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City Centre Future Access Study 2  
Auckland Transport – Commercial in Confidence

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# 1 Executive Summary

During the previous three months Auckland Transport together with their commissioned consultants, have prepared various options with outline designs and draft cost estimates for Auckland's City Centre Future Access Study 2 (CCFAS2), including a new light rail system (Option 4) and a combination of a modified heavy rail network and a new light rail system (Option 9a).

Turner & Townsend have been commissioned by Auckland Transport to undertake an independent peer review of the draft estimate of capital expenditure.

Turner & Townsend have undertaken the independent review which indicates that, including the light rail vehicles, we consider the Option 4 should be in the order of \$3,673m versus the draft estimate of \$1,945m and Option 9a \$1,865m versus the draft estimate of \$1,240m.

From information received, Turner & Townsend have identified Option 4 to consist of 33.64km of light rail running, 54 Light Rail Vehicles, 35 substations and 43 light rail stops.

Turner & Townsend have similarly identified Option 9a to have a light rail alignment length of 13.24km, a heavy rail alignment length of 3.86km, 22 Light Rail Vehicles, 9 heavy rail Electric Multiple Units, 15 substations, 2 heavy rail stations and 17 light rail stops.

At Appendix 1 and 2 there are indicative cost summaries that capture the findings of this report and presents an alternative overall cost that Turner & Townsend consider to be a more likely scenario than the current draft estimate.

## **Direct construction costs**

Direct construction costs include the costs a main contractor would incur for labour, plant / equipment, materials and other sub-contract costs.

The direct construction costs within the draft estimate have been estimated at \$655m for Option 4 and \$405m for Option 9a, compared to this review of \$1,127m for and \$569m respectively.

The primary drivers for the overall differential in both options are existing utilities modifications, road and footpath works, traction power and the allowances for various rail systems.

### **Indirect construction costs**

Indirect construction costs include the costs a main contractor would incur in preparing final designs, providing project insurances and security bonds and preliminaries which include the core site management team, site supervision, temporary site facilities of compounds, lay-down areas and offices, consumables, temporary utilities, traffic management and the like. The other indirect construction costs are main contractor's corporate overhead and profit margin.

The indirect cost elements also show significant divergence between the draft estimate and this review. The principle reason for the difference is that Turner & Townsend have assessed the allowances for the above items at a higher percentage given the type and quantity of works, the requirements for the proposed light rail 'wire free' technology and our experience of previous and current light rail systems and significant infrastructure programmes internationally.

The indirect construction costs within the draft estimate have been estimated at \$212m for Option 4 and \$131m for Option 9a. This compares with this review of \$669m and \$281m respectively.

### **Project / client costs**

Project / client costs include the costs that the owner will incur in the development, delivery and commissioning of the project including the teams responsible for development management, project management, commercial and schedule management, business and local community communications, stakeholder management, environment management, the Project Board, the Environmental Impact Statement and legal costs. Other costs include external engagements that cover planning, engineering and architectural design, programme, project and cost management, health and safety and other independent and specialist advisers.

This review suggests that the client costs are increased from the draft estimate assumption of \$80m for Option 4 and \$49m for Option 9a to \$195m and \$98m respectively which still places the project towards the lower end of expected ranges of light rail, heavy rail and infrastructure projects globally.

### **Risk and contingency**

The design and engineering evidence that we have reviewed indicates that the CCFAS2 is at an early stage of development and therefore the scope of work must be considered very flexible and hence subject to a great deal of uncertainty and risk. The draft estimate contains a P50 risk allowance of 20%.

This review suggests that a more appropriate risk and contingency allowance in the order of 30% should be considered for adoption at this stage with the expectation that this will reduce as the definition of scope increases and agreements are reached with government agencies, utility providers, contractors and advisors.

### **Conclusion**

The design and construction of new light rail systems in New Zealand and Australia requires a high percentage of imported skills, expertise and equipment. Turner & Townsend's research and experience of planning for light rail systems in Australia, including wire free technology in Sydney, indicates that the draft estimate for Auckland is overly optimistic and set at too low a level. It is recommended that the current draft estimate is reviewed in more detail and supported by more evidence based data.

## 2 Brief and methodology

### 2.1 Scope

Review the capital cost estimates and undertake benchmarking including indirect construction cost elements, client costs and risk and contingency and comment on their appropriateness.

Review the appropriateness of the rates and allowances made in the estimate with commentary on elements that appear to be outside of expected ranges. A detailed re-measure or verification of the quantities not part of the scope of services.

### 2.2 Basis of Review

The basis of the review is of the estimates supplied by Auckland Transport, in conjunction with supplied route images and Turner & Townsend industry benchmarks from works of a similar nature.

### 2.3 Turner & Townsend capability

Turner & Townsend have provided cost planning and risk management services in support of numerous Business Cases for major infrastructure projects in Australia including the North West Rail Link (Sydney), Sydney CBD (Central Business District) and South East Light Rail and Wynyard Walk pedestrian link (Sydney). Other business cases that we have supported include Brisbane's Cross River Rail and the Gold Coast Light Rail project.

We are on the Australian Government's Department of Infrastructure and Regional Development's panel of Infrastructure Advisory Services, providing base cost estimate and contingency review services.

Through our global network of 87 offices we have access to light rail, heavy rail and other infrastructure project data that is based on robust information that can be trusted. We are currently working closely with rail owners / operators in Australia, the UK, Europe, Middle East and Africa and have most recently brought our experience of Edinburgh Trams to Sydney in support of the AUD\$1,600m investment in an extended light rail system.

This experience gives us in-depth knowledge of the issues involved with setting appropriate budgets for significant infrastructure investments funded by government or a combination of public and private entities.

## 2.4 Benchmarking

Using our experience and knowledge of light rail and other infrastructure projects we have benchmarked the allowances for overhead and profit, risk and contingency and project leadership and management costs against other comparable projects whilst appreciating that there will be specific project issues and other impacts of delivering a new light rail system through Auckland's city centre.

Other similar light rail systems that we have detailed access to include, but not limited to, Sydney Light Rail (Australia), Newcastle (Australia), Perth light rail (Australia), Edinburgh Trams (UK), Nottingham Express (UK), Stagecoach Supertram (Sheffield, UK) and Dublin Luas (Ireland). Our rolling stock database includes over 65 orders covering 17 countries and spanning over 10 years.

The methodology for reviewing the capital costs for the key elements of the project followed the principles below;

**Property acquisition** - A review of the estimated property acquisition costs is not included as part of the scope of this review so we have retained the values as given in the draft estimate.

**Existing utilities** – An overall rate per kilometre was calculated and compared to other similar projects in addition to an assessment of what the utilities cost represented as a percentage of the light rail infrastructure and systems total cost. It is recognised that each project has specific issues and there are examples where expenditure on this scope of work has been minimal.

**Trackform** – Specific consideration given to the light rail steel track required and the cost implications of curved track requirements. An overall rate per metre for the trackform was derived from other similar projects and compared to the draft estimate.

**Rail alignment (structures)** -A rate per metre for elevated structures was compared to other similar structures.

**Stops** – Allowances per stop were based on similar stops on the Sydney light rail project and other light rail projects globally.

**Precincts** – The road works and footpath works between stops were considered overall and assessed against the typical percentage these works usually form as part of the overall scope.

**Bulk and traction power** - Unit rates for supply and installation were applied to the elemental quantities of substations, overhead wiring, small power and lighting from our internal cost database.

**Rail systems** – Benchmarked rates from our internal cost database for supply and installation of communications and security systems, tram and traffic control signalling, combined services route, passenger information systems and ticketing systems were applied to the alignment length.

**Depot and stabling** – Rates per facility/building, including fitout, and an operations control centre were compared to other similar projects on a total cost and a cost per light rail vehicle basis.

**Contractor's indirect costs** - The specific project requirement for preliminaries including the core management and site based teams, temporary construction facilities such as construction sites, office buildings and lay down areas, insurances, traffic management and main contractor's design costs were analysed as percentages of total direct construction cost and benchmarked against comparable projects.

**Project / owner's costs** - Requirements for external appointments and internal Department of Transport costs calculated as a percentage of total construction costs and benchmarked against comparable projects.

**Rolling stock** – The unit rate was compared to our database of light rail vehicle orders allowing for the addition of wire free technology which is assumed to include some form of on-board energy storage system.

**Risk and contingency** - Based on the information available upon which the estimate has been prepared, together with the assumptions made, direct costs, indirect costs, engineering, procurement and management, the adequacy of the total risk allowance as a percentage of the total cost was assessed and benchmarked against comparable projects.

## 2.5 Exclusions

The following items are excluded from this review;

- Escalation – all costs are assumed to be 4<sup>th</sup> Quarter 2014 and there is no provision for escalation over the period from 1<sup>st</sup> Quarter 2015 to commencement of revenue services.
- Land and property – this cost category includes land acquisitions, relocations, alterations / refurbishments / demolitions and legal and other fees. The costs contained in the draft estimate



## **2.6 Information Received**

The following reference documents were received from Auckland Transport and were used to form the basis of our review:

- CCFAS2 Draft Estimate estimate-2.12.2014 (WT Partnership)
- Operational costing of LRT/bus options 4, 6, 8 and 9, 21 November 2014 (MRCagney)
- Route images – Option 4 (pdf file) and Option 9A (jpg file)
- CCFAS2 LRT Staging Plan 21 Nov D (URS, 42127353-SK017-D.dwg, 10/11/14)

### 3 Cost estimate summaries

#### 3.1 Option 4

The latest draft estimate at a P50 confidence level for the CCFAS2 project is \$1,614m plus light rail vehicles of \$331m, giving a total of \$1,945m as set out below;

	All costs \$m		Total \$	Total \$m per km
1	Land & Property		282.3	8.4
2	Investigation & Reporting		29.9	0.9
3	Developed Design & D&C Monitoring		49.8	1.5
4	<b>Design &amp; Construct contract</b>			0.0
4.01	Track (34 km alignment)		352.1	10.5
4.02	Power (inc. 35 Nr substations)		76.2	2.3
4.03	Systems		20.1	0.6
4.04	Statutory Undertakers Equipment		63.7	1.9
4.05	Highway Costs		13.9	0.4
4.06	Stops (43 Nr)		54.9	1.6
4.07	Support Facilities		74.4	2.2
4.08	Design		26.2	0.8
4.09	Programme & Project Management		185.9	5.5
	<b>Subtotal</b>		<b>867.5</b>	<b>25.8</b>
4.10	Off site overhead and Profit		130.1	3.9
	<b>Total D&amp;C</b>		<b>997.6</b>	<b>29.7</b>
5	Contingency P50	19%	254	7.6
6	<b>Subtotal @4Q14 prices</b>		<b>1,613.6</b>	<b>48.0</b>
7	Rolling Stock	54 Nr	331.0	9.8
8	<b>Total Costs @4Q14 Prices</b>		<b>1,944.7</b>	<b>57.8</b>

Table 1- Draft estimate as presented

In order to compare the CCFAS2 project with other similar light rail systems we have analysed the draft estimate and re-ordered some of the line items to reach a standard elemental format as set out below;

	All costs \$m		Total \$m	Total \$m per km
	<b>Direct construction costs</b>			
1	Track (34 km alignment)	53.8%	352.1	10.5
2	Power (inc. 35 Nr substations)	11.6%	76.2	2.3
3	Systems	3.1%	20.1	0.6
4	Utilities	9.7%	63.7	1.9
5	Roadworks	2.1%	13.9	0.4
6	Stops (43 Nr)	8.4%	54.9	1.6
7	Depot & Stabling Facility	11.4%	74.4	2.2
<b>8</b>	<b>Direct construction costs</b>	<b>100.0%</b>	<b>655.4</b>	<b>19.5</b>
9	Preliminaries	23.9%	156.4	4.6
10	Traffic management	4.5%	29.5	0.9
12	Contractor's design	4.0%	26.2	0.8
<b>13</b>	<b>Indirect construction costs</b>		<b>212.1</b>	<b>6.3</b>
<b>14</b>	<b>Total construction costs</b>		<b>867.5</b>	<b>25.8</b>
15	Contractor's OH&P	15.0%	130.1	3.9
<b>16</b>	<b>Total contractor's costs</b>		<b>997.6</b>	<b>29.7</b>
15	Rolling stock (LRVs)	54 Nr	331.02	9.8
<b>16</b>	<b>Subtotal</b>		<b>1,328.6</b>	<b>39.5</b>
	Planning & Development	2.3%	29.9	0.9
	Client Design	2.3%	29.9	0.9
	Client Costs	1.5%	20.0	0.6
	<b>Owners management costs total</b>	<b>6.1%</b>	<b>79.8</b>	<b>2.4</b>
	<b>Subtotal</b>		<b>1,408.4</b>	<b>41.9</b>
	Property acquisitions		282.3	8.4
	<b>Subtotal</b>		<b>1,690.7</b>	<b>50.3</b>
	Risk and contingency 19% excluding LRVs 15% including LRVs		254.0	7.6
<b>33</b>	<b>Subtotal</b>		<b>1,944.7</b>	<b>57.8</b>

Table 2 – Draft estimate in standardised cost breakdown structure

In reviewing the data presented we have found several anomalies in formulas used to arrive at the current estimate based on the information provided. We have assessed that the accurate representation of the provided information is as follows.

	All costs \$m		Total \$m	Total \$m per km
	<b>Direct construction costs</b>			
1	Track (34 km alignment)	53.8%	352.1	10.5
2	Power (inc. 35 Nr substations)	11.6%	76.2	2.3
3	Systems	3.0%	19.8	0.6
4	Utilities	9.7%	63.7	1.9
5	Roadworks	2.1%	13.9	0.4
6	Stops (43 Nr)	8.4%	54.9	1.6
7	Depot & Stabling Facility	11.4%	74.4	2.2
<b>8</b>	<b>Direct construction costs</b>	<b>100.0%</b>	<b>655.0</b>	<b>19.5</b>
9	Preliminaries	23.9%	156.4	4.6
10	Traffic management	4.5%	29.5	0.9
12	Contractor's design	4.0%	26.2	0.8
<b>13</b>	<b>Indirect construction costs</b>		<b>212.1</b>	<b>6.3</b>
<b>14</b>	<b>Total construction costs</b>		<b>867.1</b>	<b>25.8</b>
15	Contractor's OH&P	15.0%	130.1	3.9
<b>16</b>	<b>Total contractor's costs</b>		<b>997.2</b>	<b>29.6</b>
15	Rolling stock	54 Nr	331.02	9.8
<b>16</b>	<b>Subtotal</b>		<b>1,328.2</b>	<b>39.5</b>
	Planning & Development	2.3%	29.9	0.9
	Client Design	2.3%	29.9	0.9
	Client Costs	1.5%	20.0	0.6
	<b>Owners management costs total</b>	<b>6.0%</b>	<b>79.8</b>	<b>2.4</b>
	<b>Subtotal</b>		<b>1,408.0</b>	<b>41.9</b>
	Property acquisitions		282.3	8.4
	<b>Subtotal</b>		<b>1,690.3</b>	<b>50.3</b>
	Risk and contingency 20% excluding LRVs 16% including LRVs		275.6	8.2
<b>33</b>	<b>Subtotal</b>		<b>1,965.9</b>	<b>58.4</b>

Table 3 – Draft estimate with corrections

In reviewing each element we would recommend various adjustments to the overall costs as summarised in the table below. Total cost increases from \$1,945m to \$3,673, an increase of some 89%;

	All costs \$m		Total \$m	Total \$m per km
	<b>Direct construction costs</b>			
1	Track (34 km alignment)	18.8%	211.5	6.3
2	Power (inc. 35 Nr substations)	25.3%	285.6	8.5
3	Systems	8.1%	90.8	2.7
4	Utilities	29.0%	326.8	9.7
5	Roadworks	4.2%	47.5	1.4
6	Stops (43 Nr)	5.3%	59.4	1.8
7	Depot & Stabling Facility	9.4%	105.8	3.1
<b>8</b>	<b>Direct construction costs</b>	100.0%	<b>1,127.4</b>	<b>33.5</b>
9	Preliminaries	36.8%	414.9	12.3
10	Traffic management	4.5%	50.7	1.5
12	Contractor's design	18.0%	202.9	6.0
<b>13</b>	<b>Indirect construction costs</b>		<b>668.5</b>	<b>19.9</b>
<b>14</b>	<b>Total construction costs</b>		<b>1,795.9</b>	<b>53.4</b>
15	Contractor's OH&P	15.0%	269.4	8.0
<b>16</b>	<b>Total contractor's costs</b>		<b>2,065.3</b>	<b>61.4</b>
15	Rolling stock	54 Nr	368.3	10.9
<b>16</b>	<b>Subtotal</b>		<b>2,433.6</b>	<b>72.4</b>
	Planning & Development	1.7%	41.4	1.2
	Client Design	2.5%	60.8	1.8
	Client Costs	3.8%	92.5	2.8
	<b>Owners management costs total</b>	8.0%	<b>194.7</b>	<b>5.8</b>
	<b>Subtotal</b>		<b>2,628.3</b>	<b>78.1</b>
	Property acquisitions		282.3	8.4
	<b>Subtotal</b>		<b>2,910.6</b>	<b>86.5</b>
	Risk and contingency	30.0%	762.7	22.7
<b>33</b>	<b>Subtotal</b>		<b>3,673.3</b>	<b>109.2</b>

Table 4 – Revised estimate based on peer review

### 3.2 Option 9a

The latest draft estimate at a P50 confidence level for the CCFAS2 project is \$1,033m plus light rail vehicles of \$135m and heavy rail of \$72m, giving a total of \$1,240m as set out below;

	All costs \$m		Total \$	Total \$m per km
1	Land & Property		192.7	11.3
2	Investigation & Reporting		18.5	1.1
3	Developed Design & D&C Monitoring		30.8	1.8
4	<b>Design &amp; Construct contract</b>			
4.01	Track (LR 13 km, HR 4 km alignment)		218.8	12.8
4.02	Power (inc. 15 substations, LR only)		30.2	1.8
4.03	Systems		7.7	0.5
4.04	Statutory Undertakers Equipment		30.3	1.8
4.05	Highway Costs		6.5	0.4
4.06	Stops (17 Nr LR, 2 Nr HR)		38.3	2.2
4.07	Support Facilities		73.3	4.3
4.08	Design		16.2	0.9
4.09	Programme & Project Management		114.9	6.7
	<b>Subtotal</b>		<b>536.2</b>	<b>31.4</b>
4.10	Off site overhead and Profit		80.4	4.7
	<b>Total D&amp;C</b>		<b>616.6</b>	<b>36.1</b>
5	Contingency P50	20%	174.0	10.2
<b>6</b>	<b>Subtotal @4Q14 prices</b>		<b>1,032.6</b>	<b>60.4</b>
7.01	Rolling Stock – Light rail	22 Nr	134.9	7.9
7.02	Rolling Stock – Heavy rail	9 Nr	72.0	4.2
<b>8</b>	<b>Total Costs @4Q14 Prices</b>		<b>1,239.5</b>	<b>72.5</b>

Table 5- Draft estimate as presented (LR = Light Rail, HR = Heavy Rail)

In order to compare the CCFAS2 project with other similar light rail systems we have analysed the draft estimate and re-ordered some of the line items to reach a standard elemental format as set out below;

	All costs \$m		Total \$m	Total \$m per km
	<b>Direct construction costs</b>			
1	Track (LR 13 km, HR 4 km alignment)	54%	218.8	12.8
2	Power (inc. 15 substations, LR only)	8%	30.2	1.8
3	Systems	2%	7.7	0.5
4	Utilities	8%	30.3	1.8
5	Roadworks	2%	6.5	0.4
6	Stops (17 Nr LR, 2 Nr HR)	10%	38.3	2.2
7	Depot & Stabling Facility	18%	73.3	4.3
<b>8</b>	<b>Direct construction costs</b>	<b>100%</b>	<b>405.1</b>	<b>23.7</b>
9	Preliminaries	24%	96.7	5.7
10	Traffic management	5%	18.2	1.1
12	Contractor's design	4%	16.2	0.9
<b>13</b>	<b>Indirect construction costs</b>		<b>131.1</b>	<b>7.7</b>
<b>14</b>	<b>Total construction costs</b>		<b>536.2</b>	<b>31.4</b>
15	Contractor's OH&P	9%	80.4	4.7
<b>16</b>	<b>Total contractor's costs</b>		<b>616.6</b>	<b>36.1</b>
15	Rolling stock (LRVs)	22 Nr	134.9	7.9
16	Rolling stock (AM Class EMUs)	9 Nr	72.0	4.2
<b>17</b>	<b>Subtotal</b>		<b>823.5</b>	<b>48.2</b>
	Planning & Development	3%	18.5	1.1
	Client Design	3%	18.5	1.1
	Client Costs	2%	12.3	0.7
	<b>Owners management costs total</b>	<b>7%</b>	<b>49.3</b>	<b>2.9</b>
	<b>Subtotal</b>		<b>872.8</b>	<b>51.0</b>
	Property acquisitions		192.7	11.3
	<b>Subtotal</b>		<b>1,065.5</b>	<b>62.3</b>
	Risk and contingency 20% excluding Rolling Stock 16% including Rolling Stock		174.0	10.2
<b>33</b>	<b>Subtotal</b>		<b>1,239.5</b>	<b>72.5</b>

Table 6 – Draft estimate in standardised cost breakdown structure (LR = Light Rail, HR = Heavy Rail)

In reviewing the data presented we have found several anomalies in formulas used to arrive at the current estimate based on the information provided. We have assessed that the accurate representation of the provided information is as follows.

	All costs \$m		Total \$m	Total \$m per km
	<b>Direct construction costs</b>			
1	Track (LR 13 km, HR 4 km alignment)	54%	218.8	12.8
2	Power (inc. 15 substations, LR only)	8%	30.2	1.8
3	Systems	2%	7.7	0.5
4	Utilities	8%	30.3	1.8
5	Roadworks	2%	6.5	0.4
6	Stops (17 Nr LR, 2 Nr HR)	10%	38.3	2.2
7	Depot & Stabling Facility	18%	73.3	4.3
<b>8</b>	<b>Direct construction costs</b>	<b>100%</b>	<b>405.1</b>	<b>23.7</b>
9	Preliminaries	24%	96.7	5.7
10	Traffic management	5%	18.2	1.1
12	Contractor's design	4%	16.2	0.9
<b>13</b>	<b>Indirect construction costs</b>		<b>131.1</b>	<b>7.7</b>
<b>14</b>	<b>Total construction costs</b>		<b>536.2</b>	<b>31.4</b>
15	Contractor's OH&P	15%	80.4	4.7
<b>16</b>	<b>Total contractor's costs</b>		<b>616.6</b>	<b>36.1</b>
15	Rolling stock (LRVs)	22 Nr	134.9	7.9
16	Rolling stock (AM Class EMUs)	9 Nr	72.0	4.2
<b>17</b>	<b>Subtotal</b>		<b>823.5</b>	<b>48.2</b>
	Planning & Development	3%	18.5	1.1
	Client Design	3%	18.5	1.1
	Client Costs	2%	12.3	0.7
	<b>Owners management costs total</b>	<b>7%</b>	<b>49.3</b>	<b>2.9</b>
	<b>Subtotal</b>		<b>872.8</b>	<b>51.0</b>
	Property acquisitions		199.8	11.7
	<b>Subtotal</b>		<b>1,072.6</b>	<b>62.7</b>
	Risk and contingency 20% excluding Rolling Stock 16% including Rolling Stock		174.0	10.2
<b>33</b>	<b>Subtotal</b>		<b>1,246.6</b>	<b>72.9</b>

Table 7 – Draft estimate with corrections (LR = Light Rail, HR = Heavy Rail)



In reviewing each element we would recommend various adjustments to the overall costs as summarised in the table below. Total cost increases from \$1,240m to \$1,865m, an increase of some 50%;

	All costs \$m		Total \$m	Total \$m per km
	<b>Direct construction costs</b>			
1	Track (LR 13 km, HR 4 km alignment)	31.0%	176.4	5.2
2	Power (inc. 15 substations, LR only)	18.8%	107.3	3.2
3	Systems	1.4%	7.7	0.2
4	Utilities	22.6%	128.6	3.8
5	Roadworks	1.1%	6.5	0.2
6	Stops (17 Nr LR, 2 Nr HR)	6.7%	38.3	1.1
7	Depot & Stabling Facility	18.4%	104.6	3.1
<b>8</b>	<b>Direct construction costs</b>	<b>100.0%</b>	<b>569.4</b>	<b>16.8</b>
9	Preliminaries	29.9%	170.1	5.1
10	Traffic management	4.5%	25.6	0.8
12	Contractor's design	15.0%	85.4	2.5
<b>13</b>	<b>Indirect construction costs</b>		<b>281.1</b>	<b>8.4</b>
<b>14</b>	<b>Total construction costs</b>		<b>850.5</b>	<b>25.2</b>
15	Contractor's OH&P	15.0%	127.6	3.8
<b>16</b>	<b>Total contractor's costs</b>		<b>978.1</b>	<b>29.0</b>
15	Rolling stock (LRVs)	22 Nr	134.9	4.0
16	Rolling stock (AM Class EMUs)	9 Nr	72	2.1
<b>17</b>	<b>Subtotal</b>		<b>1,185.0</b>	<b>33.0</b>
18	Planning & Development	2.1%	24.5	0.7
19	Client Design	2.5%	29.3	0.9
20	Client Costs	3.7%	44.0	1.3
<b>21</b>	<b>Owners management costs total</b>	<b>8.3%</b>	<b>97.8</b>	<b>2.9</b>
<b>22</b>	<b>Subtotal</b>		<b>1,282.8</b>	<b>31.9</b>
23	Property acquisitions		199.8	5.9
<b>24</b>	<b>Subtotal</b>		<b>1,482.6</b>	<b>37.8</b>
25	Risk and contingency	25.8%	382.8	11.4
<b>36</b>	<b>Subtotal</b>		<b>1,865.4</b>	<b>49.2</b>

Table 8 – Revised estimate based on peer review (LR = Light Rail, HR = Heavy Rail)

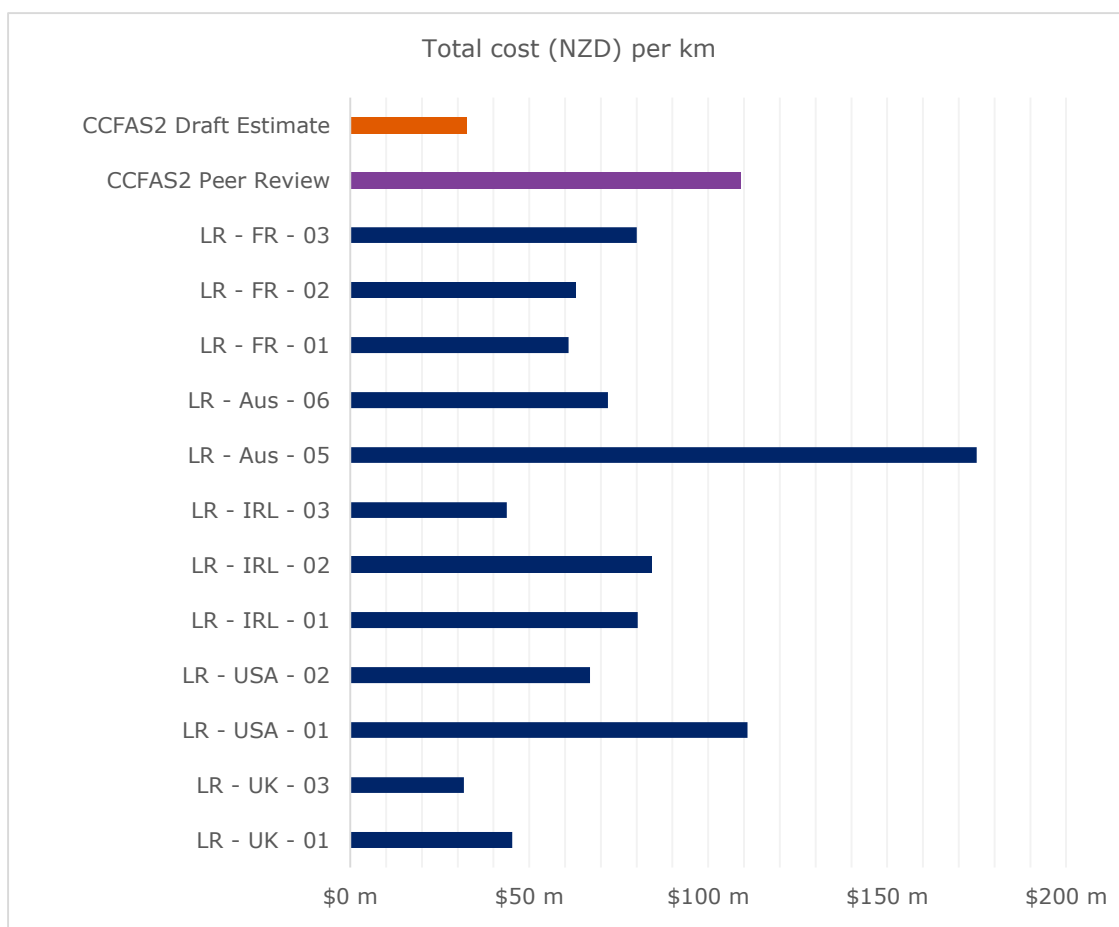
## 4 Cost reviews

### 4.1 Overall cost

To be able to use international light rail projects as comparators for Auckland the data set has to include projects that are similar in nature and extent. It is very difficult and not relevant to compare Auckland’s planned 34 km network, or even shorter initial stages, with simple short extensions to existing light rail networks.

The design and construction of light rail systems in New Zealand and Australia requires a high percentage of imported skills, expertise and equipment. Turner & Townsend’s research and experience of planning for light rail systems in Australia, including wire free technology in Sydney, indicates that a cost of some NZD\$60m per km for Auckland is overly optimistic and set at too low a level.

A selection of relevant projects is given in the graph below, which can be supplemented with further similar projects from our global database.



Graph 1 – Overall cost of light rail projects per route alignment km  
 (LR = Light Rail, HR = Heavy Rail)

## 4.2 Direct construction costs

In the time available it was not possible to consider individual unit rates in detail or verify the quantities used. The major cost components were assessed at a high level either at a total cost per route alignment, such as trackform, overhead wiring, road works and the like or at a facility level such as the depot and stabling or in some case a slightly more detailed level such as number of substations, stops and the like.

### 4.2.1 Trackform

Option 4 has an alignment length of 33.6 km and Option 9a 17.1 km (13.2 km of light rail and 3.9 km of heavy rail). The trackform and storm water drainage appears to be set at a high level of pricing and there are opportunities to reduce this cost component, as shown in the table below;

	Draft Estimate \$/km	Revised Estimate \$/km	Difference \$m/km
Option 4	10.5	6.3	(4.2)
Option 9a	12.8	5.2	(7.6)

Table 4.2.1 – Trackform per alignment km

Some detailed observations for the trackform are;

- Track - there is a cost within the draft estimate for "Make good asphalt carriage way adjacent to slab" with a cost of \$500/m. We would normally include this cost within the Roadworks budget.
- Track - the formwork rate of \$120/m appears high. We would normally expect to see circa \$15-\$20/m, especially when it is re-usable.
- Track - our benchmarked data would be circa \$4,200/m - \$4,900/m for trackwork. The draft estimate has \$6,270 plus the rail boot which is included within the drainage. This appears high.
- Drainage - the draft estimate includes the rail boot within the drainage heading and this would normally be within the track component. This equates to \$2,616/m versus an expected range of \$350-\$500/m, leaving \$573/m for drainage (based on the Dominion road option). This appears high as \$250-\$300/m would be the expected range for drainage.

#### **4.2.2 Bulk and traction power**

When considering the bulk and traction power requirements it would appear that the pricing of the feeders, substations and transformers reflect smaller sizes and capacities than those required for a light rail system which results in a shortfall of cost in this area.

The draft estimate contains 43 light rail substations for Option 4 and 15 for Option 9a, with heavy rail substations excluded. As a minimum we would advocate using a cost of \$2.3m per traction substation.

Additional notes and observations are given at Appendix 4.

#### **4.2.3 Light rail systems**

Contained within the systems heading there needs to be provision for small power and lighting, combined services route, communications systems, security systems, passenger information system, road traffic and LRV signalling and ticketing systems.

The allowances made for rail systems are largely one line items and do not appear to contain any detail, especially when compared to the detail in other areas such as the depot facility building. It is clear that this area of the draft estimate is understated and requires more work to better reflect the scope of works required to deliver a wire free light rail system.

#### **4.2.4 Existing utilities**

The costs of existing utilities modifications are significantly lower as a proportion of the overall light rail infrastructure cost when compared to other international projects. It is recognised that Auckland city centre may have very few below and above ground utilities that require protection, relocation or diversion and the project team will have a deeper understanding of this position. However, this is an area of high risk for all light rail projects in our experience.

If indeed the corridors are largely utility free then the costs could be considerably lower when compared to other light rail projects.

#### **4.2.5 Stops**

Option 4 contains a total of 43 new light rail stops and Option 9a a combination of 17 new light rail stops and 2 new heavy rail platforms.

The average cost per stop in the draft estimate equates to \$1.3m which is reasonable when compared to other similar light rail systems that have a variety of city centre and suburban stop locations.

#### **4.2.6 Light rail depot and stabling**

Specific site conditions such as ground conditions, topography, sensitive noise receptors and the like can dictate a wide range of cost for depots and stabling facilities, as can the total fleet size with increased economies of scale for larger fleets. With the requirement for a temporary depot there will be some duplication of infrastructure which lead to some cost inefficiencies. The benchmark data indicates that the draft estimate is at the lower end of expectations so our suggested allowance is above the current assumption.

The draft estimate equates to \$1.4m per LRV and our revised estimate contains \$2.0m per LRV.

#### **4.2.7 Rolling stock**

The light rail vehicles are priced competitively but current market intelligence suggests that the unit price does not properly reflect the desire for wire free technology and we would recommend a unit price of at least \$6.8m per vehicle, versus the draft estimate of \$6.1m.

We do not possess detailed knowledge of the Auckland Transport AM Class Electric Multiple Unit rolling stock pricing and have therefore assumed that the draft estimate of \$8.0m per three car train is appropriate.

### **4.3 Indirect construction costs**

The following subsections summarise the findings and differences between the current estimate and the review undertaken by Turner & Townsend for the indirect construction cost elements.

#### **4.3.1 Preliminaries**

Preliminaries comprise the management resources and temporary facilities needed to deliver the permanent works. They vary with the method and circumstances of the project and are very dependent upon the duration of the construction durations. Typically preliminaries include the core project and site management teams, stakeholder and community relations, the site compounds and offices and traffic management activities and staff.

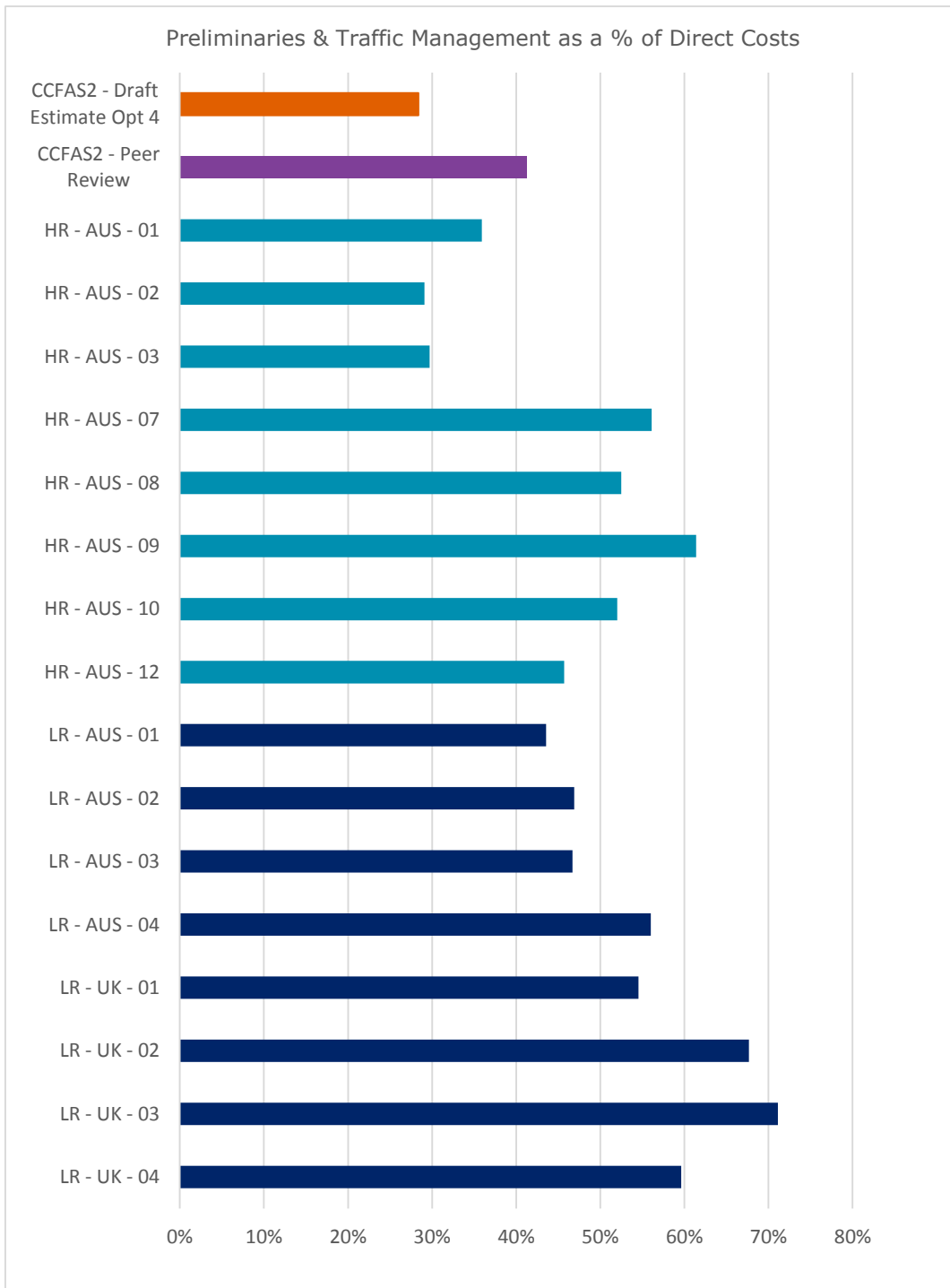
Preliminaries in the draft estimate at 28% are set at the lower end of what might be expected for a light rail system but may reflect what might be possible in New Zealand with lower people costs. However, it must be stressed that there will be requirements for light rail experts to be temporarily relocated to Auckland to undertake some of the specialised work associated with the management, installation and commissioning of a complex wire free light rail system into an established urban environment. Although people costs are generally lower in New Zealand there will still be a requirement for overseas staff to be deployed for the construction phase with the associated additional expense

We have assessed that the preliminaries should be set at a level of 35% or greater

In recommending an appropriate allowance (as a percentage of total direct construction costs) for preliminaries we considered various other light and heavy rail projects. The projects have been anonymised to retain client confidentiality.

Graph 1 plots the preliminaries percentages. The data set shows that there is considerable variability in the preliminaries percentages, 29% to 71%, among these projects which can be explained to a considerable extent by the fact that preliminaries vary considerably with the works method, circumstances and complexity of the project.

The heavy rail projects have been completed under either an Alliance delivery model or on a design and construct basis, with the Alliance projects tending to have higher preliminaries cost.



Graph 2 - Preliminaries as percentage of direct construction costs in NSW and internationally (HR = Heavy Rail, LR = Light Rail)

#### **4.3.2 Contractor's design**

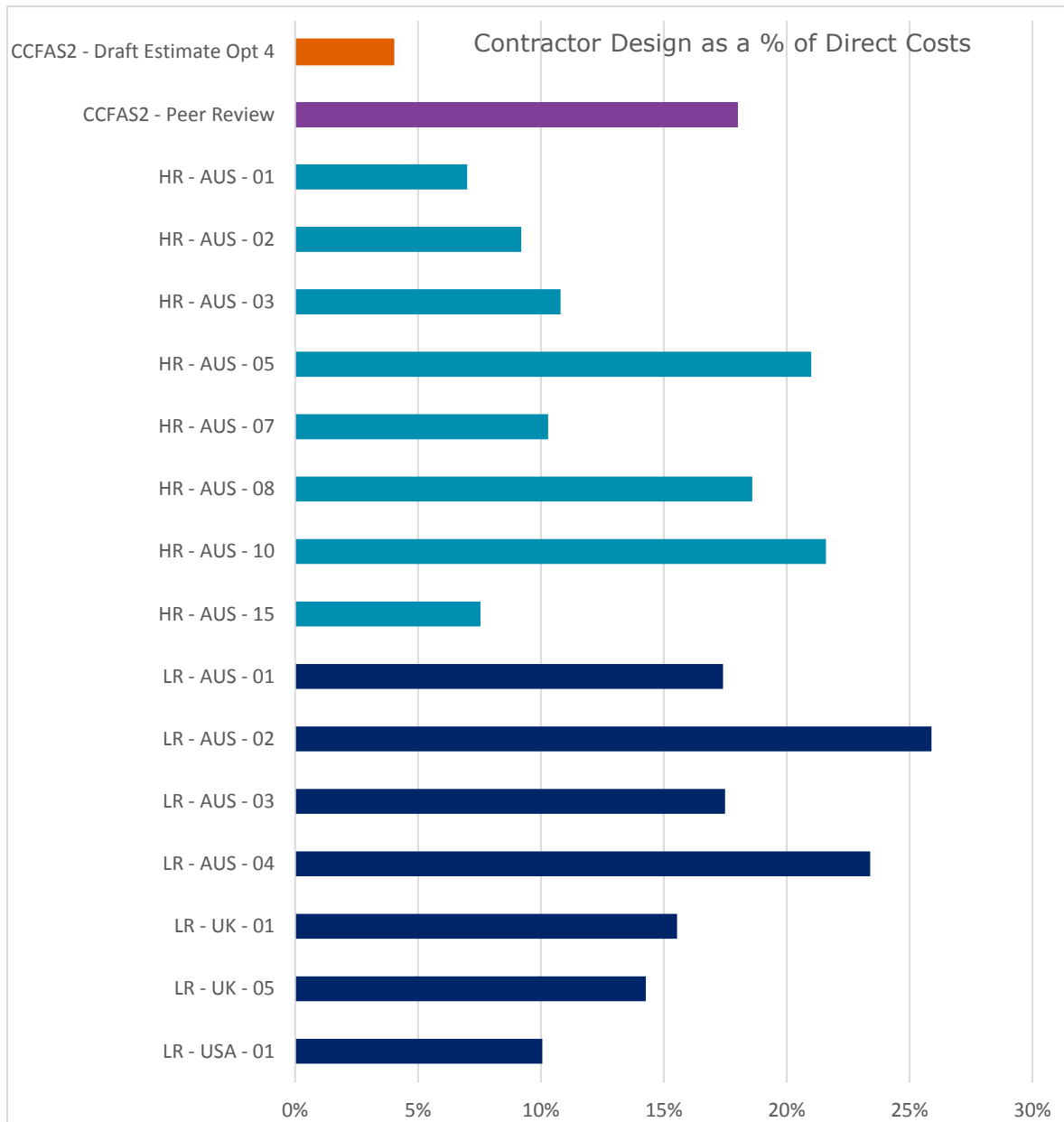
The contractor's design allowance is in addition to any design undertaken by professional engineering companies engaged by Auckland Transport. The allowance includes the cost of detail design, construction support and any detail design required in conjunction with the utilities providers.

The light rail systems design will form a considerable proportion of the total design effort, with expertise from outside of New Zealand. The requirements for a 100% wire free system will drive additional cost into both the client and contractor's design totals.

The draft estimate contains a provision of 4% which, in Turner & Townsend's experience of light rail projects in Australia and globally, would represent exceptional performance. To better reflect the complex design associated with a light rail project that relies heavily of specialist rail systems experts that are not resident in New Zealand we would suggest a percentage of at least 18%.

Graph 2 plots the design percentages of 15 rail projects to demonstrate typical design proportion ranges.





Graph 3 - Design allowances for previous project  
 (HR = Heavy Rail, LR = Light Rail)

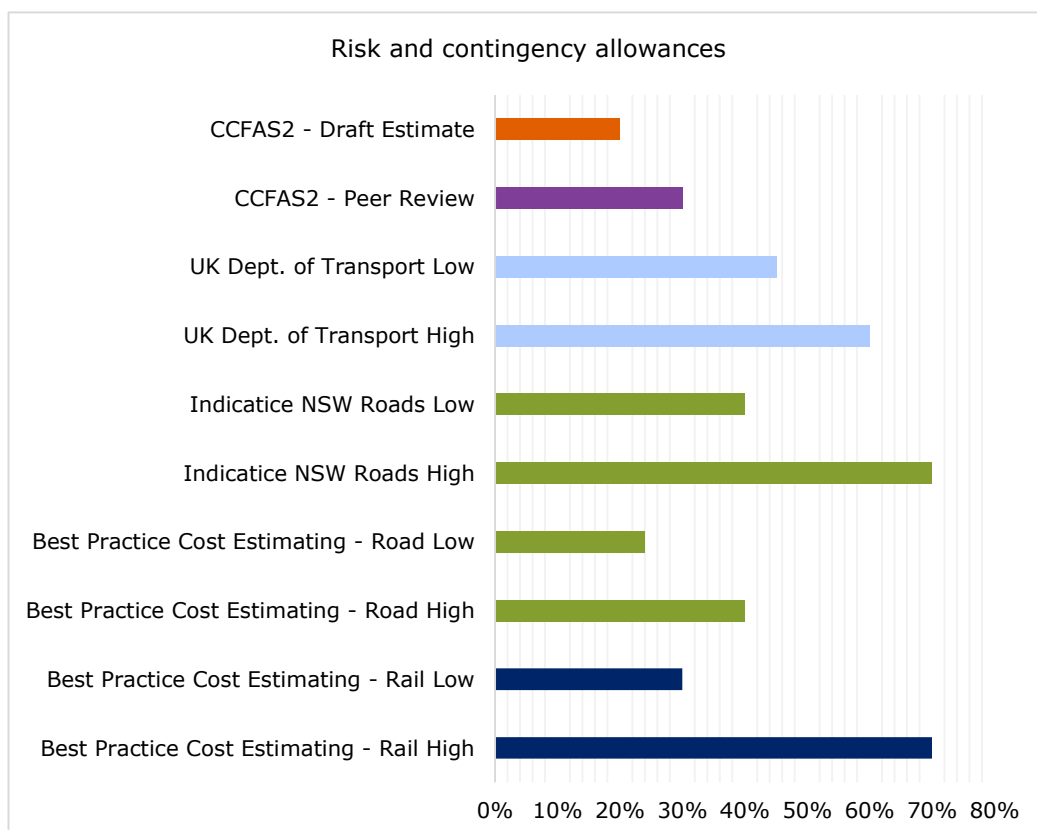
#### 4.4 Risk & contingency

A P50 risk and contingency allowance of 20% for the project (excluding LRVs) must cover uncertainties in scope, quantities, unit rates and other risk events. Turner & Townsend consider this percentage as too low at this stage of the project development and scope definition.

A more realistic level would be in the order of 30%, based upon Turner & Townsend recent experience of major engineering projects in Australia and internationally.

It is worth taking into consideration the Australian Government’s Dept. of Infrastructure and Regional Development guidance (Best Practice Cost Estimation) that a risk allowance could be up to 40% for road projects and 70% for rail projects, when at Project Scoping stage. We consider that the Auckland CCFAS2 project may have just reached Project Scoping stage.

Similarly, New South Wales Roads & Maritime Services guidance ranges from 40% to 70% and a study by the UK Dept. of Transport into optimism bias suggests a range of 45% to 60% and above for projects in the early stages of development.



Graph 4 – Typical risk and contingency allowances at early stage of project development

## Appendix 1

### **Option 4 cost summaries**

Option 4 Summary

Element	Item description	Draft Estimate 2.12.2014 Price NZ\$	T&T Peer review Price NZ\$ (inflated 0%)	Comments
		<b>33,636m</b>	<b>33,636m</b>	Length
1. Land and Property		<b>282,312,093</b>	<b>282,312,093</b>	
2. Investigation and Reporting		<b>29,877,147</b>	<b>41,127,703</b>	Percentage based calculation
3. Developed design reporting including D&C Contract monitoring		<b>49,795,251</b>	<b>154,228,888</b>	Draft Estimate 2.12.2014 has a total 5%. T&T have increased to 7.5%.
4. Detailed design and Construction		<b>867,513,286</b>	<b>1,788,161,011</b>	Split of the total is No1-6
	1.Track	352,137,531	211,499,179	Bridges and support structures & Portals or underpasses costs have been left as per the Draft Estimate 2.12.2014, as T&T have no drawings to price. The track has been reduced \$58m and drainage by \$82m based on market knowledge.
	2. Power	76,178,920	350,989,324	Power supply has been excluded, so the estimate is like for like. Substations and underground power was under-priced. \$78m increase in substations and \$131m increase in underground power.
	3. Systems	20,126,578	90,783,564	Draft Estimate 2.12.2014 was under-priced.
	2.Statutory undertakers Equipment	63,717,800	326,807,376	Draft Estimate 2.12.2014 was under-priced.
	3.Highway costs	13,906,015	47,460,647	T&T have used the Draft Estimate 2.12.2014 price for cycleway. Draft Estimate 2.12.2014 price for highway seems very low. T&T believe the works outside of the corridor have not been allowed for.
	4. Stops	54,892,860	54,892,860	Stops price has been pro-rated from benchmarked data. The Draft Estimate 2.12.2014 bus interchange price has been used by T&T.
	5.Support Facilities	74,410,308	105,785,855	T&T have used the administration building/Control centre & Temporary depot cost within the comparison.
	6. Design	26,214,802	202,115,530	Draft Estimate 2.12.2014 had 4%. T&T benchmarked data and market knowledge highlights the design is severely under-priced. 15-20% would be more comfortable. T&T have allowed 18% for this comparison exercise.
	6.Programme and Project Management	185,928,472	463,181,424	The Draft Estimate 2.12.2014 has preliminaries at 22%. T&T have increased to 30% based on market knowledge.
	check	-	<b>65,354,748</b>	
Off site Overheads and Profit @ 15% risk		<b>130,126,992</b>	<b>268,224,152</b>	WT Risk @ 20.27% . T&T Risk @ 30%.
		<b>253,962,477</b>	<b>760,216,155</b>	1.0795 exchange rate used
	<b>Total expected cost</b>	<b>1,613,587,246</b>	<b>3,294,270,002</b>	



## Appendix 2

### **Option 9a cost summaries**

Summary HR & LR

Element	Item description	Draft Estimate 2.12.2014 Price NZ\$	T&T Peer review Price NZ\$ (inflated 0%)	Comments
		<b>17,099</b>	<b>17,099</b>	Length
1. Land and Property		<b>192,681,194</b>	<b>199,821,194</b>	Draft Estimate 2.12.2014 has an error in calculations. \$7m. Percentage based calculation Draft Estimate 2.12.2014 has a total 5%. T&T have increased to 7.5%.
2. Investigation and Reporting		<b>17,995,062</b>	<b>24,455,672</b>	
3. Developed design reporting including D&C Contract monitoring		<b>29,991,770</b>	<b>73,367,015</b>	
4. Detailed design and Construction		<b>521,595,966</b>	<b>850,632,056</b>	Split of the total is No1-6 Insufficient time to fully analyse the costs, therefore the Draft Estimate 2.12.2014 has been used and adjusted in line with T&T's benchmarked data. T&T reduced by \$31m  Insufficient time to fully analyse the costs, therefore the Draft Estimate 2.12.2014 has been used and adjusted in line with T&T's benchmarked data. Added an additional \$52m for the power and an additional \$25 for the substations Insufficient time to fully analyse the costs, therefore the Draft Estimate 2.12.2014 has been used. The initial view is the estimate is low, although the benchmarked data is not readily available to change the Draft Estimate 2.12.2014. Insufficient time to fully analyse the costs, therefore the Draft Estimate 2.12.2014 has been used. An additional \$98m has been added to the utilities estimate.  Insufficient time to fully analyse the costs, therefore the Draft Estimate 2.12.2014 has been used. The initial view is the estimate is low, although the benchmarked data is not readily available to change the Draft Estimate 2.12.2014. Insufficient time to fully analyse the costs, therefore the Draft Estimate 2.12.2014 has been used. The initial view is the estimate is low, although the benchmarked data is not readily available to change the Draft Estimate 2.12.2014. Insufficient time to fully analyse the costs, therefore the Draft Estimate 2.12.2014 has been used. The initial view is the estimate is low, therefore an additional \$30m has been added to the to depot. Draft Estimate 2.12.2014 had 4%. T&T benchmarked data and market knowledge highlights the design is severely under-priced. T&T have allowed 15%.  The Draft Estimate 2.12.2014 has preliminaries at 22%. T&T have increased to 25%.
	1.Track	207,841,052	176,391,909	
	2. Power	30,196,080	107,328,999	
	3. Systems	7,669,021	7,669,021	
	2.Statutory undertakers Equipment	30,272,600	128,630,124	
	3.Highway costs	6,514,830	6,514,830	
	4. Stops	38,280,052	38,280,052	
	5.Support Facilities	73,270,308	104,645,855	
	6. Design	15,761,758	85,419,119	
	6.Programme and Project Management	111,790,265	195,752,147	
Off site Overheads and Profit @ 15% risk		<b>78,239,394</b> <b>170,370,037</b>	<b>127,594,808</b> <b>382,761,225</b>	WT Risk @ 20.27% . T&T Risk @ 30%. 1.0795 exchange rate used
<b>Total expected cost</b>		<b>1,010,873,423</b>	<b>1,658,631,970</b>	





## Appendix 3

### **Query and response summary**

# Queries / Observations Issue: 1

Tel: 02 8245 0000  
Fax: 02 8245 0099  
Level 14, 55 Clarence Street Sydney 2000

<b>From:</b>	David Creegan	<b>To:</b>	Auckland Transport
<b>Date:</b>	03.12.14	<b>Copy:</b>	
<b>Project:</b>	City Centre Future Access Study 2 (CCFAS2)	<b>Job Ref:</b>	

Nr	Query	Response (04-Dec-14)
1	<b>Power supply</b> - Why has this been excluded from the estimate?	Upgrade of Transpower's grid only has been excluded
2	How many <b>substations</b> are allowed for?  Post response note:  From our analysis of the draft estimate it would appear that the following substations are included; Stage 1 - 3 Nr Stage 2 - 6 Nr Stage 3 - 4 Nr Stage 4 - 4 Nr Stage 5 - 18 Nr	One Substation has been allowed every 1.5km of route as advised by Arup , (Queen street 2 no, Dominion Road 4 no, Stoddard 2 no, Sandringham 4 no, Mt Eden, 4 no, Quay to new market 3 no, Newmarket to Onehunga 4 no) Total 23 Nr
3	<b>Statutory undertakers</b> - What level of detail and design was available when the estimate was produced?	Statutory undertakers the level of detail is as that shown on Auckland Council web site GIS viewer, plus a site observation , For Dominion road we have greater details as a project was about to get underway for its upgrade. Generally the storm water and sewer is near to the centre of the road, water is all over the place, the rest is either in the footpaths or overhead.
4	<b>Depot</b> - Final summary tab - 4. Detailed design and Construction, 5.Support Facilities 1. & 2. What is the basis for the estimates of the \$1,000,000 & \$2,000,000? They do not appear within the build up for the 'Depot Link'	These are plugged figures that need to be combined with the temp depot, what is required in addition to the existing bus/ traffic ops for just Queen street stage has not been detailed.
5	How many <b>Light Rail Vehicles</b> should be included and what is the unit price?  Post response note:  \$6,130,000 per LRV Option 9a 22 Nr, Option 4 54 Nr	The vehicles costs have been included by the others

Nr	Initial Observations	Response (04-Dec-14)
1	<p><b>Design</b> Costs appear very low at 4% of direct construction costs. Ranges for similar light rail projects globally are c. 15% to +20%.</p> <p>Post response note:</p> <p>3% (of total D&amp;C cost) for Investigation and Reporting (I&amp;R), includes planning, approvals and funding activities.</p> <p>5% (of total D&amp;C cost) for Developed design, includes preliminary design, reference design, detailed design, procurement and programme and project management (3% for the design and procurement, 2% for management).</p>	<p>Only detailed design is at 4% as this is the bit the contractors will do there is another 3% for I&amp;R and 5% for Developed design a total of 11% possibly light overall.</p>
2	<p>There appears to be errors in the 'Final Summary' tab. Calculations for columns Stage 1 Total, Stage 2 Total, Stages 1 – 3 do not pick up all of the cells. The Total column appears to be correct.</p>	<p>This has been corrected</p>
3	<p>The temporary depot has a very detailed cost plan totalling \$15,270,308. Then the <b>stage 2 depot</b> has a round \$50,000,000 in the estimate with no back up. The round number seems to be a plug figure rather than a cost estimate.</p>	<p>Correct it is a plugged figure based on advice from Arup there is no details of the requirements</p>
4	<p>The cost allowance for substations appears to be very low on first inspection</p>	<p>I was concerned with this cost in the last update this has been increased to \$305k each, do T&amp;T have any better current information</p>
5	<p><b>Light rail systems, signalling and telecoms</b> appears to be set at a very low price point and may not include all scope required for a wire free light rail system.</p>	<p>Signalling is based on the number of intersections that need traffic light alterations , telecoms is for the backbone only the head equipment is included in the support facilities, if they have any better information this would be appreciated</p>
6	<p><b>Statutory undertakers</b> – Appears to have been priced very low when compared to other light rail systems in major city centre locations.</p>	<p>This has recently been increased due to the requirement to move 195m of kerb line at each station, see also comment on Query 3 the amount not included is \$63m</p>
7	<p><b>Project Management costs.</b> – Final summary tab - 3. Developed design reporting including Design &amp; Construct Contract monitoring, 5.Programme and Project Management. The total of these is 2%. We would expect to see a lot higher percentage, possibly in the range of 7% to +11%.</p>	<p>PM costs of 7-11% appear high to me Victoria what are your thoughts</p>
8	<p>The <b>Highway</b> costs appear to be low. Turner &amp; Townsend need to understand the route in more detail to comment further.</p>	<p>Highway costs have been based on the clearance of any obstructions in the centre of the road, is has generally been assumed that the tracks run down the centre of the road and there would be little change to the road profile, a stitch make up has been included in the track bed and a similar item has also been included in the station/ station footpaths</p>

Nr	Initial Observations	Response (04-Dec-14)
9	The project is the first wire free light rail system in New Zealand and the first 100% wire free system globally we understand. The <b>P50 risk</b> allowance appears to be low when compared to other projects at this stage of development and considering no project of this nature has been constructed	The risk assessed contingency is being worked on, currently it is lower than that detailed on the spread sheet of 20%
10	Spreadsheet, CCFAS2 Draft Estimate estimate- 2.12.2014, tab HR & LR has a lot of cells containing #VALUE!	These have been corrected
11	<b>Preliminaries &amp; Traffic Management</b> are lower than expected with respect to the direct construction cost component at a composite rate of 24%. Benchmarked light rail data indicates a preliminaries and traffic management composite percentage over 25%, with some examples closer to 48% and above.	P&G For NZ a P&G of over 24% for a design and build contract would be surprising , it would be useful to know what form of procurement and associate P&G % then have information on  [P&G = Preliminaries & General]

## Appendix 4

### **Additional power and rail systems notes**

## Light Rail

- Power/Substations
  - The quantity of substations needs to be revised, at present the quantity is aligned with the number of stops, instead of the usual 1.5-2km along the route; the substation spacing was detailed by email from Arup's Andy Wood on 04/12/2014.
  - The rate for the substation is significantly low. It appears that general distribution 11kV kiosk substations have been costed, these are not the type of substation required for light rail power reticulation. This type of substation may be the source of the power for the light rail substation.
  - Internal cabling cost will be higher due to cable, trays, termination, testing and commissioning.
  - No allowance appears to have been made for AC and DC commissioning.
- Power/Underground
  - The allowance for the light rail substation feeders is significantly low. The feeder route will generally be routed within the road footprint to avoid services and can be more than one kilometre in length. This means the installation of cable jointing and change of direction pits along the buried route and a much lower trenching productivity rate, road closure fees and more traffic management. Metre rate= \$1,563
  - Substation feeder cable: The allowance appears to be too high, this takes into account the cost of the cable (11kV 3 core 240 mm<sup>2</sup> XLPE), cable hauling, cable jointing and termination. Metre rate= \$172
- Power/Charger stations
  - There is no cost breakdown. There is most likely a requirement for 2 Nr 400 mm<sup>2</sup> DC feeder cables to each charger station with an approximate length of 1,320 m between the substation and the charger station. The cost of the cable supply and installation is approximately \$285,000, an additional amount of \$50,000 per charger unit will also be required.
- Telecommunications
  - Ducts: The duct installation rate is too low, based on a first principles estimate for a 0.5 x 1.2 m trench with a productivity of 25 m per crew per day.
  - Fibre cable: The installation of a 24 core single mode optical fibre cable is assumed. The rate appears to be at least 50% too low considering OTDR testing, cable supply and installation.

## Heavy Rail

- The cable support system cost is at least 20% too low based on a first principles estimate for 100mm (Comms), 150mm (signalling) and 200mm (HVAC) galvanised steel trough (GST).