Appendix I. Auckland Airport Rail Alignment Challenge Workshop Report

SMART (Rail to the Airport)

Auckland Transport

SMART Workshop 2: Airport Rail Alignment

| Draft

2 June 2016

Client Reference

Document history and status

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SMART (Rail to the Airport)

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1. Introduction

This document provides a record of discussions from *Workshop 2: Airport rail alignment options*, held from 11:00am – 3:00pm on Friday 8 April 2016.

The purpose of the workshop was to understand the key features, benefits and risks associated with both heavy rail and light rail alignment options within the Auckland Airport environment. The conclusions from discussions during this workshop will inform further option development/refinement and the multi-criteria analysis (MCA) process to input into the Rail to the Airport Indicative Business Case.

The workshop agenda covered the following items:

1. Introductions and workshop purpose;
2. Scope: corridor Airport approach from north, via SH20A, south of Montgomerie Road;
3. Overview of heavy rail and light rail alignment options;
4. Group discussion of features, benefits and risks of heavy and light rail alignment options;
5. Overview of next steps.

1.1 'Parking Lot' Items

The following items were identified as factors which may influence the Airport alignment options but were agreed to lie outside of the scope for the workshop.

Further investigation is required relating to the following:

- Rail alignment options to the north and east, and how these are being considered / not precluded;
- Bus travel times – the journey time for bus trips from the Airport to the city is useful for comparison purposes and is assumed to be 45 minutes.
- Implications of the Onehunga Line failing to meet requirements for rail to the Airport. The Ōtāhuhu option was assessed previously and the Business Case is to tie all options together; and
- The use of tram trains as an alternative option.

1.2 Auckland Airport Development Context

Auckland International Airport Ltd ('the Airport') has developed a long-term development programme to be implemented over the next 30 years to accommodate forecasted growth.

Auckland Airport is required to have confirmed their decision regarding heavy rail or light rail within the airport by June 2016 which aligns with the time frame for the delivery of the SMART Indicative Business Case. The international and domestic Airport terminals are to be combined by 2020 - 2021 and the second runway will be built and operational by around 2025 (± 3 years). It has been advised to plan rail construction approximately 5 years ahead of this expected timeframe to align with this planned development for the Airport.

The new runway is likely to be developed in two stages. The new runway will be constructed to the north of the Airport and to the west of George Bolt Memorial Drive and this will form the interim runway scenario in 2025. The runway is currently planned to be extended to its full length to the east of George Bolt Memorial Drive after 2044 to form the ultimate runway scenario.

2. Overview of Alignment Options

The workshop provided a high-level overview of the heavy and light rail alignment options which have been developed for the SMART project through the Airport area. This overview included a summary of the Onehunga Branch Line double tracking assessment which was covered in a previous workshop held on 1 April 2016.

2.1 Heavy Rail

Four alignment options for heavy rail were initially discussed during the workshop as shown in Figure 2.1.

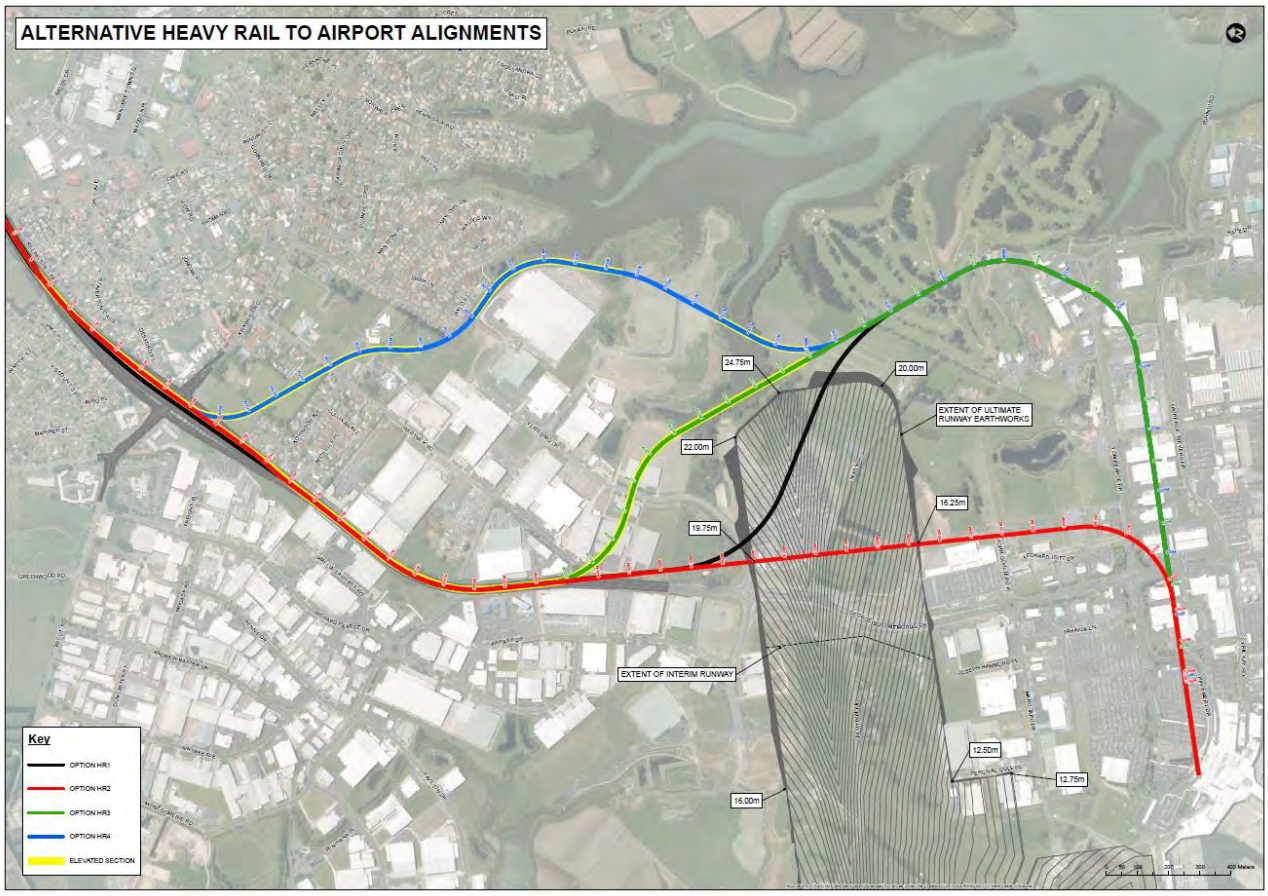

Figure 2.1 Heavy rail alignment options within the Auckland Airport environment

The heavy rail alignments approach the Airport environment on an elevated structure along the centre of SH20A, and passes above the Kirkbride Road interchange. The design of the Kirkbride Road interchange and the vertical profile used for the mainline motorway (gradients of approximately 4.6%) as it passes beneath Kirkbride Road in a trench does not enable heavy rail to run at grade through this section.

Option HR1 was the initial alignment used in the business case assessment for SMART, based on points provided to Auckland Transport by the Airport. Initial assumptions included that this alignment could be constructed using cut and cover tunnel methodologies. It was acknowledged during the workshop discussion that this was early information and the Airport's thoughts on a potential rail alignment have progressed since that time.

Option HR2 was developed to provide a more direct connection to the Airport terminal. To achieve this connection the alignment then grades down to enable the heavy rail to pass beneath the future second runway extension proposed by the Airport. To achieve this, SH20A requires separation of the northbound and southbound carriageways in the vicinity of Montgomerie Road to enable the heavy rail to transition from being

on structure to below ground. The widening of SH20A will require purchase of adjacent commercial / industrial property. The heavy rail alignment then proceeds southward in twin bored tunnels (inbound and outbound), approximately 20 to 25m below ground level to connect to a station located below the Airport Terminal.

Options HR3 and HR4 were developed to demonstrate alternative options that could avoid the future second runway (including extension). It was considered that these alignments could be developed using a mix of elevated structure, at grade and tunnelled sections.

During the workshop Airport representatives tabled a plan which illustrated their current master plan thinking in terms of a potential future heavy rail alignment, shown below in Figure 2.2.

It was noted during discussion of this alignment that due to the progressive development of the Airport land over time, construction of a rail alignment would require some form of bored tunnel methodology to avoid surface impacts. Cut and cover tunnel construction, or providing the rail alignment at grade, was considered as a nonstarter.

A further heavy rail option was discussed, with the rail alignment transitioning to an elevated structure south of the second runway extension. This was raised as a potential option given the likely expense associated with tunnelling the rail alignment, and the incompatibility to provide for heavy rail at grade through the Airport area given the master plan layouts.

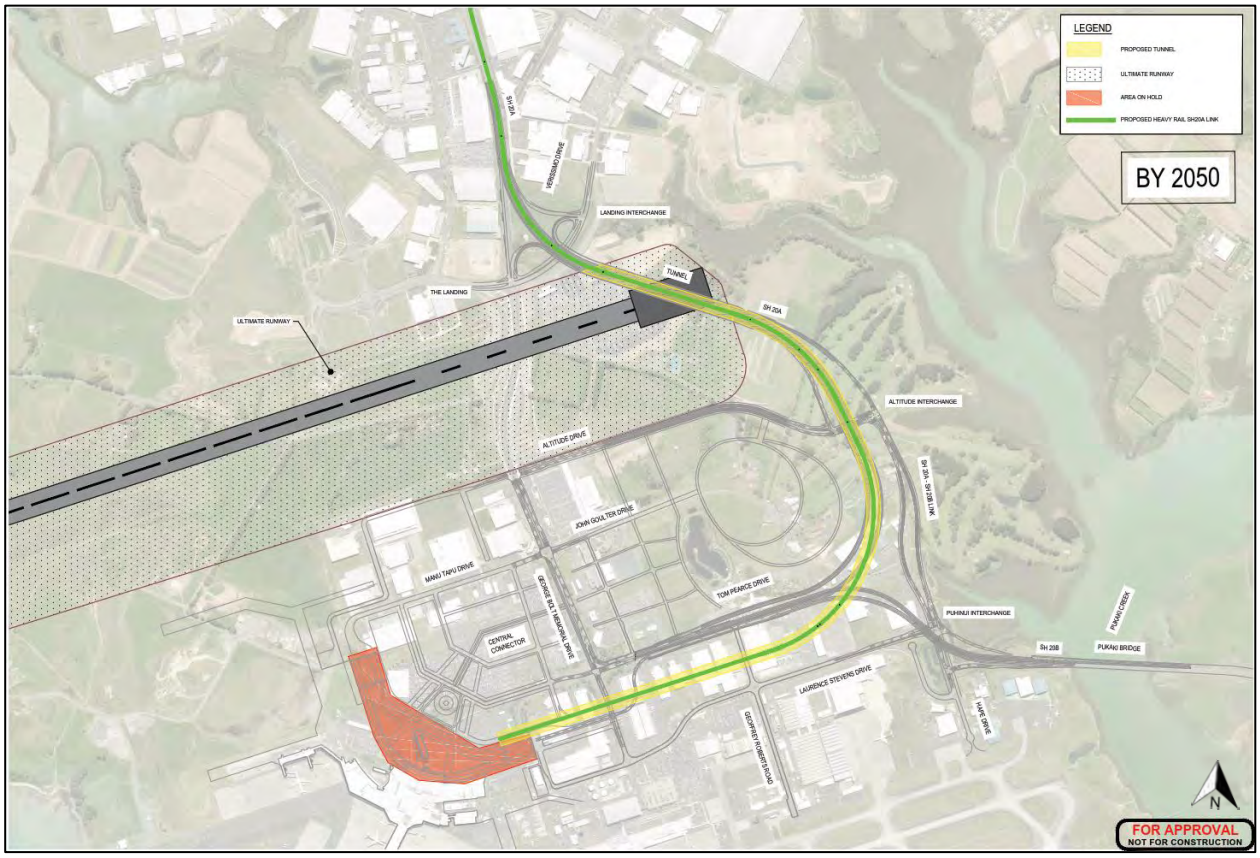

Figure 2.2 Draft heavy rail master plan alignment option

2.2 Light Rail

Three light rail alignment options were initially discussed during the workshop as shown in Figure 2.3.

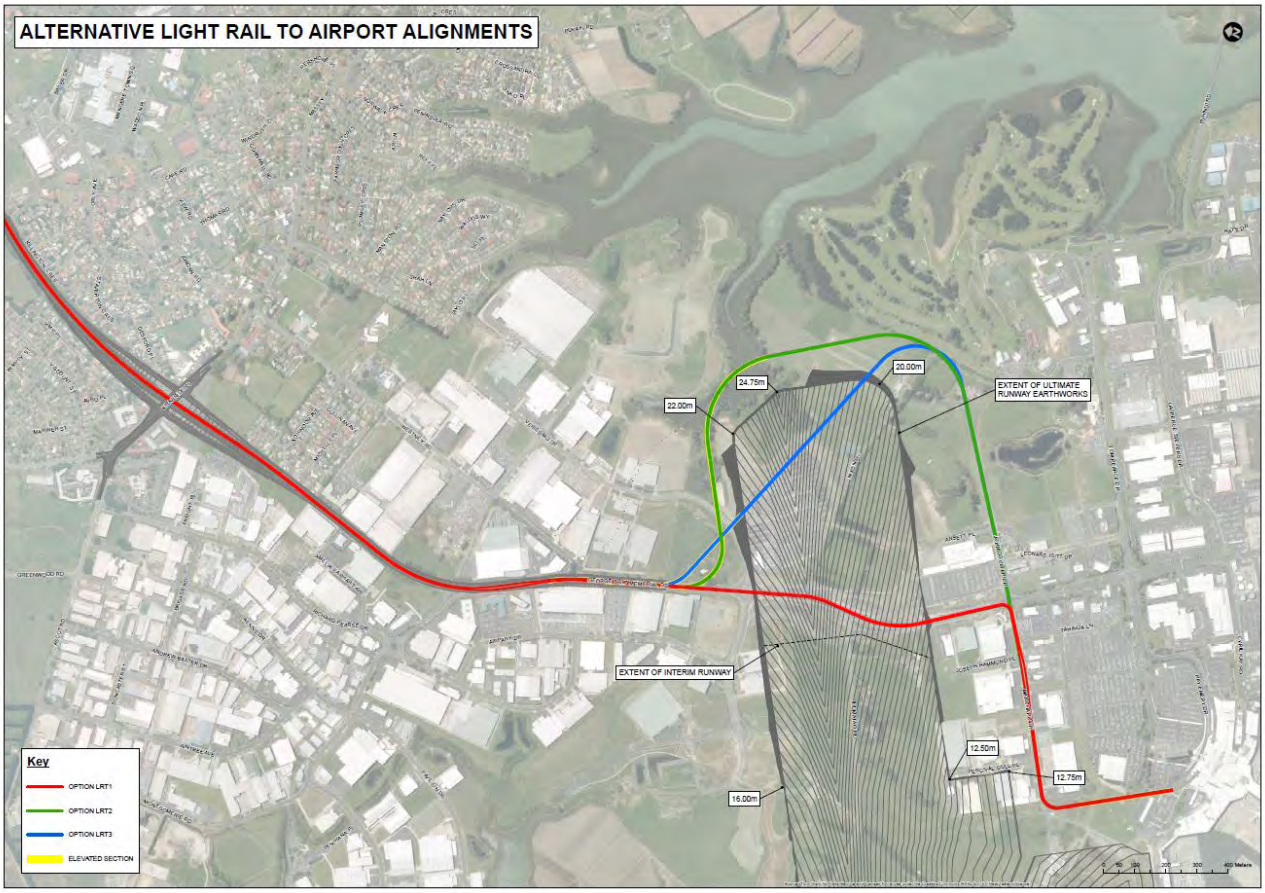

Figure 2.3 Initial light rail alignment options within the Auckland Airport environment

The light rail alignments approach the Airport in the centre of SH20A at the same grade as the motorway lanes and passes beneath Kirkbride Road utilising space allocated for it through the motorway trench. These light rail alignments were developed without any information in relation to the potential future road network with the Airport area. Option LR1 was developed on the assumption George Bolt Memorial Drive would lowered beneath the second runway, and the light rail alignment would continue to remain within the road corridor due to being able to traverse similar vertical gradients. Option LR2 was developed to avoid the second runway extension, and Option LR3 developed to have an alignment similar to that of the HR1 option that was initially provided by the Airport.

As with the heavy rail discussion, during the workshop Airport representatives tabled a plan which illustrated their current master plan thinking in terms of a potential future light rail alignment, shown below in Figure 2.4.

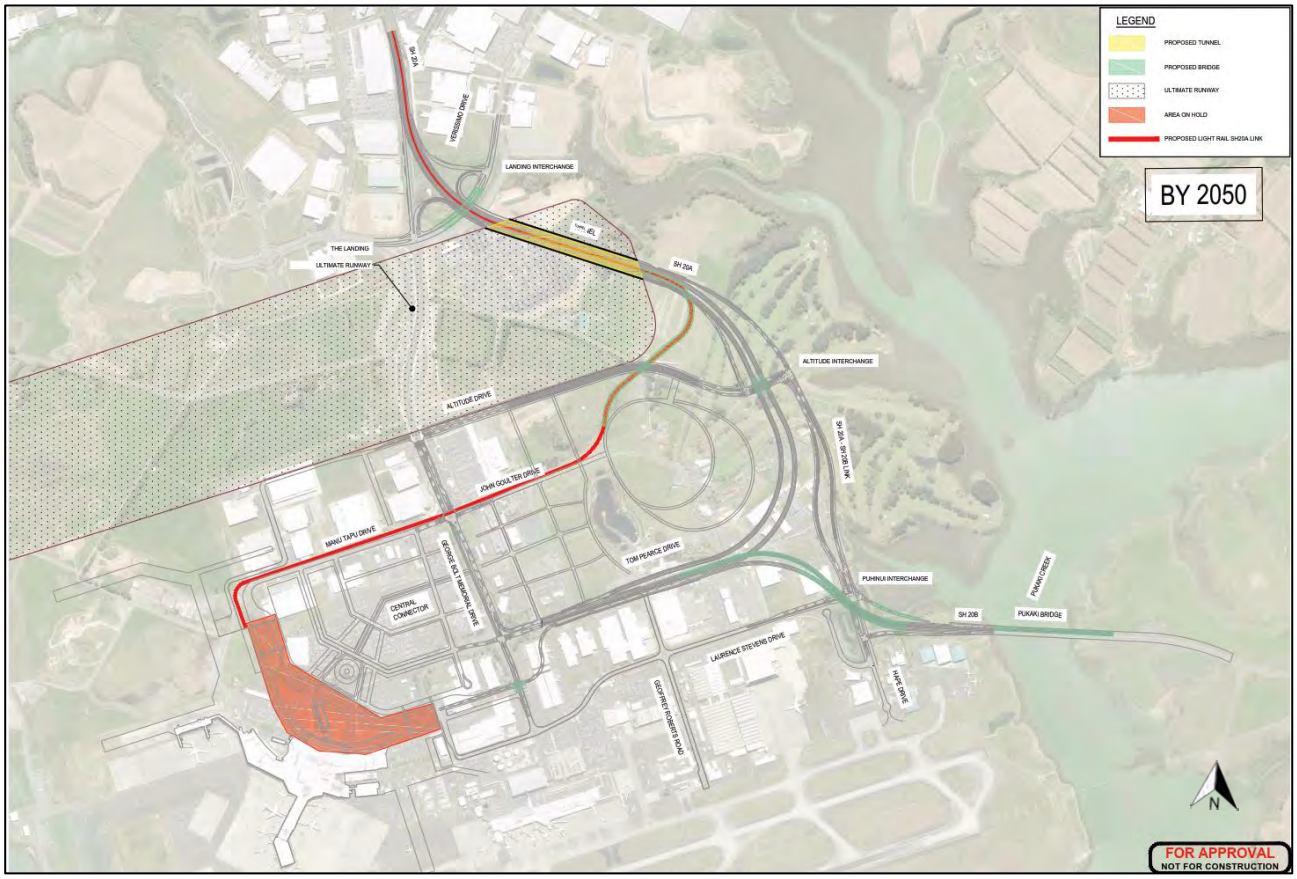

Figure 2.4 Draft light rail master plan alignment option

The alignment developed by the Airport to integrate with their draft master plan transport infrastructure retains the light rail within the centre of SH20A as it enters the Airport area. The alignment remains within the centre of SH20A as it passes through the proposed Landing interchange and beneath the north east corner of the future second runway extension. The light rail alignment then passes above the future Airport road network on structure and then runs along the north side of John Goulter Drive at grade, before connecting to the new Airport terminal. Stations are provided in the vicinity of John Goulter Drive (at grade) and at the Airport terminal (elevated).

3. Heavy Rail Alignment Options Assessment

The features, benefits and risks of each of the heavy rail alignment options were discussed and a number of items were identified which may require further investigation. Actions and those responsible for carrying out the actions are noted in section 6.

3.1 Features

3.1.1 Indicative Cost Estimates

Appropriate comparative costs for the heavy rail alignment options were discussed during the workshop and are summarised in Table 3.1. These broad, indicative costs are based on the following assumptions and were discussed in the context of a broad relationship to similar recent Australian examples:

- All alignments are double-tracked.
- Twin bored heavy rail tunnels with cross passages are required.
- HR2 could enable a second station to be located in the vicinity of John Goulter Drive, positioning it in a similar location to that proposed for the light rail alignment developed by the Airport and would be included for the purposes of the comparative costs.

Table 3.1 Heavy rail option cost estimates (Airport section only)

Alignment	Number of stops	Indicative Cost
Heavy rail – elevated	1	$350 – $400 M
Heavy rail – tunnel (HR2)	1 (future-proofed for an additional stop)	$650M +

Option feasibility estimates are to be developed once the alignment options are updated following the workshop.

3.1.2 Grade

It had previously been assumed that the maximum grade for heavy rail for the purposes of alignment design would be 2%. However, it was confirmed during the workshop that 3% was an acceptable maximum gradient that should be used for the alignment design of options within the business case. This assumes the live load be for passenger trains only, with no heavy freight.

3.1.3 Road layout

It was agreed that an elevated heavy rail alignment could potentially be feasible within the Airport environment. However, elevated options may not have the potential benefit of adding a second station in the future.

3.1.4 Tunnel configuration

The following design criteria have been adopted to date:

- Twin bored tunnels, approximately 7 m diameter (as constructed), 6.5 m ID;
- Emergency egress cross passages at approximate 250 m centres along the tunnel alignment;
- Tunnel separation approximately 8 m (approximately 15 m track centre line to track centre line);

- Precast segmental lining with double gasketed system for water tightness;
- Tunnel low point and sump at Airport Station;
- Minimum depth (cover) to tunnel crown below surface of 10 m; and
- Assumed dive structure and cut and cover transition tunnel at northern portal.

3.2 Benefits

Typical benefits of heavy rail relative to light rail were discussed and include the following:

- Potentially higher travel speeds and faster journey times;
- Greater service capacity; and
- Better provisions for passengers with luggage.

3.3 Risks

3.3.1 Tunnelling

Ground conditions at the Airport are a significant cost risk for tunnelling and will dictate the construction methodology adopted. The tunnel alignment will be below the groundwater table and the expected geological conditions (soft soils) suggest that continuous permanent concrete tunnel lining will be required. Construction of the tunnels is assumed to be by Tunnel Boring Machine (TBM) with a capability to pressurise the tunnel face during construction.

It is expected that the tunnel configuration would be twin parallel tunnels, approximately 7 m in diameter, with emergency egress cross passages spaced at 250 m centres along the alignment. Additional surface egress via shafts may also be required subject to more detailed Fire Engineering studies and confirmation of the location of any additional station(s) and land availability, particularly airside.

It is assumed that the minimum depth (cover) to the tunnel crown below the surface is at least 1 x tunnel diameter, however noting the poor ground conditions and high risk of settlement, provision of 10 m of cover has been adopted in finalising the vertical alignment and construction methodologies. As such the rail alignment will require dive structures and a section of cut cover tunnel before sufficient depth is achieved to commence tunnel boring.

Flooding during construction is a major hazard and cost risk, given the topography of the site, typically 6 to 8 m above sea level, and poor drainage. Cut and cover construction for the entire tunnel alignment was not considered feasible given the significant surface impacts this approach would have on the developed Airport land. Tunnel boring will require approximately 2 hectares of land to be used as a main construction and launch site for the TBM's including provisions for spoil handling and disposal.

TBM retrieval would be facilitated at the proposed Airport terminus station box (see 3.3.2 below), or if not feasible the machines could be 'buried' in sacrificial stub tunnels beyond the station box.

3.3.2 Station Requirements

The four heavy rail alignment options discussed at the workshop provide underground Airport access and all would require an underground station near the Airport terminal. Heavy rail alignments at grade were not considered feasible within the Airport considering planned development within the area.

A sealed (watertight) station 'box' structure will need to be constructed underneath the Airport terminal and it was confirmed that construction will adopt a top down cut and cover methodology with diaphragm walls. The

approximate dimensions of the station box would be a minimum of 300 m x 50 m to provide for station platforms, back of house and M&E facilities including tunnel and station ventilation and emergency egress, train storage, turning facilities, crossovers on the station approach and other rail services.

For these heavy rail alignment options to be feasible, it was confirmed that the proposed Airport Station box would need to be built prior to the tunnel construction, and at the same time as the terminal upgrades. If the station box is unable to be built first or if issues regarding staging with the terminal upgrades cannot be resolved, this will effectively preclude heavy rail options that require an underground terminus station.

3.3.3 Property Impacts

It was noted that heavy rail alignments must pass over the Kirkbride Interchange. In relation to Option HR2, the alignment then transitions down to enable the heavy rail to pass beneath the future second runway extension proposed by the Airport. To achieve this, SH20A requires separation of the northbound and southbound carriageways in the vicinity of Montgomerie Road to enable the heavy rail to transition from being on structure to below ground. The widening of SH20A will require purchase of adjacent commercial / industrial property over and above that originally assessed with the initial Option HR1 alignment.

3.3.4 Interchange Impacts

As per the Auckland Airport development master plans, an interchange is proposed at The Landings (north of the future runway on SH20A). The Airport has concerns regarding the impact of rail alignments on the interchange and how these impacts can be mitigated. Further investigation is required to assess and mitigate potential impacts on this interchange.

4. Light Rail Alignment Options Assessment

The features, benefits and risks of each of the light rail alignment options were discussed and a number of items were identified which required further investigation. Actions and those responsible for carrying out the actions are noted in section 6.

4.1 Features

4.1.1 Cost Estimate

Comparative costs for the light rail alignment options were developed during the workshop following the main discussions and are summarised in Table 4.1. The cost estimate is based on the assumption that the alignment is double-tracked.

Table 4.1 Light rail alignment cost estimates

Alignment	Number of stops	Cost Estimation
Light rail	2	$150 - $200 M

Although these costs were suggested for comparative purposes and further assessment will be required, it was determined that the light rail option was likely to be considerably cheaper than the elevated and tunnelled heavy rail options. This is due to the LRT option having an elevated rather than underground station and generally lesser structural works. An option feasibility estimate will be developed once the alignment option based on the Airport master plan alignment has been updated following the workshop.

4.2 Benefits

Typical benefits of light rail options were discussed and include the following:

- Construction is significantly cheaper than heavy rail options;
- Can be constructed at grade;
- Higher level of connectivity; and
- Greater opportunity for additional stations in areas of development.

4.3 Risks

An important assumption was noted during the workshop that the proposed light rail alignment along Dominion Road must be built to extend light rail to the Airport.

5. Draft Multi-criteria Analysis Criteria

Draft criteria for assessing both heavy and light rail alignment options using a multi-criteria analysis (MCA) tool were developed during the workshop. It was agreed at the workshop that the most robust evaluation method would be to compare the preferred heavy rail alignment option to the preferred light rail alignment option in the context of the overall SMART project, and not in the Airport environment in isolation.

The draft list of potential assessment criteria developed during the workshop includes the following:

- Customer experience;
- Journey time, frequency and reliability;
- Cost (Capex and Operations and Maintenance);
- Unit capacity (including luggage, standing, seating provisions);
- Service capacity;
- Constructability;
- Market (catchment within 400 - 800m of stations to justify a second station for each mode and option);
- Staging / phasing within Airport requirements;
- Environmental impacts;
- Consents;
- Land acquisition;
- Amenity; and
- Transport connectivity (southern connection and rest of rail network).

It was agreed that this list could be refined and measures for each criterion to be developed as part of the IBC process.

6. Conclusions

It was concluded that constructability and phasing with Airport development is an important consideration as well as overall cost. The upgraded terminal is a significant investment for Auckland Airport and the value of the terminal needs to be optimised. This is a key consideration for the preferred option.

Development within Auckland Airport will have an impact on the Airport road network and layout and it was confirmed by Arup that the road layout is as per the Auckland Airport Master Plan. The Airport plans and road alignments are to be updated following the Auckland Airport Board review of the Draft Master Plan. Further investigation and drawings of alignment options could then be undertaken depending upon the feedback of the Board review.

In summary, further investigation of additional options will required to reach a preferred rail alignment for both heavy rail and light rail in the airport environment. The additional options and actions are outlined in the following sections.

6.1 Heavy Rail

The preferred heavy rail option of those discussed during the workshop was Option HR2, the most direct alignment which provided an opportunity to future-proof for an additional station and best served areas of development. This option required further refinement and mitigation at the proposed interchange north of the Airport. This option would be refined to include an additional underground station located near John Goulter Drive. The Airport terminal station will also be underground. The second station would provide a level of connectivity similar to light rail alignment options, especially with the forecast growth and development within the Airport area. This option will form part of the overall preferred option for heavy rail within the SMART business case.

In addition, it was agreed during the workshop that a further direct heavy rail alignment option could be developed. This option would extend straight from SH20A, underneath the interim runway and directly connect to the northern end of the Airport terminal (indicative alignment shown in Figure 6.1). This alignment may provide benefits in terms of geometric design and slight improvements to travel time.

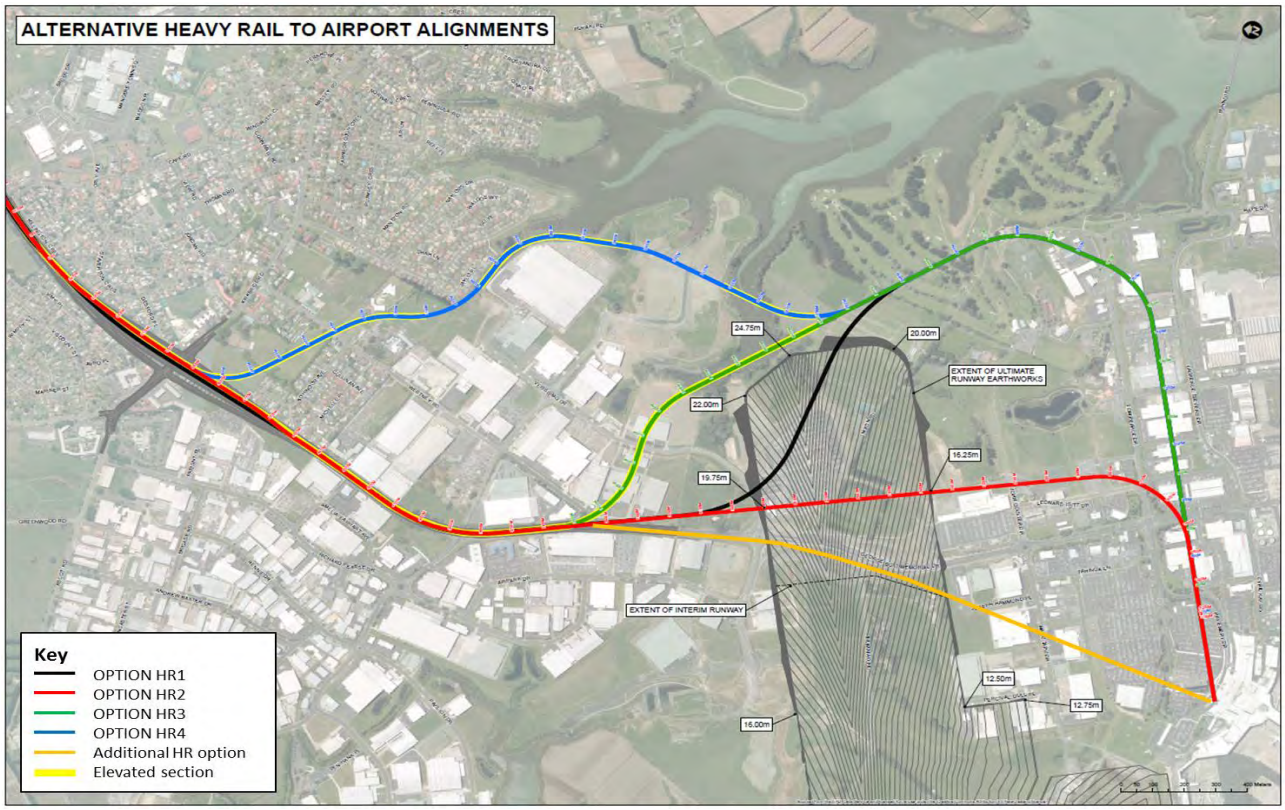

Figure 6.1 Heavy rail alignment options including the indicative additional alignment

6.2 Light Rail

Arup and Auckland Airport representatives provided an overview of the future Airport development scenario and how the full solution provides for an LRT alignment option. The current view of the master plan layout was to be further discussed at an Airport Board meeting due to be held during the week following the workshop.

The light rail master plan alignment shown in Figure 2.4 would be used as the basis for the preferred light rail option for the SMART business case, subject to Airport Board feedback on the draft master plan and further investigation of this option once alignment information is provided by Auckland Airport.

6.3 Summary of Actions

Table 6.1 provides a summary of actions and responsibilities resulting from the workshop.

Table 6.1 Summary of actions from the workshop

Mode	Item	Action	Responsible
Heavy rail	Additional option investigation	• Investigate elevated heavy rail alignment options. • Investigate and cost the additional heavy rail direct alignment. • Investigate and cost the additional heavy rail alignment including the station.	Jacobs
	Reconsider 3% grade	• Reconsider heavy rail alignments with 3% vertical grade.	Jacobs

Light rail	Modify options	• Modify options to align with future Airport road layout.	Jacobs
	Additional option investigation	• Investigate and cost an additional light rail alignment based on plans supplied by Auckland Airport.	Jacobs
Heavy rail and light rail	Road layout plans	• Provide Airport plans and road layout once the Airport has reviewed the draft Master Plan.	Arup / Airport
	Travel time	• Calculate travel time / benefits of alignment options.	Jacobs
	Cost estimates	• Update and provide more detailed risk and cost estimates.	Jacobs (Mark Revis)
	Draft criteria	• Refine criteria and performance measures	Jacobs (Auckland Transport to approve)