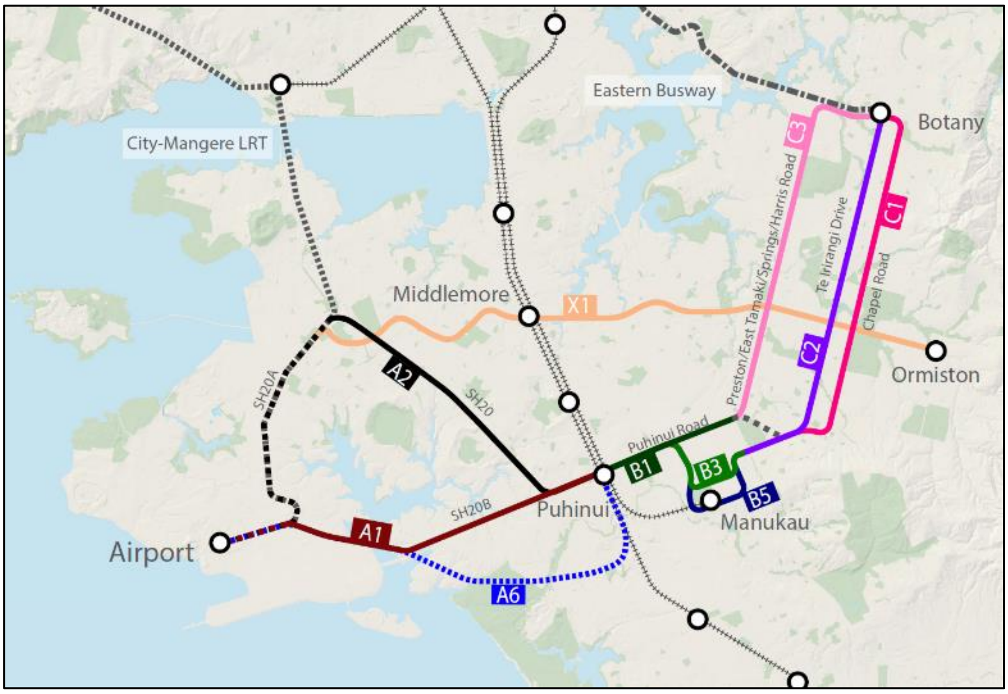

Figure 4: A2B long list options for MCA

The heavy rail option considered in the long list only provided connects the rail network at Puhinui Station with the airport. To enable assessment as part of an Airport – Botany RTN, the heavy rail assessment was paired with a rapid transit (either BRT or LRT) connection from Puhinui to Botany for the MCA, a is shown in Figure 5. This implies a transfer opportunity at Puhinui Station from the proposed heavy rail line to a BRT/LRT service travelling to Botany Town Centre via Manukau Station and allows the heavy rail option to be considered as part of a complete airport to Botany link.

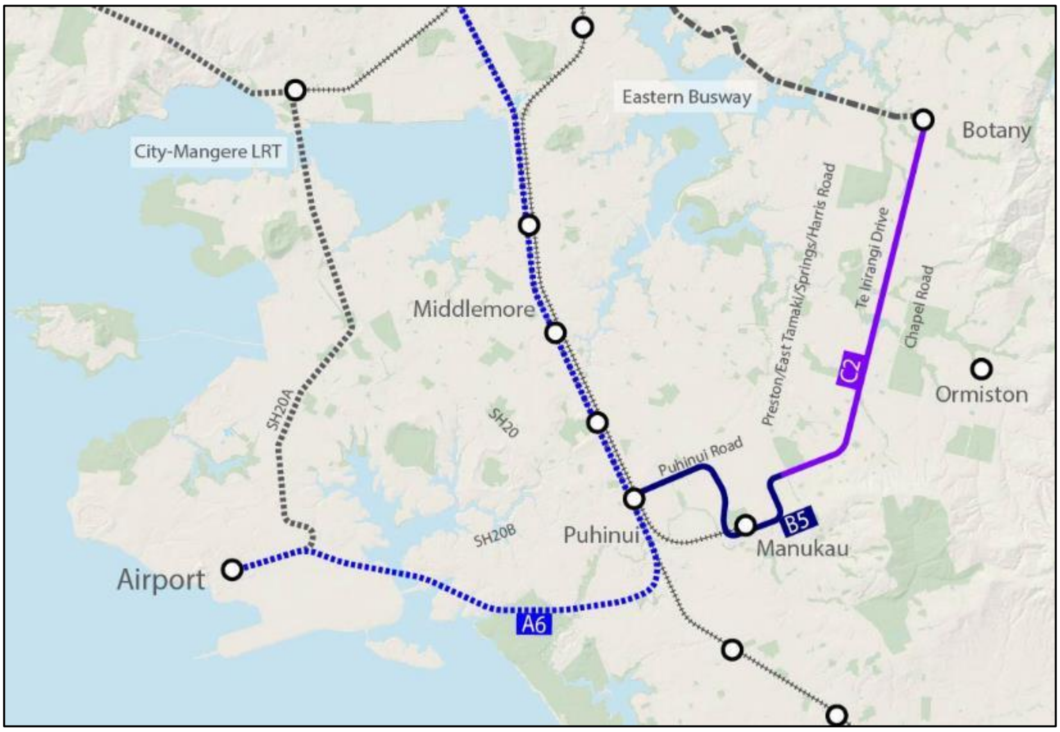

Figure 5: Heavy rail with Puhinui to Botany BRT/LRT for the MCA

3.3 Long list assessment

3.3.1 Forecast demands, service levels and mode requirements

Public transport service levels are a critical factor in total travel times and the quality of the service offering, and therefore a critical factor in attracting and retaining users as waiting time a key consideration in overall travel time for people. Higher frequencies mean lower overall journey times, other things being equal.

The regional public transport plan sets a minimum service level of four vehicles per hour per direction (4 vphpd, 15-minute headways) for the rapid transit network. Furthermore, it acknowledges this minimum standard is considered a basic level of 'frequent' service and indicates 6 vphpd (10 minute headways) is preferred for all rapid transit routes to minimise wait times, facilitate transfers, and minimise overall journey times.

The frequency of service, multiplied by the capacity per vehicle, equates to the total passenger capacity of the service. Table 4 shows the peak passenger demand per hour predicted for 2048; the capacity per vehicle for bus, light rail and heavy rail and the frequency and headway required to meet the demand with full utilisation.

This table indicates that, at the moderate passenger demand levels predicted for the Puhinui to Airport section of the A2B corridor, heavy rail represents a significant oversupply of capacity, even at minimum service levels in the third decade.

This indicates that even the smallest unit of heavy rail (a 3-car single unit AM class EMU) operating at minimum service levels would only just approach full utilisation at peak times, at the peak load point in 2048. Furthermore, operating the line with standard 6-car EMU trainsets (as currently used on all Auckland's main lines at peak times) would result in only one train every twenty to thirty minutes at full occupancy at peak times in 2048. Correspondingly if a ten-minute headway was operated using standard 6-car trains, they would remain less than 1/3rd full at the busiest point on the line at peak times.

Conversely, these data indicate that BRT style buses would deliver much better utilisation, with the 2048 peak demand being met with one vehicle every four to five minutes, and correspondingly much better service levels, operating efficiency and lower costs per passenger. Accordingly, bus-based mass rapid transit was identified as the most appropriate balance between capacity, demand, and operational performance.

Table 4: A2B capacity and utilisation by mode at peak, 2048

Mode	Capacity per vehicle (pax)	Peak demand per hour, Puhinui to Airport (pax)	Vehicles per hour at peak, full utilisation	Headway at peak, full utilisation
Standard bus	70	2,000	28 to 29 vph	Every 2 to 3 minutes
High capacity BRT bus	150	2,000	13 to 14 vph	Every 4 to 5 minutes
Light rail (33m unit)	225	2,000	8 to 9 vph	Every 6 to 7 minutes
Light Rail (66m unit)	450	2,000	4 to 5 vph	Every 12 to 15 minutes
Heavy Rail (3-car EMU)	375	2,000	5 to 6 vph	Every 10 to 12 minutes
Heavy Rail (6-car EMU)	750	2,000	2 to 3 vph	Every 20 to 30 minutes

Reproducing Figure 1 and adding the capacities from Table 4, creates Figure 6 that illustrates the significant oversupply that would be created by an eastern heavy rail connection to the airport. This graph shows that a high-frequency BRT service would better address demands at the Botany end of the route, providing a greater level of service for people accessing the airport than the minimum service that would be delivered by a heavy rail link.

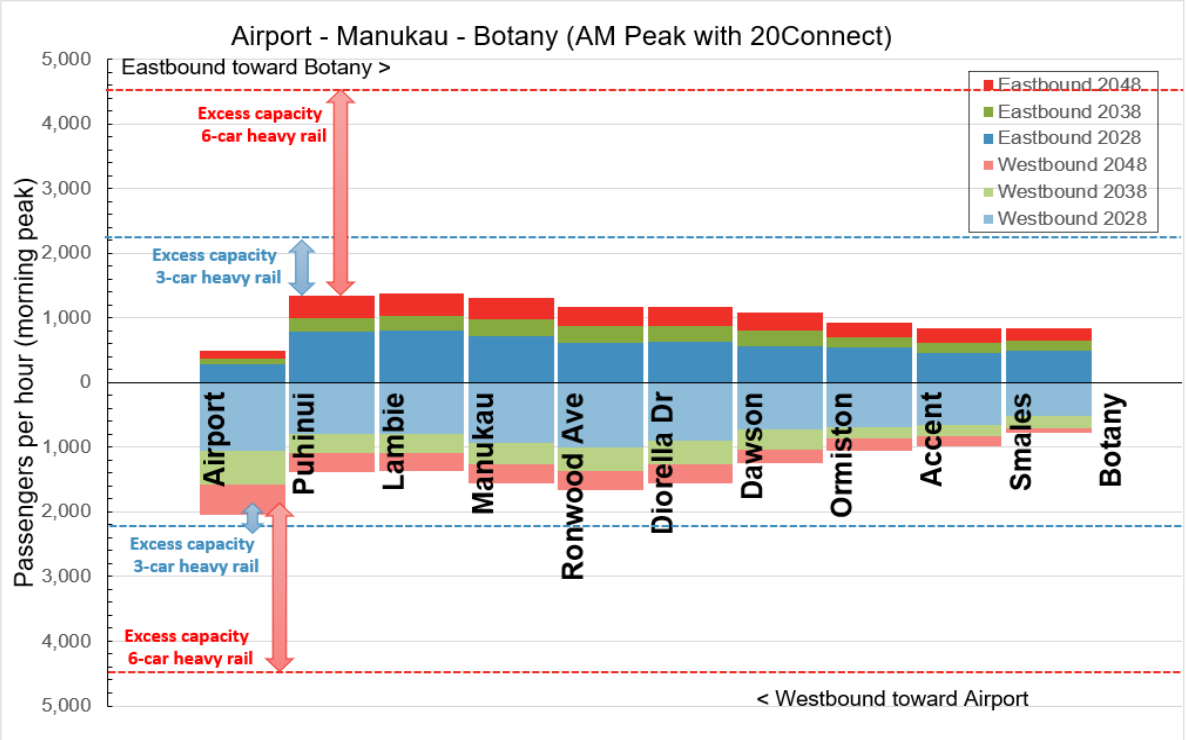

Figure 6: A2B demands 2048 AM peak hour, with heavy rail capacity at minimum service standards (at 6 vphpd)

3.3.2 Project objectives assessment

When assessed against the KPIs for Investment Objectives for A2B, the heavy rail option had mixed results.

The heavy rail option performed well against some metrics and poorly against others. The key differentiators that were identified for the heavy rail option compared to the other options were:

- **Access to education, jobs and healthcare**: Favourable. The rail connection from the Airport continues through Puhinui to Britomart, thus increasing the frequency of rail services to the north along the Southern line which accesses key healthcare, education and employment areas. This reduces the average wait time for transfer services and extends the catchment of tertiary institutes and hospitals close to the train line, which were the primary indicator of this metric.
- **Directness of key journeys**: Unfavourable. The heavy rail option forces a transfer for the key journeys travelling to the east or south of Puhinui, whereas the other options all provide a direct service from the airport to the east of Puhinui and Manukau. “Key journeys” were defined specifically to meet the objectives of the A2B project.
- **Te Taiao (effect of air, land, water and other resources)**: Unfavourable. The heavy rail option performed worse than the other options for this metric due to the higher consumption of land for new transport infrastructure than would be necessary for the BRT/LRT options.

Against the project objective criteria in the MCA, the heavy rail option generally performed similarly to or worse than the other options being assessed. Of the options for connecting the Airport to Puhinui, heavy rail was the worst performing option overall.

3.3.3 Feasibility assessment

The feasibility assessment considered the engineering feasibility of each option. The purpose of this assessment is to identify the main engineering constraints and risks of each option and to determine if/how those constraints can be mitigated. This assessment considered factors such as:

- Constructability
- Construction disruption
- Construction cost and risk
- Safety in design and construction
- Operation and maintenance
- Ability to obtain consents

The heavy rail option scored worst on all aspects of this assessment. The scale, cost, complexity and disruption associated with the heavy rail option is significantly greater than the two BRT or LRT options it was compared to.

3.3.4 Environmental effects assessment

The environmental effects of each option were also assessed by specialists in the relevant topic areas, including:

- Ecology
- Arboriculture
- Stormwater
- Landscape and visual impact
- Urban design
- Social
- Noise and vibration
- Archaeology
- Contaminated land
- Air quality

The heavy rail option performed similarly to other options against some and worse against other environmental criteria. In particular, the effects on contaminated land were considered significantly different to the other options. The preferred alignment is likely to encounter significant areas of contamination. The alignment is likely to traverse a closed landfill (McLaughlin Landfill) which is poorly documented and will provide significant engineering constraints.

Overall, the heavy rail option was the worst performing option against environmental criteria. Some of the negatives of the heavy rail option were considered significant and could be avoided by using the BRT/LRT options, so those were generally preferred from the environmental standpoint.

3.4 Outcome of A2B long list assessment

The best performing options progressed to the short list assessment stage. The heavy rail option was one of the options for the 'A' segment of the corridor (between the Airport and Puhinui), so only the long list results for that segment are covered here.

Options A1 and A2 were advanced to the short list assessment stage. These two options performed relatively similarly across many of the metrics. When compared to one another, they have some different benefits and complexities. The details of these benefits and complexities will be best assessed in more detail at the short list stage. Option A6 (heavy rail from the Airport to Puhinui) was discarded at the long list stage as its overall assessment was worse than the other two options. In particular, the heavy rail option:

- Performed poorly on feasibility criteria including likely cost, constructability, construction disruption
- Is likely to have worse environmental impacts than BRT and LRT options
- Was assessed to provide no additional benefit in meeting the project objectives over BRT and LRT options
- Would provide a capacity, even at minimum service levels, well in excess of the forecast requirements.

4 References

'Sieving Process Methodology Outline' technical note completed by MRCagney (issued on the 7 August 2018).

South-Western Multi-Modal Airport Rapid Transit (SMART) Interim Scheme Assessment Report (December 2013)

Approved by:

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