TE MANATŪ WAKA
MINISTRY OF TRANSPORT

OC230830
16 October 2023

[redacted]

Tēnā koe [redacted]

I refer to your email dated 18 September 2023, requesting the following under the Official Information Act 1982 (the Act):

> *"Please provide the cabinet papers and minutes and any reports referred to in those papers or minutes that approved the original and additional funding for City Rail Link."*

Eight documents fall within the scope of your request. Five documents are already publicly available; therefore I am refusing part of your request under Section 18(d) of the Act. The remaining three documents in scope of your request are detailed in the document schedule attached in Annex 1. The document schedule outlines how the documents you requested have been treated under the Act.

PwC prepared its City Rail Link (CRL) Economic Assessment Update in 2022. The update was based on the information available and applicable market conditions at that time. It is possible that subsequent events and updated information could lead to different findings and conclusions today.

You have the right to seek an investigation and review of this response by the Ombudsman, in accordance with section 28(3) of the Act. The relevant details can be found on the Ombudsman's website **www.ombudsman.parliament.nz**

The Ministry publishes our Official Information Act responses and the information contained in our reply to you may be published on the Ministry website. Before publishing we will remove any personal or identifiable information.

Nāku noa, nā

Andrew Hicks
Acting Manager, Programme Assurance and Commercial

Table 1 Annex One - Document Schedule

Doc #	Date	Document	Decision on release
1	April 2019	CRL Economics Update	Document is released in full
2	April 2019	CRL Base Case Indicative Update	Document is released in full
3	October 2022	CRL Economics Update	Document is released in full
4	April 2017	Cabinet Minute for Vote Transport Budget 2021	Refused under 18(d) The document is available here: www.treasury.govt.nz/sites/default/files/2017-11/b17-3722539.pdf
5	July 2017	Cabinet Paper for Budget 2017	Refused under 18(d) The document is available here: www.treasury.govt.nz/sites/default/files/2017-11/b17-3700165.pdf
6	August 2019	Budget 2019 Cabinet Minute	Refused under 18(d) The document is available here: www.treasury.govt.nz/sites/default/files/2019-08/b19-4106574.pdf
7	August 2019	Budget 2019 Cabinet Paper	Refused under 18(d) The document is available here: www.treasury.govt.nz/sites/default/files/2019-08/b19-4115776.pdf
8	March 2023	2023 cabinet paper and minute	Refused under 18(d) The document is available here: http://www.transport.govt.nz/assets/Uploads/Proactive-Release-of-Cabinet-Paper-for-the-Auckland-City-Rail-Link-Project-Additional-Funding.pdf

Document 1

pwc

Strictly Confidential

John Williamson
Programme Director CRL Developments
City Rail Link Limited
PO Box 105777
Auckland 1143

11 April 2019

CRL Economic Assessment Update

Dear John

PwC have been engaged by City Rail Link Ltd (CRLL) to update the economic assessment prepared as part of the 2015 business case for the project (prepared by Auckland Transport) and undertake an assessment of the impacts of various scope changes to the City Rail Link (CRL) on the estimated benefits.

This letter has been prepared in accordance with our Letter of Engagement dated 21 February 2019 and should be read in conjunction with the restrictions outlined in Appendix A.

Summary

We have updated the economic assessment of the CRL base case (as per the 2015 business case) to 2018 dollars to reflect updates applied to the NZ Transport Agency's Economic Evaluation Manual (EEM) and to allow a comparison with the revised cost estimates being developed (also in 2018 dollars), noting these are not yet available.

- Based on a spend profile and escalation rates provided by CRLL, a benefit-cost ratio (BCR) of 1 is still maintained if the capital cost is lower than:
    - $5,119 million (unescalated, in 2018 dollars)
    - $5,815 million (escalated to the year of spend)
- This value is considered to be conservative as it does not reflect the additional benefits associated with:
    - any scope changes since the business case was completed, for example the inclusion of 9-car future proofing means future benefits would be higher than assessed
    - recent growth in rail patronage being higher than forecast at the time of the business case, as existing rail passengers receive considerable benefits from CRL.

Updated base case assessment

The update has focused solely on updating the benefit values from 2014 dollars to 2018 dollars and adjusting for revised timelines. Revised inputs to the economic model (ie transport modelling outputs) have not been used.

The economic evaluation of a project relies on an assessment of the present value (PV) of costs and benefits. The cost of a project is generally estimated in the dollars of a chosen base year (here it is 2018) and then escalated using an inflation adjustment to derive the total outturn cost. The PV of the project cost is then derived through discounting of the base year cost.

Following the update and revision to the benefit calculations, the CRL generates total benefits including wider economic benefits with a PV of $4.49 billion in 2018 dollars over the 40 year assessment period.

To assess the impact of the change in the value of the PV of the total benefits on the BCR, we require the capital and operating cost estimates along with the spend profile to generate the PV of the costs. Revised operating costs have been provided by CRLL (in 2018 dollars), but updated capital costs are not available at this time. However, CRLL have provided an indicative capex spend profile which we can utilise to back calculate the PV of the capital cost that maintains a BCR of 1.0 (as we have calculated the PV of the operating costs). This back calculation gives a capital cost PV of $4.04 billion in 2018 dollars.

Using the PV of the capital costs of $4.04 billion and the spend profile from CRLL, we can then remove the discounting effects and find that a total capital cost of $5.12 billion (undiscounted in 2018 dollars, or $5.82 billion when escalated to the year of spend) maintains a BCR of 1. This means that as long as the revised cost estimate is less than this (and the spend profile is not significantly different from that used), then the CRL base case remains justified based on the conservative economic assessment that has been undertaken.

The updated base case assessment of the benefits and costs is summarised in Table 1 below, for the capital cost scenario that maintains a BCR of 1.

Table 1 Benefit and cost assessment summary (40 year period, 2017-2056)

	Undiscounted total (2018 dollars, billions)	PV (2018 dollars, billions)
Conventional benefits	$13.25	$3.13
WEBs	$5.60	$1.36
Total benefits	**$18.85**	**$4.49**
Capital costs	$5.12[1]	$4.04
Operating costs	$1.49	$0.45
Total costs	**$6.60**	**$4.49**

Source: PwC analysis

[1] When escalated to the year of spend, this results in a total outturn capital cost of $5.82 billion.

As previously identified through the Gateway Review process, the overall assessment is still considered to be conservative given the use of the standard 40 year assessment period for such a transformational, long-life project. When the assessment period is extended to 60 years, the gross benefits increase by a further 23%, which would also improve the BCR as the future annual benefits dwarf the annual operating costs. The overall benefits would also be expected to increase further if the benefits of recent scope changes (eg 9-car future proofing) or growth in rail patronage over the last few years were incorporated as noted above.

Scenario assessment

CRLL are currently considering a number of scope change scenarios that would impact the cost of the CRL infrastructure and consequently the train service patterns that could operate. Changes to the train services would have resulting impacts on the benefits that are generated by the project.

With no ability to undertake detailed transport modelling for the different scenarios due to time constraints, we have developed an alternative methodology to estimate the potential impacts on the base case benefits of the different scenarios by utilising outputs from transport modelling undertaken as part of the 2015 business case.

Given the limitations of the information available, but recognising that the public transport travel time savings make up approximately 60% of the conventional benefits, we have split the methodology to estimate impacts on public transport travel time benefits and other conventional benefits separately.

Following an operational assessment of the different scenarios, only one scenario has been assessed using the methodology we have developed.

Scenario 2a sees the removal of K Rd station from the CRL scope.[2] In terms of train service patterns, it has little impact as the base case train plan is still applicable. Services running through CRL will have a minor reduction in journey time to reflect one less deceleration/acceleration cycle and no dwell time at the station. There could however be a minor increase in dwell time at other stations as passenger loadings at those locations would likely increase (ie it is not simply a case of removing the passengers associated with the station from the system completely).

Under this scenario it is likely that some (and possibly most) people would continue to travel, perhaps to Aotea, and then transfer to a bus or walk back towards their destination. This erodes most (or all) of the travel time benefit they were getting with the station in place. However it means that the impact on the other conventional benefits may be modest.

We have developed two cases to estimate the possible outcomes for Scenario 2a:

- A “possible worst case” where public transport travel time benefits reduce by 22.3% and other conventional benefits reduce by 16%
- A “possible best case” where public transport travel time benefits only reduce by 50% of the above and other conventional benefits only reduce by 25% of the above.

[2] There are a number of other minor components to this scenario, however they do not impact the train services and therefore can be ignored for the purposes of estimating the impacts on base case benefits.

Table 2 Scenario 2a (Remove K Rd station) benefit assessment PV summary

	Base Case (2018 dollars)	Scenario 2a – Worst case (2018 dollars)	Scenario 2a – Best case (2018 dollars)
Conventional benefits	$3,133m	$2,614m (83% of base case)	$2,949m (94% of base case)
WEBs	$1,357	$1,132m	$1,277m
Total benefits	**$4,490m**	**$3,747m** (83% of base case)	**$4,227m** (94% of base case)

Source: PwC analysis

The analysis of Scenario 2a suggests that if K Rd station is removed, then the project is likely to still generate between 83% - 94% of the benefits of the base case. Putting it another way, removing the K Rd station is likely to remove between $263m - $743m worth of benefits over the 40 year assessment period. This suggests that if the PV of the cost saving from removing the station is less than $263m, then from an economic perspective it would make sense to retain the station as the estimated benefits it generates outweigh the potential cost saving from removing it.

Another consideration that should inform decision making on this scenario is the impact on the development and regeneration opportunity in the area surrounding the K Rd station. Recent work by PwC for the Ministry of Transport highlighted the significant development potential within the precinct surrounding the K Rd station. With the station removed, it is likely that this potential would either not be able to be fully realised, be realised at a considerably slower rate or not realised at all.

Limitations

We reiterate that the assessment is an estimation only, based on limited information, short timeframes and an overarching assumption that the overall benefits can be assessed or considered using a number of overarching assumptions. With additional time, the scenarios should be modelled, though we note that this would require the base case to be reassessed given the modelling tools and land use inputs have changed since the 2015 business case assessment was completed.

Further detail relating to the base case update and scenario analysis is provided in Appendix B.

We are happy to discuss any aspects of the findings of our review with you in more detail.

Yours sincerely

Jarrod Darlington
Director
Email: jarrod.s.darlington@pwc.com
T: 09 355 8105

Craig Rice
Partner
Email: craig.rice@pwc.com
T: 09 355 8641

Appendix A: Restrictions

This letter has been prepared for City Rail Link Limited (CRLL) to detail the update of the economic assessment of CRL and assess the impacts on the base case benefits of various CRL scope changes. This letter has been prepared solely for this purpose and should not be relied upon for any other purpose. We accept no liability to any party should it used for any purpose other than that for which it was prepared.

This letter has been prepared solely for use by CRLL and may not be copied or distributed to third parties without our prior written consent.

To the fullest extent permitted by law, PwC accepts no duty of care to any third party in connection with the provision of this report and/or any related information or explanation (together, the "Information"). Accordingly, regardless of the form of action, whether in contract, tort (including without limitation, negligence) or otherwise, and to the extent permitted by applicable law, PwC accepts no liability of any kind to any third party and disclaims all responsibility for the consequences of any third party acting or refraining to act in reliance on the Information.

We have relied on information provided by CRLL as part of our engagement and certain information, by its nature, is not able to be independently verified. We have not conducted any form of audit in respect of CRLL. For information we have not been able to independently verify, we express no opinion on the reliability, accuracy, or completeness of the information provided to us and upon which we have relied.

The statements and opinions expressed herein have been made in good faith and are based on information as at the date of this letter, on the basis that all information relied upon is true and accurate in all material respects, and not misleading by reason of omission or otherwise.

We reserve the right, but will be under no obligation, to review or amend our report, if any additional information, which was in existence on the date of this report, was not brought to our attention, or subsequently comes to light.

This letter is issued pursuant to the terms and conditions set out in our Letter of Engagement dated 21 February 2019.

Appendix B: Supporting detailed analysis

Background

The economic assessment of CRL was prepared for the business case in early 2015 and the benefits and costs were based in 2014 dollars.

As part of the project's Gateway Review process, the economic assessment was revised in September 2016 to reflect updated analysis of reliability improvements (increasing the benefits) and revised cost estimates. As the residual value benefit was calculated as a function of cost, this benefit also increased slightly.[3] The Gateway Review also recommended that the calculation of the Wider Economic Benefits (WEBs) was expanded beyond agglomeration only and this was completed to include the benefits associated with imperfect competition and increased labour supply.

Base case update

We have updated the assessment to 2018 dollars to reflect updates applied to the NZ Transport Agency's Economic Evaluation Manual (EEM) and to allow a comparison with the revised cost estimates being developed (also in 2018 dollars).

The update has focused solely on updating the benefit values from 2014 dollars to 2018 dollars and revised inputs to the economic model (ie transport modelling outputs) have not been used. The process and results of this update are discussed below.

The EEM update factors applied to the various benefit streams are shown in Table 3.

The vehicle operating costs in the EEM have been updated since the original assessment was completed. These new base values (2015 dollars) have subsequently been input into the economic model so the appropriate update factor can be applied (coincidentally the update factor is the same).

Table 3 Update factors

Benefit stream	EEM base date	Update factor to July 2014 dollars (2015 business case)	Update factor to July 2018 dollars (this update)
Travel time	2002	1.42	1.50
Vehicle operating costs	2008	1.07	-
Vehicle operating costs	2015	-	1.07
Public transport user benefits	2008	1.14	1.21
Walking and cycling benefits	2008	1.14	1.21
Emission reduction benefits	2015	-	1.07

Source: EEM update factors 2014, 2018

[3] The Gateway Review identified that this method for calculating the residual value reflected a conservative estimate of the residual value of the CRL given the extremely long life of the infrastructure.

For the remaining relevant benefit streams, the process has been to apply the new update factors and adjust the assessment period to reflect an updated Year 0 and revised CRL opening date. This impacts the discounted cost and benefit streams. These inputs are shown in Table 4.

Table 4 Economic model inputs

	Business case / Gateway Review	Updated assessment
Year 0	2013	2017
CRL opening year	2023	2024
Base date for costs and benefits	2014	2018
Discount rate (base)	6%	6%
Evaluation period (base)	40 years (2013 – 2052)	40 years (2017 -2056)

2017 is used as Year 0 in this updated assessment given the considerable cost spent to date (discussed further in the 'sunk cost' section below).

Conventional benefits

The present value (PV) of the conventional transport benefits are shown in Table 5 for the business case, the revision associated with the Gateway Review and this update. The updated assessment to 2018 dollars uses the same methodologies and inputs as were used in the Gateway Review.

Table 5 Conventional benefit PV summary

	Business Case (2014 dollars)	Gateway Review (2014 dollars)	Updated assessment (2018 dollars)
Travel time • PT users • Road users	 $1,279m $136.4m	 $1,279m $136.4m	 $1,762m $194.8m
Decongestion	$14.3m	$14.3m	$20.8m
Vehicle operating cost reduction	$9.6m	$9.6m	$11.3m
Additional PT user benefits	$42.4m	$42.4m	$57.4m
Reliability improvement	$317.0m	$519.7m	$693.4m
Health benefits from walking	$125.0m	$125.0m	$172.2m
Emissions reduction	$5.6m	$5.6m	$8.2m
Residual value	$94.0m	$108.3m	$213.0m
Total conventional benefits	**$2,023m**	**$2,240m**	**$3,133m**

Source: PwC analysis

Note that as the residual value is a function of capital cost, it may fluctuate slightly. The value shown reflects a capital cost that maintains a benefit-cost ratio (BCR) of 1.0 (discussed later) and is expected to be the upper bound value. Any change to the overall capital cost will subsequently change this value, though the impact on the total conventional benefits would be minor (a reduction of up to approximately $70m (2%)).

Wider Economic Benefits (WEBs)

The estimated WEBs associated with the CRL cover three categories:

- Agglomeration
- Imperfect competition
- Increased labour supply.

SGS previously calculated the agglomeration benefits for the 2015 business case, and the process is complex. Without the SGS model or going back to SGS for a formal update, we have used the undiscounted values for 2026, 2036 and 2046 (and linear interpolation in between) from the supporting SGS report to recreate an approximate profile of agglomeration benefits over time that generate the PV of $866 million, based on the parameters in the business case (ie CRL opening in 2023, a 6% discount rate and 40 year evaluation period). Beyond 2046, we have applied a compounding growth rate to generate values that closely match the SGS graph of the undiscounted benefit stream out to 2073.[4] Based on the business case assessment parameters (discount rate, CRL opening year, Year 0 and assessment period) this 'reconstructed' agglomeration benefit stream generates a very similar PV of $866 million (within 0.05%), and a similar undiscounted value of $3,920 million (compared to $4,100 million - within 4.4%).

When compared with the agglomeration sensitivity tests using different discount rates of 8% and 4%, the difference between the SGS reported PVs and those calculated from our reconstructed agglomeration stream is 1.2% for the 8% discount rate and 1.3% for the 4% discount rate. This suggests that the reconstructed agglomeration benefit stream is a close representation of the SGS model and is considered sufficient for the purposes of updating the assessment.

As agglomeration is typically measured in the change in gross value added (GVA) per worker due to the increased productivity associated with higher effective job density (EJD), we have used the change in GDP per employed person in Auckland as a proxy for updating the base input data. Based on Infometrics data, there has been a compound annual growth rate (CAGR) of 0.7% pa (in real terms) from 2014 to 2018 in GDP/employed person in Auckland.[5]

To provide an updated estimate of the agglomeration benefits in 2018 dollars we have used the reconstructed agglomeration benefit stream over time, adjusted for the updated Year 0 and assessment period, applied the 0.7% pa to reflect potential revised base inputs and applied CPI to adjust from 2014 dollars to 2018 dollars, using a CAGR of 1.01%pa based on Stats NZ CPI data.

Employment in the Auckland city centre over the last 4-5 years has grown at a much higher rate than the years preceding 2014 and this will have raised the EJD that is used as a baseline in the SGS model.

[4] SGS, Economic Impact of the City Rail Link, Final Report, September 2015 – Figure 4, pg 8
[5] https://ecoprofile.infometrics.co.nz/auckland/Employment/Growth and https://ecoprofile.infometrics.co.nz/auckland/Gdp/Growth

This suggests that the actual magnitude of estimated agglomeration benefits may also have increased, so the approach we have taken can be viewed as conservative.

Benefits associated with imperfect competition are calculated as a function of the transport model outputs and the values of time used in the economic model. As these values of time have been updated to 2018 dollars, the calculation flows through to the revised estimate of imperfect competition benefits.

Increased labour supply benefits reflects the additional tax collected from additional work performed and/or a move to more productive jobs and were calculated separately using detailed transport model outputs and 2014 median wage metrics. To update these to 2018 dollars, we have used the change in median weekly wage in Auckland from 2014 to 2018 to provide a way to update these benefits to 2018 dollars. The CAGR over this period was 3.55%pa[6] (in nominal terms). This annual growth rate has been applied to update this portion of the WEBs.

The PV of the WEBs calculated as part of the CRL assessment are shown in Table 6 for the business case, the revision associated with the Gateway Review and this update.

Table 6 WEBSs PV summary

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	Updated assessment (2018 dollars)
Agglomeration	$866m	$866m	$1,159m
Imperfect competition	Not included	$8m	$11m
Increased labour supply	Not included	$124m	$186m
Total WEBs	**$866m**	**$998m**	**$1,357m**

Source: PwC analysis

Total benefits

The summary of the total benefits (PV) is shown in Table 7.

Table 7 Benefits summary

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	Updated assessment (2018 dollars)
Conventional benefits	$2,023m	$2,240m	$3,133m
WEBs	$866m	$998m	$1,357m
Total benefits	**$2,889m**	**$3,238m**	**$4,490m**

Source: PwC analysis

As previously noted through the Gateway Review process, the overall assessment is still considered to be conservative given the use of the standard 40 year assessment period for such a transformational, long-life project. When the assessment period is extended to 60 years, the gross benefits increase by a further 23% to $5,530 million (PV).

[6] Stats NZ, Regional earnings for people in paid employment (1998 – 2018)

Costs

The cost estimate for CRL is being updated to reflect revised design information, and obviously forms a key part of the overall economic assessment (eg for calculating the BCR).

The operating costs associated with the base case have been updated and the comparison is provided below in Table 8.

Table 8 Operating costs

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	Updated assessment (2018 dollars)
Annual operating cost (post-opening)	$41m	$41m	$45m
PV operating costs	$340m	$340m	$451m

Source: CRLL (annual opex), PwC analysis

Updated capital costs are not available, but we are able to back calculate using an indicative capex profile to determine a capital cost that maintains a BCR of 1.0. This means that provided the total expected cost is less than this value, then the project still provides a positive return using the EEM methodology for calculating the benefits of the project (noting this methodology has been previously identified as being conservative in a number of areas).

This analysis is not definitive as the actual spend profile could differ and impact the resulting PV of the capital costs. However, it provides an indicative value.

The estimated capital cost spend profile provided by CRLL is shown below in Table 9.

Table 9 Indicative spend profile

2017	2018	2019	2020	2021	2022	2023	2024	2025
11%	5%	7%	11%	16%	18%	17%	11%	5%

Source: CRLL

Applying this profile to the capital cost and back calculating for a BCR of 1, we find that a total capital cost of $5,119m (undiscounted, in 2018 dollars) maintains a BCR of 1. This means that as long as the revised cost estimate is less than approximately $5.12 billion (and the spend profile is not significantly different to the above), then the CRL base case remains justified based on the economic assessment that has been undertaken.

Using an escalation rate of 3.8% pa (provided by CRLL), this cost of $5.12 billion (in 2018 dollars) translates to an escalated outturn cost of $5.82 billion (escalated to the year of spend).

Sunk cost

The EEM notes that sunk costs with no salvage or realisable value shall not be included in the evaluation. This often includes things like investigation, research and design costs. In the case of CRL, where considerable construction activity has already occurred through the C1 and C2 contracts around

Britomart, Commercial Bay and Albert St, it could be argued that these costs are 'sunk' as there is no value to extract from them, for example if the project was cancelled.

There has been a considerable amount of property purchases as part of the CRL project to date. This has a market value that could be realised and so is not considered to be a sunk cost.

In updating the economic assessment, we have retained the full cost of the project in the cost calculation above as we do not consider that the type of scenario we are looking at (ie 're-assessing' a project part way through construction) is consistent with the intention of the sunk cost considerations in the EEM. It would be appropriate to exclude design costs to date, however this level of granularity in the costs has not been provided to us by CRLL.

Scenario analysis

CRLL are currently considering a number of scope change scenarios that would impact the cost of the CRL infrastructure and consequently the train service patterns that could operate. Changes to the train services would have resulting impacts on the benefits that are generated by the project.

This part of our engagement has been to develop a methodology to estimate the potential impacts on the base case benefits of the different scenarios. The timeframe for the assessment is short, which means that no transport modelling is able to be carried out and this creates limitations on the accuracy of the assessment. These could be substantial, and sensitivity testing is therefore important to understand what the potential range of impacts on the benefits could be.

The information that we have available to assist us and the methodology that we have developed is summarised below.

Information and data

The economic assessment utilises a number of outputs from the transport modelling:

- APT model to determine the overall impact on public transport users in terms of travel time improvements and change in patronage. The outputs are aggregated at a network level.
- ART model to determine the impacts on car users across the Auckland region (excluding the city centre). The outputs are aggregated at the network level.
- SATURN model to determine the impacts on car users within the city centre. The outputs are aggregated at the network level.

The fact that the outputs are aggregated at the network level presents a number of challenges when attempting to estimate the effects of different scope changes that impact the train services that can operate (as the train services are the primary driver of benefit generation).

To overcome this challenge we have utilised other information sources, including other outputs from the transport modelling at the time of the business case, to assist in estimating the impacts that the scope changes may have on the benefits generated by CRL. These other data sources are discussed below.

- Rail patronage plots for 2026, 2036 and 2046 that identify the patronage on the rail lines between stations. These are not split by service, but are split by inbound and outbound lines. These outputs were prepared in April 2015, for the business case modelling and are summarised in Table 10 for 2036.

Table 10 2036 morning period (2hr) rail line patronage

	Inbound	Outbound	% of total patronage		% of line	
			Inbound	Outbound	Inbound	Outbound
Western line	9,801	1,760	36%	33%	85%	15%
Southern line	8,418	2,727	31%	51%	76%	24%
Eastern line	9,232	809	34%	15%	92%	8%
Total	**27,451**	**5,296**	**100%**	**100%**	-	-

Source: CRL business case (2015) transport modelling

- Boarding and alighting totals at each station for 2026, 2036 and 2046. We have used these totals at the four stations associated with CRL being Mt Eden, K Rd, Aotea and Britomart. These outputs were prepared in April 2015, for the business case modelling and are summarised in Table 11 for 2036.

Table 11 2036 morning period (2hr) rail station volumes

	Boardings	Alightings	Total pax	Station pax by line	
				Western	Southern/Eastern
Britomart	1,947	9,871	11,817	38.7%	40.7%
Aotea	921	11,407	12,328	40.4%	42.5%
K Rd	1,542	3,350	4,892	16.0%	16.8%
Mt Eden	805	682	1,487	4.9%	-
Total	**5,215**	**25,309**	**30,524**	**100%**	**100%**

Source: CRL business case (2015) transport modelling

- Travel time improvement summary from the business case for each line and station to use in a weighted travel time analysis. We have adjusted the travel time saving for the Western line to K Rd down from 31 mins to 18 mins to reflect a more realistic rail to bus interchange location (eg Mt Eden) and short walk from Symonds St. We considered that retaining the 31 minute saving would overestimate the proportion of overall travel time benefits attributable to K Rd from the Western line.

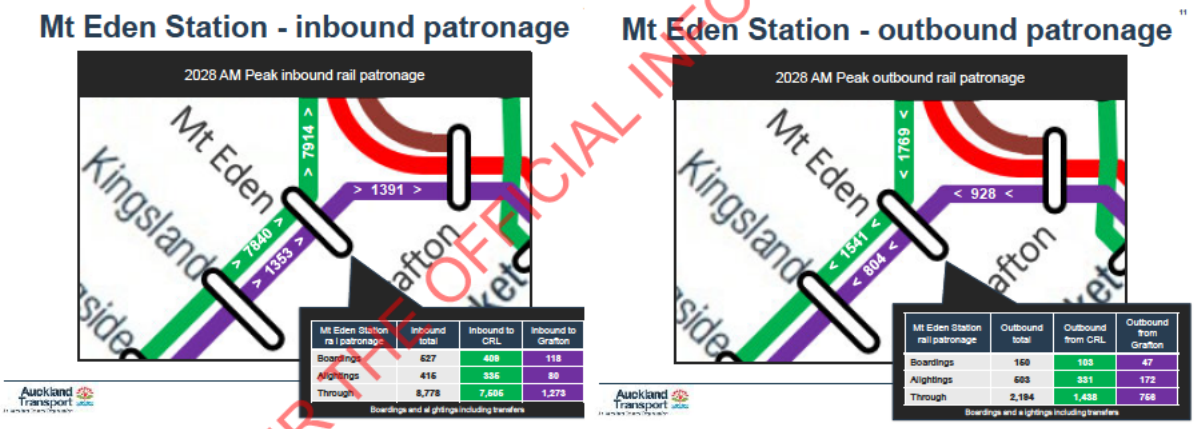
Table 12 Business case travel time savings (inbound, mins)

	Britomart	Aotea	K Rd
Western line	7	17	18*
Southern line	0	9	18
Eastern line	0	9	12

Source: CRL Business Case (2015), adjustment for Western line to K Rd from 31mins to 18mins

- Recent AFC modelling (March 2019) requested by Auckland Transport that shows the split of patronage on the Western line in term of CRL services versus Grafton services as shown in Figure 1. While absolute line volumes differ from those used in the 2015 business case, we consider that using the proportional relationship is appropriate and have used these proportions in the subsequent analysis.

Figure 1 Rail patronage at Mt Eden, 2028 morning period (2hr)



Source: Auckland Transport (March 2019)

To generate the travel time benefit relationship weighting by line shown in Table 13, we have used a combination of the above the information:

- Travel time savings by line/station (Table 12)
- Total patronage by line (Table 10)
- Total patronage by station (Table 11).

Table 13 Initial travel time benefit apportionment by line

	Weighted % of total travel time benefit	Travel time benefit ratio
Western line	53%	2.6
Southern line	27%	1.3
Eastern line	20%	1

Source: CRL business case (2015) transport modelling, PwC analysis

As the Western line services receive a considerable distance reduction (ie no longer travelling via Newmarket), this relationship appears reasonable.

Using the data above, we are then able to make a number of broad assessments/assumptions into how the benefits can be assessed to allow estimates to be made on the impact of different scope changes.

Methodology / Developing estimation factors

To simplify the analysis, we have used the 2036 modelled information to determine proportions that are used in the methodology. However, when absolute numbers are required, we have used forecast volumes from 2026, 2036 and 2046. For example, if an absolute change is required (as opposed to percentage factoring), we insert the appropriate forecast year data in the calculations in the benefits model. This could occur when a station is removed, meaning remaining passengers receive a further travel time benefit that would be impossible to estimate as a percentage.

Given the limitations of the information available, but recognising that the public transport travel time savings make up approximately 60% of the conventional benefits, we have split the methodology to estimate impacts on public transport travel time and other conventional benefits separately.

Splitting or proportioning the travel time benefits by line incorporates the following:

- Proportional relationship for travel time savings for the Western/Southern/Eastern lines
- Split of Western rail services in the base case to CRL (85%) and Grafton (15%) based on the recent AFC modelling (refer Figure 1). This means that for passengers on the Western line, we assume that the travel time benefits are generated by 85% of the overall patronage, as those going to Grafton or beyond do not receive any travel time improvement from the do-minimum (no CRL).[7]
- Split of Southern rail services in the base case to CRL (75%) and Parnell (25%) based on the inbound volume split at Newmarket from the modelled patronage plots. This means that for passengers on the Southern line, we assume that the travel time benefits are generated by 75% of the overall patronage, as those going via Parnell experience the same travel time (to Britomart) as in the do minimum (no CRL).[8] We acknowledge that some 'to CRL' patronage used in this calculation will actually be on the Otahuhu – Henderson service, so this split could vary.

The revised proportion of travel time benefits by line is shown in Table 14. Compared to the initial proportions (Table 13), the split between the Southern and Eastern line is much closer, once the allowance for the line split at Newmarket is taken into account.

[7] This is not strictly the case as the direct West – Otahuhu service will be responsible for some of the overall benefits associated with CRL.
[8] This is not strictly the case as some passengers on the services travelling Parnell will be going to Aotea and therefore receive significant benefits over the do-minimum.

Table 14 Travel time benefit apportionment by line

	Travel time benefit ratio	% patronage to CRL	Overall
Western line	2.6	85%	52.6%
Southern line	1.3	75%	23.4%
Eastern line	1	100%	24.0%

Source: CRL business case (2015) transport modelling, PwC analysis

Incorporating this information, we can establish an estimation of the travel time benefits by line and by direction.

Table 15 Travel time benefits by line/direction

	Total	Inbound	Outbound
Western line	52.6%	44.6%	8.0%
Southern line	23.4%	17.7%	5.7%
Eastern line	24.0%	22.0%	1.9%
Total	**100%**	**84.3%**	**15.7%**

Source: CRL business case (2015) transport modelling, PwC analysis

Using the line patronage volumes (refer Table 10) as a proxy, we can establish an estimation of the other conventional benefits by line and direction as these are not related to the time saved.

Table 16 Other conventional benefits by line/direction

	Total	Inbound	Outbound
Western line	35%	29.9%	5.4%
Southern line	34%	25.7%	8.3%
Eastern line	31%	28.2%	2.5%
Total	**100%**	**83.8%**	**16.2%**

Source: CRL business case (2015) transport modelling, PwC analysis

Using the boarding and alighting data as a proxy (refer Table 11), we can establish an estimation of the other conventional benefits by station. Note that only the Western line services stop at Mt Eden, so any benefits generated there are only associated with the Western line.

Table 17 Other conventional benefits by station/line

	Western line	Southern/Eastern line
Britomart	38.7%	40.7%
Aotea	40.4%	42.5%
K Rd	16.0%	16.8%
Mt Eden	4.9%	-
Total	100%	100%

Source: CRL business case (2015) transport modelling, PwC analysis

When we overlay the travel time by line splits, we can establish an estimation of the travel time benefits by station as well. In terms of travel time benefits, we assume that no travel time benefits are generated by Southern or Eastern services at Britomart. Compared to existing travel times (ie today), the CRL does not impact these, though we acknowledge increased service frequency and additional capacity is a significant improvement on these lines and that the improved frequency makes effective journey times shorter (less wait time). This assumption could therefore be weighting slightly too high a proportion of travel time savings from the Southern and Eastern services on Aotea and K Rd stations.

Table 18 Travel time benefits by station and by line

	Western line	Southern line	Eastern line	Total
Britomart	21.4%	-	-	21.4%
Aotea	22.3%	16.8%	17.2%	56.3%
K Rd	8.9%	6.6%	6.8%	22.3%
Mt Eden	-	-	-	-
Total	52.6%	23.4%	24.0%	100%

Source: CRL business case (2015) transport modelling, PwC analysis

Treatment of WEBs.

The WEBs (updated to 2018 dollars) associated with the base case are factored by the proportion of the total base case conventional benefits that each scenario is estimated to generate. For example, if Scenario X generates 90% of the conventional benefits from the base case, then 90% of the base case WEBs are also assumed to be generated.

Scenario assessment

As noted above, the limited information and short timeframe means we are only able to calculate two factors to apply; one for the public transport travel time benefits and one for the remaining conventional benefits. We then apply these to the different benefit streams and calculate the resulting benefits. Given the approximate nature of this assessment exercise and underlying assumptions, sensitivity testing of those factors is also included.

We reiterate that the assessment is an estimation only, based on limited information, short timeframes and an overarching assumption that the benefits can be cut or considered in a number of ways. With additional time, the scenarios should be modelled, though we note that this would require the base case to be reassessed given the modelling tools and land use inputs have changed since the 2015 business case assessment was completed.

A number of scenarios have been developed by CRLL for consideration. However, prior to estimating the benefit impacts, all scenarios were assessed from an operational perspective in a workshop with Auckland Transport, KiwiRail, CRLL and representatives from the project sponsors. The outcomes of that workshop (reported separately) highlighted a number of operational 'fatal flaws' with most scenarios and only one scenario was deemed appropriate to consider further: This scenario, Scenario 2a, is discussed below.

Scenario 2a: Remove K Rd station

This scenario sees the removal of K Rd station from the CRL scope. In terms of train service patterns, it has little impact as the base case train plan is still applicable. Services running through CRL will have a minor reduction in journey time to reflect one less deceleration/acceleration cycle and no dwell time at the station. There could however be a minor increase in dwell time at other stations as passenger loadings at those locations would likely increase (ie it is not simply a case of removing the passengers associated with the station from the system completely). There are a number of other minor components to this scenario, however they do not impact the train services and therefore can be ignored for the purposes of estimating the impacts on base case benefits.

To estimate the impact on travel time benefits of removing the K Rd station, we can see from Table 18 that K Rd is estimated to generate 22.3% of the travel time benefits and from Table 17, approximately 16% of the other conventional benefits. As there are no impacts on the services that are operating, looking at, or cutting the benefits in other ways is not required (based on the methodology developed).

It is important to note that this does not assume that *patronage* reduces by 22.3%, rather the travel time savings generated are reduced. For example, it is likely that some (and possibly most) people would continue to travel, perhaps to Aotea, and then transfer to a bus or walk back towards their destination. So these people are still public transport passengers, but they are no longer receiving much (or any) of the travel time benefit they were getting with the station in place.

In terms of the other conventional benefits, the impacts could vary, with the 16% likely to represent the impact at the upper end. This would mean that virtually all the passengers associated with the station reverted back to their behaviour in the do minimum (ie without CRL). They could revert back to bus (thereby removing benefits associated with reliability improvements, additional rail users and walking) or car (thereby reducing the benefits associated with car travel).

The recent AFC modelling from March 2019, referred to earlier, incorporated a test that closed K Rd station and the impact was minor on overall rail patronage, with most K Rd passengers redistributing to Aotea and some to Britomart. This suggests the 16% reduction in conventional benefits in our simplified methodology would likely be too high.

If some did remain on rail, and use Aotea station as the model test suggests will be the case, then while their travel time benefits would erode, many of the other conventional benefits would remain (more or less proportional to those who stayed travelling by rail). In this case, there could either be additional health benefits from walking further, or a different land use response with some employment expected around the K Rd station relocating to around Aotea/Mt Eden/Britomart where the rail accessibility is much better. This impact is not able to be estimated through this process.

In addition to these changes, with the station removed, there is a travel time benefit to passengers travelling through the CRL tunnels as there is one less stop. The saving is estimated at 1.5 minutes, and is applied to the line volume between Aotea and K Rd stations from the base case, reduced by half of 16% to reflect the likelihood that a proportion (in this case assumed 50%) of passengers who were using K Rd would now travel to Aotea (inbound) or Mt Eden (outbound) instead.

In terms of an assessment against the base case benefits, we therefore present a range of possible outcomes for Scenario 2a:

- A "possible worst case" where public transport travel time benefits reduce by 22.3% and other conventional benefits reduce by 16%
- A "possible best case" where public transport travel time benefits only reduce by 50% of the above and other conventional benefits only reduce by 25% of the above.

Both cases incorporate the additional travel time saving to remaining rail passengers described above.

Table 19 Scenario 2a (Remove K Rd station) benefit assessment PV summary

Benefit	Base Case (2018 dollars)	Scenario 2a – Worst case (2018 dollars)	Scenario 2a – Best case (2018 dollars)
Travel time • PT users • Road users	 $1,762m $195m	 $1,428m $164m	 $1,625m $187m
Decongestion	$21m	$17m	$20m
Vehicle operating cost reduction	$11m	$9m	$11m
Additional PT user benefits	$57m	$48m	$55m
Reliability improvement	$693m	$582m	$666m
Health benefits from walking	$172m	$145m	$165m
Emissions reduction	$8m	$8m	$8m
Residual value	$212m	*$212m**	*$212m**
Total conventional benefits	**$3,133m**	**$2,614m** (83% of base case)	**$2,949m** (94% of base case)
WEBs	$1,357m	$1,132m	$1,277m
Total benefits	**$4,490m**	**$3,747m** (83% of base case)	**$4,227m** (94% of base case)

Source: PwC analysis

As noted earlier, in the absence of updated cost information, the residual value calculation is potentially reflecting an artificially high value (based on the capital cost to retain a BCR of 1). As Scenario 2a would result in a lower cost given the station is not required, the residual value associated with it would be lower (in line with the overall percentage cost saving of Scenario 2a over the base case, expected to be about 5%). This, combined with the fact that it is the relativity of the Scenario 2a outcomes compared to the base case indicates this is not a significant constraint on the analysis.

The analysis of Scenario 2a suggests that if K Rd station is removed, then the project is likely to still generate between 83% - 94% of the benefits of the base case. Putting it another way, removing the K Rd station is likely to remove between $263m - $743m worth of benefits over the 40 year assessment period.

This suggests that if the PV of the cost saving from removing the station is less than $263m, then from an economic perspective it would make sense to retain the station as the estimated benefits it generates outweigh the potential cost saving from removing it.

A limitation of this analysis is that it assumes that people's destinations in the city centre have not changed, which in reality is unlikely if the station was not built in the first place.

Further sensitivity test

We have undertaken a further sensitivity test by using a change in weighted average travel time benefit per passenger with and without the K Rd station, which adjusts the expected travel time savings to each stations from each line.

Table 20 shows the assumed savings in the business case (as shown earlier in Table 12), with the adjustment for the Western line to K Rd down to 18 mins.

Table 20 Business case travel time savings (inbound, mins)

	Britomart	Aotea	K Rd
Western line	7	17	18*
Southern line	0	9	18
Eastern line	0	9	12

Source: CRL Business Case (2015), adjustment for Western line to K Rd from 31mins to 18mins

With the K Rd station removed, there is a change in travel time saving, calculated as follows:

- 1.5 minutes travel time on board the train between Aotea and K Rd stations
    - for K Rd-bound passengers this is an increase in travel from the Western line (as they must stay on to Aotea station), but a decrease from the Southern/Eastern lines (as they get off earlier at Aotea station)
    - for Aotea/Britomart-bound passengers on the Western line, this is a decrease in travel time
- Additional walk time of 11 mins between Aotea and K Rd due to the distance of approximately 950m. This would be longer uphill and shorter downhill, but to account for both the AM and PM periods, an average is appropriate.

The revised travel time savings, and the change relative to the business case savings, are shown in Table 21 for the no K Rd station scenario.

Table 21 Travel time savings, no K Rd station (inbound, mins)

	Britomart	Aotea	K Rd
Western line	8.5 (+1.5)	18.5 (+1.5)	5.5 (-12.5)
Southern line	0	9	5.5 (-12.5)
Eastern line	0	9	2.5 (-9.5)

Source: CRL Business Case (2015),

When the station and line patronage numbers from the business case modelling are then multiplied through, it results in a reduction in the weighted average travel time saving per passenger of 17%. This is broadly in line with the 'worst case' reduction in travel time benefits estimated above and the overall results would therefore fall in the range presented earlier in Table 19.

Other considerations

Another consideration that should inform decision making on this scenario is the impact on the development and regeneration opportunity in the area surrounding the K Rd station. Recent work by PwC for the Ministry of Transport highlighted the significant development potential within the precinct surrounding the K Rd station.

With the station removed, it is likely that this potential would either not be able to be fully realised, be realised at a considerably slower rate or not realised at all. This has implications for the K Rd Plan[9] and the wider Auckland City Centre Masterplan. The flow on effects would impact city centre land use and change the focus for investment, concentrating it away from the K Rd area.

9 https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/place-based-plans/Documents/karangahape-road-plan-2014-2044.pdf

Document 2

pwc

Strictly Confidential

John Williamson
Programme Director CRL Developments
City Rail Link Limited
PO Box 105777
Auckland 1143

15 April 2019

CRL Base Case Assessment - Indicative Update

Dear John

PwC have been engaged by City Rail Link Ltd (CRLL) to update the economic assessment prepared as part of the 2015 business case for the project (prepared by Auckland Transport) to reflect new parameters (eg value of time) and a revised delivery schedule. In addition to that update, we have been asked to provide an indicative update using the most up-to-date modelling from the Auckland Forecasting Centre (AFC).

This letter has been prepared in accordance with our Letter of Engagement dated 21 February 2019 and should be read in conjunction with the restrictions outlined in Appendix A.

Summary

We have undertaken an indicative update of the 2015 CRL business case benefits using updated patronage forecasts to estimate the likely change in benefits.

The methodology applied in this indicative update suggests that the overall present value (PV) of the total benefits (including Wider Economic Benefits) has increased by between 13% - 19%. The comparison of the benefits calculated in the business case and those estimated in this indicative update is shown in Table 1 below.

Based on a spend profile and escalation rates provided by CRLL, a benefit-cost ratio (BCR) of 1 is still maintained if the capital cost is lower than $5.85 billion (unescalated, in 2018 dollars) or $6.64 billion (escalated to the year of spend).[1]

Table 1 Benefits summary

	Business case (2018 dollars)	Indicative update (2018 dollars)
Conventional benefits (PV)	$3,133m	$3,707m
WEBs (PV)	$1,357m	$1,357m - $1,647m
Total benefits (PV)	**$4,490m**	**$5,063m - $5,353m**

Source: PwC analysis

[1] These costs are based on the inclusion of the lower bound range of the WEBs above (ie PV of the total benefits is $5.06 billion).

Background

The economic assessment of CRL was prepared for the business case in early 2015. It was subsequently revised in September 2016 as part of the project's Gateway Review process to reflect updated analysis of reliability improvements (increasing the benefits) and revised cost estimates. As the residual value benefit was calculated as a function of cost, this benefit also increased slightly.[2] The Gateway Review also recommended that the calculation of the Wider Economic Benefits (WEBs) was expanded beyond agglomeration only and this was completed to include the benefits associated with imperfect competition and increased labour supply.

We recently undertook a further update of the economic assessment in April 2019 to update the base date for costs and benefits to 2018 dollars. This was to reflect updated values in the NZ Transport Agency's Economic Evaluation Manual (EEM), the revised delivery timeline and to allow a future comparison with the revised cost estimates being developed (also in 2018 dollars).

The summary of the present value (PV) of the benefits across the original business case, the Gateway Review update and the April 2019 update is shown in Table 2.

Table 2 Benefits summary

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	Updated assessment (2018 dollars)
Conventional benefits (PV)	$2,023m	$2,240m	$3,133m
WEBs (PV)	$866m	$998m	$1,357m
Total benefits (PV)	**$2,889m**	**$3,238m**	**$4,490m**

Source: PwC analysis

Transport modelling

The economic assessment of the CRL in the 2015 business case was prepared using transport model outputs from the following three models:

- Auckland Public Transport model (APT) to determine the overall impact on public transport users in terms of travel time improvements and change in patronage. The outputs are aggregated at the network level.
- Auckland Regional Transport model (ART) to determine the impacts on car users across the Auckland region (excluding the city centre). The outputs are aggregated at the network level.
- City Centre SATURN model to determine the impacts on car users within the city centre. The outputs are aggregated at the network level.

The modelling suite of tools that AFC administer has been updated since the business case was prepared, with the Auckland Macro Strategic Model (MSM) being developed. The MSM was based to 2016, so it reflects a more accurate view of the current transport demands. In addition, the underlying land use scenario inputs (eg population and employment forecasts) have been revised. The

[2] The Gateway Review identified that this method for calculating the residual value reflected a conservative estimate of the residual value of the CRL given the extremely long life of the infrastructure.

combination of these changes means that future transport demands have changed since the business case was completed and these will have a noticeable impact on the benefits generated by the CRL.

Economic assessment

In assessing the benefits of a project, such as the CRL, two scenarios are assessed – one without the project (the do minimum) and one with the project (the option). The comparison of the two scenarios allows the benefits of the project to be calculated, which then informs the overall economic assessment of the project. This was the process followed in the CRL business case that ultimately led to the agreement and commitment to deliver the CRL. This decision meant that the CRL, as a committed project, has subsequently been incorporated into all future transport networks; the project is now part of the agreed do minimum.

This creates problems for reassessing the benefits of the CRL using the MSM in the standard fashion, as there are no future networks *without* CRL to compare against. The time and effort to create a new future do minimum without the CRL is considerable as the entire transport network development over the last three years has been predicated on the assumption that CRL will be delivered around 2023/24. Therefore to provide an indication of the potential changes to the benefits associated with CRL as a result of the revised modelling forecasts within the short timeframe available, an alternative approach is required.

An indicative update to the base case

We have adopted the recent update of the business case benefits (to 2018 dollars) as the new 'base case'. Details relating to that update process have been reported separately (dated 9 April 2019) and should be referred to if further information is required. Through that process we developed a methodology for factoring the various benefit streams as a way of estimating the impacts of different scope change scenarios being considered. We are able to apply a similar approach to update the benefits associated with the business case by comparing the new MSM model outputs with those from the original business case modelling in 2015.

Note that unless specified otherwise, all values discussed are expressed in 2018 dollars.

Data/information available

As we have no new do minimum to compare the MSM outputs to, the aggregate network metrics are of little use. We are able to utilise morning period rail patronage numbers (by line and direction) and boarding and alighting information at each CRL station from the new modelling in MSM and the business case modelling in APT to understand:

- the change in city centre rail station usage (both magnitude and passenger distribution), which has an impact on the travel time benefits
- the change in overall patronage on each of the three rail lines (Western, Southern and Eastern).

With the changes in these two data sets, we can calculate a series of factors that can be applied to the business case benefits to provide an indicative update to the economic assessment of the CRL. This process is described in more detail below.

Exclusions

With the limitations on the information available, we have not been able to establish an evidenced based approach to estimate any impact on the benefits associated with private vehicle travel, being:

- road user travel time
- decongestion
- vehicle operating cost reduction
- emissions.

These benefits only account for approximately 7% of the total conventional benefits, so we do not consider that this represents a significant limitation on the overall indicative update.

The benefit of the residual value of the project is a function of the capital cost. As the actual cost estimate is not available, we have retained the capital cost that maintained a benefit-cost ratio (BCR) of 1 in the April 2019 update of the business case benefits to 2018 dollars. This is expected to be the upper bound value. Any change to the overall capital cost will subsequently change this value, though the impact on the PV of the total conventional benefits would be minor (a potential reduction of up to $70m (2%)).

Methodology

The methodology we have adopted for undertaking the indicative update to the benefits calculated in the business case is based on the broad assumption that the overall benefits (excluding those noted in the exclusions above) are proportional to rail line patronage and city centre station patronage.

The methodology is based on proportioning the benefits by the directional patronage on each of the three rail lines from the business case modelling. This was developed as a way to estimate the impacts of different scope change scenarios without carrying out extensive transport modelling. As the travel time savings are more heavily weighted to the Western line, we developed two separate approaches to proportion the public transport (PT) travel time benefits and the non-travel time benefits. These exist for the three forecast years, with the proportions shown for 2038 in Table 3 for PT travel time benefits and in Table 4 for non-travel time benefits.

Table 3 Percentage of total PT travel time benefits by rail line and direction (2038)

	Inbound	Outbound	Total
Eastern line	21.2%	1.9%	30.4%
Southern line	20.0%	6.4%	33.4%
Western line	42.8%	7.7%	36.2%
Total	**84.0%**	**16.0%**	**100%**

Source: CRL business case (2015) transport modelling, PwC analysis

Table 4 Percentage of total non-travel time benefits by rail line and direction (2038)

	Inbound	Outbound	Total
Eastern line	28.3%	2.5%	30.8%
Southern line	25.9%	8.3%	34.1%
Western line	29.7%	5.4%	35.1%
Total	**83.9%**	**16.1%**	**100%**

Source: CRL business case (2015) transport modelling, PwC analysis

We can then assess the difference in directional patronage from the MSM modelling as a proportion of the business case modelling and factor up (or down) the respective proportion of overall benefits. For example, if the Eastern line inbound patronage increased by 50%, then we would simply multiply 28.3% of the total non-travel time benefits by 150% to get the updated benefit value apportioned to the Eastern line inbound patronage.

We acknowledge that these generalisations ignore the need to assess the change in patronage over the do minimum for some of the benefit streams and by using this blanket assumption we are more likely to be estimating an upper-bound value of the change in benefits.

However, this approach is not as restrictive as it may initially seem given the CRL provides considerable benefits to existing rail users by providing decreased rail travel times. The breakdown of the benefits calculated in the business case quantifies this, with 56% of the conventional benefits coming from existing users (ie public transport travel time and rail reliability improvements). This means that it does not matter if any patronage increase is driven by higher underlying rail patronage, or additional new passengers due to the CRL as they would all be receiving travel time benefits. It makes utilising the magnitude of change in rail patronage as a means of factoring the benefits an appropriate proxy to start from, as we have a high level of confidence that at least 56% of any increase (or decrease) is being accurately reflected. It also means that the increase in patronage over the do minimum is not a constraint for estimating the increase in this portion of the benefits.

The first step in the methodology is to establish comparable values (ie for the same forecast year). The APT model outputs from the business case modelling were provided for 2026, 2036 and 2046, while the MSM now uses the forecast years of 2028, 2038 and 2048. To be able to compare the two sets of outputs, we have used linear interpolation to establish equivalent year values (ie for 2028, 2038 and 2048) from the business case modelling. Linear interpolation was used to determine the benefits in intermediate years, so this is consistent with the overall approach.

With values for rail patronage and station boarding and alighting volumes in the same forecast year established, we can compare the two to understand the change in magnitude and distribution. We present the differences in both these data sets below, using 2038 as the example. The same process is also used for 2028 and 2048 and the patterns are broadly similar.

The rail patronage at locations just outside the city centre is presented in Table 5 from the business case modelling and Table 6 from the new MSM modelling. Both inbound and outbound volumes are provided.

Table 5 Business case rail patronage by line, 2 hr morning period, 2038

	Inbound	Outbound	Total
Eastern line (*Hobson Bay*)	9,598	843	10,442
Southern line (*north of Newmarket station*)	8,766	2,807	11,573
Western line (*west of Mt Eden station*)	10,071	1,818	11,889
Total	**28,435**	**5,468**	**33,904**

Source: APT model outputs provided by AFC for the CRL Business Case (April 2015)

Table 6 MSM rail patronage by line, 2 hr morning period, 2038

	Inbound	Outbound	Total
Eastern line (*Hobson Bay*)	12,725	2,374	15,099
Southern line (*north of Newmarket station*)	8,285	3,053	11,338
Western line (*west of Mt Eden station*)	11,807	2,638	14,445
Total	**32,817**	**8,065**	**40,882**

Source: MSM outputs provided by AFC (April 2019)

We see that there is a significant increase in both directions (ie inbound and outbound), particularly on the Eastern and Western lines.[3] Table 7 highlights the volume changes by showing the MSM volumes as a proportion of those from the business case modelling.

Table 7 MSM rail patronage by line as a proportion of business case volumes

	Inbound	Outbound	Total
Eastern line (*Hobson Bay*)	133%	282%	145%
Southern line (*north of Newmarket station*)	95%	109%	98%
Western line (*west of Mt Eden station*)	117%	145%	121%
Total	**115%**	**147%**	**121%**

Source: PwC analysis

As a proportional change, we see much higher increase in outbound volumes in the MSM modelling.

[3] We understand that issues have previously been identified when looking at the split of patronage between the Eastern and Southern lines due to the service patterns, so it is generally more appropriate to look at the combined patronage on these two lines.

The patterns shown above for 2038 are very similar in 2028 and 2048. A slightly higher increase in 2048 is forecast, with 123% of the business case patronage now being forecast in MSM compared to 121% in 2028 and 2038.

We can use these proportions to estimate the impact on the non-travel time benefits in the business case by multiplying them by the proportional benefits (discussed earlier in Table 4).

Table 8 Percentage of business case non-travel time benefits (2038)

	Business case		MSM	
	Inbound	Outbound	Inbound	Outbound
Eastern line	28.3%	2.5%	37.5%	7.0%
Southern line	25.9%	8.3%	24.4%	9.0%
Western line	29.7%	5.4%	34.8%	7.8%
Total	**83.9%**	**16.1%**	**96.8%**	**23.8%**
Total	**100%**		**120.6%**	

Source: PwC analysis

Based on this approach and the revised modelling forecasts from MSM, we estimate that the non-travel time benefits generated by CRL would increase by 20.6% in 2038. As noted above, this most likely represents an upper bound value of the change.

Additional consideration for the treatment of travel time benefits

The travel time benefits generated by the CRL will be impacted by the distribution of passenger destinations in the city centre and we should therefore account for any change in distribution if possible. We consider that the comparison of the weighted average travel time savings is an appropriate way to incorporate the relative shift in distribution on top of the change in patronage discussed above.

To understand this potential change, we can use the travel time improvement summary from the business case for each line and station, shown in Table 9, to perform a weighted travel time analysis.

We have adjusted the travel time saving for the Western line to K Rd down from 31 mins to 18 mins to reflect a more realistic rail to bus interchange location (eg Mt Eden) and short walk from Symonds St. We considered that retaining the 31 minute saving would overestimate the proportion of overall travel time benefits attributable to K Rd from the Western line.

Table 9 Business case travel time savings (inbound, mins)

	Britomart	Aotea	K Rd
Western line	7	17	18*
Southern line	0	9	18
Eastern line	0	9	12

Source: CRL Business Case (2015), adjustment for Western line to K Rd from 31mins to 18mins

We can establish the weighted average travel time saving per passenger in each year in both the business case modelling and the MSM modelling and then use the difference as an additional factor in estimating the impact on the PT travel time benefits. This process incorporates the following data:

- Station patronage as a proportion of total patronage across the three city centre stations
- Line patronage (inbound plus outbound) as a proportion of the total patronage to/from the city centre at the three locations from Table 5 - Table 7
- Travel time saving by station and line from Table 9.

Station patronage, broken down by boarding and alighting totals at the city centre rail stations are presented in Table 10 from the business case modelling and Table 11 from the new MSM modelling. Boarding volumes include both initial and transfer boardings and alighting volumes include both final and transfer alightings.

Table 10 Business case station passenger volumes, 2 hr morning period, 2038

	Boarding	Alighting	Total	%age of total
Britomart	1,874	10,341	12,215	40.5%
Aotea	683	11,979	12,662	42.0%
K Rd	1,679	3,573	5,252	17.4%
Total	**4,237**	**25,893**	**30,129**	-

Source: APT model outputs provided by AFC for the CRL Business Case (April 2015)

Table 11 MSM station passenger volumes, 2 hr morning period, 2038

	Boarding	Alighting	Total	%age of total
Britomart	2,776	5,769	8,545	27.0%
Aotea	1,649	19,845	21,494	67.9%
K Rd	756	840	1,596	5.0%
Total	**5,181**	**26,454**	**31,635**	-

Source: MSM outputs provided by AFC (April 2019)

The main change between the two sets of model outputs is the distribution of passengers across the three city centre stations, with only a relatively minor increase in overall patronage. There is a large shift in the MSM outputs to Aotea as the major destination with nearly 20,000 people alighting in the morning period, compared to 12,000 in the business case. Table 12 highlights this distribution change by showing the MSM volumes as a proportion of those from the business case modelling.

Table 12 MSM station passenger volumes as a proportion of business case volumes

	Boarding	Alighting	Total
Britomart	148%	56%	70%
Aotea	241%	166%	170%
K Rd	45%	24%	30%
Total	**122%**	**102%**	**105%**

Source: PwC analysis

We see that the MSM modelling shows Britomart is now expected to have a much lower share of overall city centre rail passengers, but has more people boarding and less alighting. Alightings at Aotea station increase dramatically and it is now expected to have approximately 70% of all city centre passengers pass through it. K Rd station patronage reduces considerably to less than a third of what was previously forecast in the business case.

The patterns shown above for 2038 are very similar in 2028, though in 2048 K Rd station increases its 'share', moving up to 7% of overall city centre patronage.

This considerable change in distribution will lead to an overall change in the travel time savings that are being generated as the travel time benefit to and from each station is different. Comparing the weighted average travel time saving in each case allows us to assess and then incorporate that impact. Table 13 compares these values in each of the three forecast years.

Table 13 Weighted average travel time saving comparison (minutes)

	Business case	MSM	Difference
2028	8.86	8.94	+0.9%
2038	8.79	9.05	+3.0%
2048	8.72	8.79	+0.8%

Source: PwC analysis

We can use these differences to further factor the increase in rail patronage by line in the MSM modelling as a proxy to account for the change in patronage distribution in the city centre.

For example, the Western line inbound patronage accounts for 42.8% of the PT travel time benefits in 2038 (refer Table 3). We know that the MSM is forecasting a 17% increase in that volume (refer Table 7), so we would now estimate that 50.1% of the business case benefits would be being generated by inbound passengers on the Western line. This is further increased by an additional 3% due to the change in passenger distribution, resulting in 51.7% of the business case benefits being generated by those passengers.

Table 14 summarises the percentage of business case PT travel time benefits estimated to be generated by the revised modelling forecasts from MSM.

Table 14 Percentage of business case PT travel time benefits (2038)

	Business case		MSM	
	Inbound	Outbound	Inbound	Outbound
Eastern line	21.2%	1.9%	29.0%	5.4%
Southern line	20.0%	6.4%	19.4%	7.2%
Western line	42.8%	7.7%	51.7%	11.5%
Total	**84.0%**	**16.0%**	**100.1%**	**24.1%**
Total	**100%**		**124.2%**	

Source:PwC analysis

Based on this approach and the revised modelling forecasts from MSM, we estimate that the travel time benefits generated by CRL would increase by 24.2% in 2038. As noted above, this most likely represents an upper bound value of the change.

The resulting factors in each of the forecast years for the PT travel time benefits and non-travel time benefits are summarised in Table 15 below.

Table 15 Resulting factors

	2028	2038	2048
PT travel time benefits	119.7%	124.2%	121.6%
Non-travel time benefits	120.7%	120.6%	122.8%

Source: PwC analysis

Applying these factors to the applicable benefits streams generates new estimated benefits in each of the forecast years. We then apply linear interpolation between them to generate the annual benefit streams, consistent with the approach utilised in the original business case assessment.

Wider Economic Benefits (WEBs)

The estimated WEBs associated with the CRL cover three categories:

- Agglomeration
- Imperfect competition
- Increased labour supply.

These relate to benefits generated over and above what may otherwise eventuate without the project. As we are unable to compare the new MSM do minimum with the business case do minimum, we cannot say how much of the increase in overall patronage shown is due to underlying base growth (ie growth present in the do minimum) or attributable to the CRL. In relation to the WEBs, this means that the revised estimate will most likely lie somewhere between the business case value and an increased value that has been factored like the conventional benefits as above. We consider that it is therefore appropriate to put a range around the indicative estimate of the updated WEBs.

The business case WEBs have a PV of $1,357m. When we apply the factors used to estimate the change in non-travel time conventional benefits, the resulting PV of the WEBs increases to $1,647m.

Benefits summary

Using the factors derived through our methodology (shown in Table 15), we are able to factor the benefits calculated through the business case to provide an indicative estimate of the benefits that would be generated using the recent MSM modelling.

The results of the indicative update are shown below in Table 16. The PV is calculated using a 40 year assessment period and 6% discount rate with 2017 as Year 0 and the CRL opening in 2024.

Table 16 Benefit summary (PV)

	Business case (2018 dollars)	Indicative update (2018 dollars)
Conventional benefits		
Travel time • PT users • Road users	 $1,762m $195m	 $2,138m $195m
Decongestion	$21m	$21m
Vehicle operating cost reduction	$11m	$11m
Additional PT user benefits	$57m	$70m
Reliability improvement	$693m	$842m
Health benefits from walking	$172m	$209m
Emissions reduction	$8m	$8m
Residual value	$213m	$213m
Sub-total conventional benefits	**$3,133m**	**$3,707m**
Wider economic benefits		
Agglomeration	$1,159m	$1,159m - $1,407m
Imperfect competition	$11m	$11m - $14m
Increased labour supply	$186m	$186m - $226m
Sub-total WEBs	**$1,357m**	**$1,357m - $1,647m**
Total benefits	**$4,490m**	**$5,063m - $5,353m**

Source: PwC analysis

This analysis shows that the conventional benefits may have increased by some $574 million (18%) over those calculated in the business case. When the WEBs are included, the increase in total benefits could be between $574 - $863 million (13% - 19%).

Costs and BCR

The cost estimate for CRL is being updated to reflect revised design information, and obviously forms a key part of the overall economic assessment (eg for calculating the BCR).

Following the indicative update of the benefit calculations, we estimate that the CRL generates total benefits including WEBs with a PV of between $5.06 - $5.35 billion over the 40 year assessment period.

To assess the impact of this change in total benefits on the BCR, we require the capital and operating cost estimates along with the spend profile to generate the PV of the costs. Revised operating costs have been provided by CRLL, but as noted earlier, updated capital costs are not available at this time. However, CRLL have provided an indicative capex spend profile which we can utilise to back calculate the PV of the capital cost that maintains a BCR of 1.0 (as we are able to calculate the PV of the operating costs). In doing this back calculation we have held the PV of the residual benefit constant at $213m. This back calculation gives a capital cost PV of $4.61 - $4.90 billion (the upper bound reflects the scenario where the higher WEBs value is used).

Using the PV of the capital costs and the spend profile from CRLL, we can then remove the discounting effects and find that a total capital cost of $5.85 - $6.21 billion (undiscounted in 2018 dollars, or $6.64 - $7.06 billion when escalated to the year of spend[4]) maintains a BCR of 1, depending on whether the lower or upper value of the WEBs is included. This means that as long as the revised cost estimate is less than this (and the spend profile is not significantly different from that used), then the CRL remains justified based on the economic assessment that has been undertaken.

The indicative assessment of the benefits and costs is summarised in Table 17 below, for the capital cost scenario that maintains a BCR of 1.

Table 17 Benefit and cost assessment summary (40 year period, 2017-2056)

	Undiscounted total (2018 dollars, billions)	PV (2018 dollars, billions)
Conventional benefits	$15.44	$3.71
WEBs	$5.60 – 6.94	$1.36 - $1.65
Total benefits	**$21.04 - $22.38**	**$5.06 - $5.35**
Capital costs	$5.85 - $6.21[5]	$4.61 - $4.90
Operating costs	$1.49	$0.45
Total costs	**$7.33 - $7.70**	**$5.06 - $5.35**

Source: PwC analysis

4 CRLL have provided an annual escalation rate of 3.8% that is used in this calculation.

5 When escalated to the year of spend, this results in a total outturn capital cost of $6.64 - $7.06 billion.

Assessment is still conservative

As previously identified through the Gateway Review process, the overall assessment is still considered to be conservative given the use of the standard 40 year assessment period for such a transformational, long-life project. When the assessment period is extended to 60 years, the PV of the gross benefits increase by up to a further 24% to $6,641 million, which would also improve the BCR as the future annual benefits dwarf the annual operating costs. The overall benefits would also be expected to increase further if the benefits of recent scope changes (eg 9-car future proofing) were incorporated.

Limitations

We reiterate that the assessment outlined above is indicative only, has been prepared over a short timeframe and is based on limited information and the premise that the overall benefits can be assessed using a number of overarching assumptions. With additional time, a revised do minimum could be developed and modelled to give greater certainty of the changes, though we note that this would be a significant undertaking.

We are happy to discuss any aspects of our indicative assessment with you in more detail.

Yours sincerely

Jarrod Darlington
Director
Email: jarrod.s.darlington@pwc.com
T: 09 355 8105

Craig Rice
Partner
Email: craig.rice@pwc.com
T: 09 355 8641

Appendix A: Restrictions

This letter has been prepared for City Rail Link Limited (CRLL) to detail the update of the economic assessment of CRL and assess the impacts on the base case benefits of various CRL scope changes. This letter has been prepared solely for this purpose and should not be relied upon for any other purpose. We accept no liability to any party should it used for any purpose other than that for which it was prepared.

This letter has been prepared solely for use by CRLL and may not be copied or distributed to third parties without our prior written consent.

To the fullest extent permitted by law, PwC accepts no duty of care to any third party in connection with the provision of this report and/or any related information or explanation (together, the "Information"). Accordingly, regardless of the form of action, whether in contract, tort (including without limitation, negligence) or otherwise, and to the extent permitted by applicable law, PwC accepts no liability of any kind to any third party and disclaims all responsibility for the consequences of any third party acting or refraining to act in reliance on the Information.

We have relied on information provided by CRLL as part of our engagement and certain information, by its nature, is not able to be independently verified. We have not conducted any form of audit in respect of CRLL. For information we have not been able to independently verify, we express no opinion on the reliability, accuracy, or completeness of the information provided to us and upon which we have relied.

The statements and opinions expressed herein have been made in good faith and are based on information as at the date of this letter, on the basis that all information relied upon is true and accurate in all material respects, and not misleading by reason of omission or otherwise.

We reserve the right, but will be under no obligation, to review or amend our report, if any additional information, which was in existence on the date of this report, was not brought to our attention, or subsequently comes to light.

This letter is issued pursuant to the terms and conditions set out in our Letter of Engagement dated 21 February 2019.

Document 3

Strictly Confidential

John Williamson
Programme Director CRL Developments
City Rail Link Limited
PO Box 105777
Auckland 1143

18 October 2022

CRL economic assessment update

Dear John,

PwC has been engaged by City Rail Link Ltd (CRLL) to update the economic assessment first prepared as part of the 2015 business case for the project (prepared by Auckland Transport) and subsequently updated in 2019.

This letter has been prepared in accordance with our Letter of Engagement dated 5 October 2022 and should be read in conjunction with the restrictions outlined in Appendix A.

Summary

We have updated the economic assessment of the City Rail Link (CRL) base case (as per the 2015 business case) to 2021 dollars to reflect the most up-to-date values and methodologies in Waka Kotahi's Monetised Benefits and Costs Manual (MBCM). This includes using a discount rate of 4% and an evaluation period of 60 years, which is appropriate given the long life of the investment. The costs of the project (actual and forecast) have also been adjusted to 2021 dollars to allow an 'apples with apples' comparison with the updated benefits analysis and to calculate a revised project benefit cost ratio (BCR).

The results of the updated economic assessment in 2021 dollars are:

- Present value of benefits: **$11. 93 billion**
- Present value of costs: **$5.86 billion**
- BCR: **2.0**

The economic analysis of the CRL is considered to be conservative as it includes the costs, but does not reflect the additional benefits associated with any scope changes since the business case was completed. For example, the inclusion of 9-car future proofing means future benefits from the additional enabled capacity can be achieved.

Updated base case assessment

This update has revised the economic assessment of the CRL project, originally undertaken as part of the 2015 business case. Benefit values have been updated to 2021 dollars using update factors in the 2021 MBCM and revised base valuations in some cases (e.g. carbon and health benefits). Project costs have been updated in line with actual spend to date from CRLL and forecast costs to complete. The discount rate and evaluation period have been revised from 6% and 40 years to 4% and 60 years in line with the revised methodologies in the MBCM. Finally, a revised opening date of the end of 2025 has been reflected in the updated assessment.

The economic evaluation of a project relies on an assessment of the present value (PV) of costs and benefits. The cost of a project is generally estimated in the dollars of a chosen base year (here it is 2021, to allow comparison with the most recent benefit valuations) and then escalated using an appropriate adjustment to derive the total outturn cost. The PV of the project cost is then derived through discounting of the base year cost.

Following the update and revision to the benefit calculations, the CRL generates total benefits (including wider economic benefits (WEBs)) with a PV of $11.93 billion in 2021 dollars over a 60-year assessment period.

To assess the impact of the change in the value of the PV of the total benefits on the BCR, we have relied on revised capital cost estimates along with the spend profile provided by CRLL to generate the PV of the costs. Actual and forecast capital costs provided by CRLL have been adjusted to 2021 dollars to allow a comparison with the revised benefit assessment. Operating costs from the 2019 update have been inflated to 2021 dollars. Over a 60-year evaluation period, the PV of the costs is $5.86 billion in 2021 dollars.

The updated base case assessment of the benefits and costs is summarised in Table 1 below.

Table 1 Benefit and cost assessment summary (60-year period, 2017-2076)

	Undiscounted total (2021 dollars, billions)	PV (2021 dollars, billions)
Conventional benefits	$25.20	$7.70
WEBs	$14.65	$4.23
Total benefits	**$39.85**	**$11.93**
Capital costs	$5.11	$4.92
Operating costs	$2.51	$0.93
Total costs	**$7.62**	**$5.86**

Source: PwC analysis

The updated economic assessment results in a BCR of 2.0.

The overall assessment is considered to be conservative given the use of a 60-year assessment period for such a transformational, long-life project. When the assessment period is extended to 80 years the

gross benefits increase by a further 21%, which improves the BCR as the future annual benefits dwarf the annual operating costs. The overall benefits would also be expected to increase further if the benefits of recent scope changes (eg 9-car future proofing) were incorporated to offset the additional costs (which are included) as noted above.

The increase in the magnitude of the benefits is considerable when compared to the previous economic assessments; however, this is as a result of the combination of:

- updating to 2021 dollars
- reducing the discount rate from 6% to 4%
- extending the evaluation period from 40 years to 60 years, meaning a further 20 years of benefits are being counted at a lower discount rate.

Limitations

We note that the assessment is based on the original economic assessment for the project undertaken as part of the 2015 business case. This used the land use and modelling assumptions at the time, which have since moved on with the passing of time. The long-term impacts of Covid-19 on travel behaviour, and public transport in particular, are also unknown at this time. Rail patronage is currently considerably lower than pre-Covid levels and the recovery period could delay the realisation (and impact the associated magnitude) of some of the previously estimated benefits associated with CRL.

Further detail relating to the base case update is provided in Appendix B.

We are happy to discuss any aspects of the update with you in more detail.

Yours sincerely,

Jarrod Darlington
Director
E: jarrod.s.darlington@pwc.com
T: 027 306 9971

James Harper
Partner
E: james.f.harper@pwc.com
T: 022 012 9874

Appendix A: Restrictions

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This letter has been prepared solely for use by CRLL and may not be copied or distributed to third parties without our prior written consent. We note that CRLL will also share a copy of this letter with the project sponsors.

To the fullest extent permitted by law, PwC accepts no duty of care to any third party in connection with the provision of this report and/or any related information or explanation (together, the "Information"). Accordingly, regardless of the form of action, whether in contract, tort (including without limitation, negligence) or otherwise, and to the extent permitted by applicable law, PwC accepts no liability of any kind to any third party and disclaims all responsibility for the consequences of any third party acting or refraining to act in reliance on the Information.

We have relied on information provided by CRLL as part of our engagement and certain information, by its nature, is not able to be independently verified. We have not conducted any form of audit in respect of CRLL. For information we have not been able to independently verify, we express no opinion on the reliability, accuracy, or completeness of the information provided to us and upon which we have relied.

The statements and opinions expressed herein have been made in good faith and are based on information as at the date of this letter, on the basis that all information relied upon is true and accurate in all material respects, and not misleading by reason of omission or otherwise.

We reserve the right, but will be under no obligation, to review or amend our report, if any additional information, which was in existence on the date of this report, was not brought to our attention, or subsequently comes to light.

It is not possible to assess with any certainty the implications of Covid-19 on CRLL or the economy as a whole, both generally in terms of how long the current crisis may last and more specifically in terms of its impact on a specific business or the wider economy. We note our advice is subject to significant caveats and caution at this time due to uncertainty that exists for businesses including (amongst other matters) the demand for products or services, access to capital, supply chain disruption, and the extent and duration of the measures implemented by various governments and authorities to contain and/or prevent spread of Covid-19.

This letter is issued pursuant to the terms and conditions set out in our Letter of Engagement dated 5 October 2022.

Appendix B: Supporting detailed analysis

Background

The economic assessment of CRL was first prepared for the business case in early 2015 and the benefits and costs were based in 2014 dollars.

As part of the project's Gateway Review process, the economic assessment was revised in September 2016 to reflect updated assessment of reliability improvements (increasing the benefits) and revised cost estimates. As the residual value benefit was calculated as a function of cost, this benefit also increased slightly.[1] The Gateway Review also recommended that the calculation of the WEBs was expanded beyond agglomeration only and this was completed to include the benefits associated with imperfect competition and increased labour supply.

The economic assessment was again updated in April 2019 to reflect the updated benefit valuations published in Waka Kotahi's 2018 Economic Evaluation Manual (EEM) – the predecessor to the MBCM.

Base case update

The updates that we have made to the economic assessment of the CRL are described below:

- Updated the benefit valuations for reducing CO_2, PM_{10} and NO_x emissions and health benefits (walking) in line with the MBCM
- Updated benefit valuations using the MBCM's update factor for benefits to July 2021 dollars as shown in Table 2
- Reduced the discount rate from 6% to 4% to align with the MBCM
- Increased the evaluation period from 40 to 60 years, consistent with the guidance for long-lived infrastructure in the MBCM
- Inflated the WEBs from the 2015 business case to 2021 dollars, using the same underlying approach that was used as part of the 2019 update
- Extended the construction program until the end of 2025 and set the opening date of CRL to January 2026, with benefits starting to accrue from this date
- Updated capital expenditure (capex) profiles to align with information provided by CRLL in nominal terms:
    - Historical capex is escalated using the *Heavy and Civil Engineering Construction Producer Price Index* (Statistics New Zealand)[2] to adjust to 2021 dollars
    - Forecast capex is de-escalated by 3.8% per annum to adjust to 2021 dollars. This was the escalation rate provided by CRLL for the 2019 update
- Added a further $700 million (nominal) in capital cost, spread equally across Q4 FY2024 – Q2 FY2026, as advised by CRLL, and de-escalated as above to adjust the cashflow to 2021 dollars

[1] The Gateway Review identified that this method for calculating the residual value reflected a conservative estimate of the residual value of the CRL given the extremely long life of the infrastructure.
[2] Statistics New Zealand, Producers Price Index NZSIOC level 4, Quarterly (June 2022)

- Inflated annual operating cost estimates from 2018 to 2021 dollars at a CAGR of 3.1%, calculated using the *Consumers Price Index* (Statistics New Zealand)[3].

There have been no revisions to inputs (i.e. transport modelling outputs) used in the economic model.

Table 2 Update factors

Benefit stream	EEM/MBCM base date	Update factor to July 2014 dollars (2015 business case)	Update factor to July 2018 dollars	Update factor to July 2021 dollars
Travel time	2002	1.42	1.50	1.59
Vehicle operating costs	2008	1.07	-	
Vehicle operating costs	2015	-	1.07	1.15
Public transport user benefits	2008	1.14	1.21	1.28
Walking and cycling benefits	2008	1.14	1.21	
Walking and cycling benefits	2018	-	-	1.06
Emission reduction benefits	2015	-	1.07	1.15

Source: EEM update factors 2014, 2018, MBCM update factors 2021

One of the major changes to the economic evaluation methodology in the MBCM since the 2019 update is the adoption of a 4% discount rate and an acceptance of 60 years as a suitable evaluation period for long-lived infrastructure. The economic assessment parameters are summarised below in Table 3.

Table 3 Economic assessment parameters

	Business case / Gateway Review	2019 update	2022 update
Year 0	2013	2017	2017
CRL opening year	2023	2024	2026

[3] Statistics New Zealand, Consumers Price Index, June 2022 Quarter, all groups

	Business case / Gateway Review	2019 update	2022 update
Base date for costs and benefits	2014	2018	2021
Discount rate (base)	6%	6%	4%
Evaluation period (base)	40 years (2013 – 2052)	40 years (2017 -2056)	60 years (2017 – 2076)

Source: PwC analysis

We stress that care needs to be taken when comparing the different assessments shown in the following pages given the different base dates for costs and benefits. For example, directly comparing the magnitude of the benefits in 2015 dollars with those in 2021 dollars is not appropriate given inflation between those two points in time. The differences in the assessments are further exacerbated by the fact that the discount rate and evaluation period have changed.

Conventional benefits

The PV of the conventional transport benefits are shown in Table 4 for the business case, the revision associated with the Gateway Review the 2019 update, and this update. The updated assessment to 2021 dollars uses the same methodologies and inputs as were used in the Gateway Review.

Table 4 Conventional benefit PV summary

	Business Case (2014 dollars)	Gateway Review (2014 dollars)	2019 update (2018 dollars)	2022 update (2021 dollars)
Travel time • PT users • Road users	 $1,279m $136.4m	 $1,279m $136.4m	 $1,762m $194.8m	 $4,543m $593.7m
Decongestion	$14.3m	$14.3m	$20.8m	$66.2m
Vehicle operating cost reduction	$9.6m	$9.6m	$11.3m	$26.0m
Additional PT user benefits	$42.4m	$42.4m	$57.4m	$137.7m
Reliability improvement	$317.0m	$519.7m	$693.4m	$1575.2m
Health benefits from walking	$125.0m	$125.0m	$172.2m	$588.6m
Emissions reduction	$5.6m	$5.6m	$8.2m	$64.0m
Residual value	$94.0m	$108.3m	$213.0m	$104.0m

	Business Case (2014 dollars)	Gateway Review (2014 dollars)	2019 update (2018 dollars)	2022 update (2021 dollars)
Total conventional benefits	**$2,023m**	**$2,240m**	**$3,133m**	**$7,699m**

Source: PwC analysis

The increase in the magnitude of the benefits is considerable; however, as noted earlier this is as a result of the combination of:

- updating to 2021 dollars
- reducing the discount rate from 6% to 4%
- extending the evaluation period from 40 years to 60 years, meaning a further 20 years of benefits are being counted at a lower discount rate.

WEBs

The discussion relating to updating the estimated WEBs below is replicated from our 2019 update note, with the only changes being any factors to update values to 2021 dollars.

The estimated WEBs associated with the CRL cover three categories:

- Agglomeration
- Imperfect competition
- Increased labour supply.

SGS previously calculated the agglomeration benefits for the 2015 business case, and the process is complex. Without the SGS model or going back to SGS for a formal update, we have used the undiscounted values for 2026, 2036 and 2046 (and linear interpolation in between) from the supporting SGS report to recreate an approximate profile of agglomeration benefits over time that generate the PV of $866 million, based on the parameters in the business case (ie CRL opening in 2023, a 6% discount rate and 40-year evaluation period). Beyond 2046, we have applied a compounding growth rate to generate values that closely match the SGS graph of the undiscounted benefit stream out to 2073.[4] Based on the business case assessment parameters (discount rate, CRL opening year, Year 0 and assessment period) this 'reconstructed' agglomeration benefit stream generates a very similar PV of $866 million (within 0.05%), and a similar undiscounted value of $3,920 million (compared to $4,100 million - within 4.4%).

When compared with the agglomeration sensitivity tests using different discount rates of 8% and 4%, the difference between the SGS reported PVs and those calculated from our reconstructed agglomeration stream is 1.2% for the 8% discount rate and 1.3% for the 4% discount rate. This suggests that the reconstructed agglomeration benefit stream is a close representation of the SGS model and is considered sufficient for the purposes of updating the assessment.

[4] SGS, Economic Impact of the City Rail Link, Final Report, September 2015 – Figure 4, pg 8

As agglomeration is typically measured in the change in gross value added (GVA) per worker due to the increased productivity associated with higher effective job density (EJD), we have used the change in GDP per employed person in Auckland as a proxy for updating the base input data. Based on Infometrics data, there has been a compound annual growth rate (CAGR) of 0.4% pa (in real terms) from 2014 to 2021 in GDP/employed person in Auckland.[5]

To provide an updated estimate of the agglomeration benefits in 2021 dollars we have used the reconstructed agglomeration benefit stream over time, adjusted for the updated assessment period, applied the 0.4% pa to reflect potential revised base inputs and applied CPI to adjust from 2014 dollars to 2021 dollars, using a CAGR of 1.85%pa based on Statistics New Zealand CPI data.

Employment in the Auckland city centre over the last 4-5 years has grown at a much higher rate than the years preceding 2014 and this will have raised the EJD that is used as a baseline in the SGS model. This suggests that the actual magnitude of estimated agglomeration benefits may also have increased, so the approach we have taken can be viewed as conservative.

Benefits associated with imperfect competition are calculated as a function of the transport model outputs and the values of time used in the economic model. As these values of time have been updated to 2021 dollars, the calculation flows through to the revised estimate of imperfect competition benefits.

Increased labour supply benefits reflects the additional tax collected from additional work performed and/or a move to more productive jobs and were calculated separately using detailed transport model outputs and 2014 median wage metrics. To update these to 2021 dollars, we have used the change in median weekly wage in Auckland from 2014 to 2021 to provide a way to update these benefits to 2021 dollars. The CAGR over this period was 3.06%pa[6] (in nominal terms). This annual growth rate has been applied to update this portion of the WEBs.

The PV of the WEBs calculated as part of the CRL assessment are shown in Table 5.

Table 5 WEBSs PV summary

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	2019 update (2018 dollars)	2022 update (2021 dollars)
Agglomeration	$866m	$866m	$1,159m	$3,705m
Imperfect competition	Not included	$8m	$11m	$31m
Increased labour supply	Not included	$124m	$186m	$494m
Total WEBs	**$866m**	**$998m**	**$1,357m**	**$4,229m**

Source: PwC analysis

[5] https://ecoprofile.infometrics.co.nz/auckland/Employment/Growth and https://ecoprofile.infometrics.co.nz/auckland/Gdp/Growth

[6] Statistics New Zealand, Regional earnings for people in paid employment (2014 – 2021)

Total benefits

The summary of the total benefits (PV) is shown in Table 6.

Table 6 Benefits PV summary

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	2019 update (2018 dollars)	2022 update (2021 dollars)
Conventional benefits	$2,023m	$2,240m	$3,133m	$7,699m
WEBs	$866m	$998m	$1,357m	$4,229m
Total benefits	**$2,889m**	**$3,238m**	**$4,490m**	**$11,928m**

Source: PwC analysis

The overall assessment is considered to be conservative given the use of a 60-year assessment period for such a transformational, long-life project. When the assessment period is extended to 80 years, the gross benefits increase by a further 21% to $14.6 billion (PV), which improves the BCR as the future annual benefits dwarf the annual operating costs. The overall benefits would also be expected to increase further if the benefits of recent scope changes (e.g. 9-car future proofing) were incorporated.

Costs

Operating costs

The operating costs associated with the base case have been updated in line with inflation calculated using the *Consumers Price Index* (Statistics New Zealand)[7] and the comparison is provided below in Table 7.

Table 7 Operating costs

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	2019 update (2018 dollars)	2022 update (2021 dollars)
Annual operating cost (post-opening)	$41m	$41m	$45m	$49m
PV operating costs	**$340m**	**$340m**	**$451m**	**$931m**

Source: CRLL (annual opex), PwC analysis

Capital costs

Table 8 summarises the revised nominal spend profile (actual and forecast) for the project. We have included all costs prior to 2017 in the 2017 total.

[7] Statistics New Zealand, Consumers Price Index, June 2022 Quarter, all groups

Table 8 Capital costs ($m, nominal)

2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
502	133	288	611	1,034	818	875	459	400	**5,119**
10%	3%	6%	12%	20%	16%	17%	9%	8%	**100%**

Source: CRLL

In order to update the BCR for the project, we needed to convert all costs to 2021 dollars to allow an 'apples with apples' comparison with the revised total benefits. Our methodology for doing so is as follows:

- Actual capital costs incurred before 2021 are escalated to 2021 dollars using the *Heavy and Civil Engineering Construction Producer Price Index* (Statistics New Zealand)[8].
- Forecast capital costs beyond 2021 are de-escalated using an escalation rate of 3.8% per annum. This escalation rate was previously provided by CRLL as part of the 2019 update.

The nature of this update, where significant spend has already occurred, creates an unusual situation in terms of how those historical costs should be treated, especially with regards to the evaluation period and application of discounting. The MBCM does not provide guidance on 're-assessing' projects part way through construction, dealing only with future costs and benefits.

We provide some discussion around four potential approaches for treating the historical costs in the updated economic assessment below.

One approach is to consider them as sunk costs as the majority of them have no salvage or realisable value. However, we do not consider that the type of scenario we are looking at (i.e. effectively 're-assessing' a project part way through construction) is consistent with the intention of the sunk cost considerations in the MBCM. It would be appropriate to exclude design costs to date, however this level of granularity in the costs has not been provided to us by CRLL.

Another approach is to consider all historical costs as occurring at once (i.e. at the time of the assessment, 'time zero') and reducing the forward evaluation period to reflect the number of years already passed. **This is the approach that we have adopted for the purpose of this update.**

A third approach would be to treat time zero as 2017, and accept that the base date for benefits and costs can be 2021 (i.e. in advance of time zero). Discounting is then applied from that time zero, effectively as if the assessment has occurred in 2017.

A fourth approach adopts time zero as today and, using the discount rate provided in the MBCM, inflates historical cost and discounts future cost to time zero.

The summary of the capital costs (PV) is shown in Table 9 using the approach summarised above for this update.

[8] Statistics New Zealand, Producers Price Index NZSIOC level 4, Quarterly (June 2022)

Table 9 Capital costs PV summary

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	2019 update (2018 dollars)	2022 update (2021 dollars)
PV capital costs	**$1,853m**	**$1,894m**	**n/a**	**$4,925m**

Source: CRLL (annual opex), PwC analysis

To understand the impact of the difference approaches to the treatment of the historical costs, we have undertaken the analysis using all three approaches. As noted above, we do not believe treating the historical costs as sunk costs is an appropriate approach given the nature and intent of this update. The results are summarised in Table 10 in terms of the impact on the PV of the capital costs. Under the approach where historical costs are inflated to 2021, the PV of capital costs increases by 3.5% and the BCR remains 2.0, suggesting the difference in approach is immaterial to the overall outcome of the assessment.

Table 10 Capital cost treatment analysis (2021 dollars)

Description	Discount from time zero = 2021, reduced evaluation period	Discount from time zero = 2017	Time zero = 2021, inflate historical costs
PV capital costs	$4,925m	$4,357m	$5,097m

Source: PwC analysis

Economic summary

The summary of the total benefits and costs (PV) associated with CRL is shown in Table 11.

Table 11 Economic summary

	Business Case (2014 dollars)	Gateway Revision (2014 dollars)	2019 update (2018 dollars)	2022 update (2021 dollars)
Conventional benefits	$2,023m	$2,240m	$3,133m	$7,699m
WEBs	$866m	$998m	$1,357m	$4,229m
Total benefits	**$2,889m**	**$3,238m**	**$4,490m**	**$11,928m**
Total costs	**$1,853m**	**$1,894m**	**n/a**	**$5,856m**
BCR (incl. WEBs)	**1.6**	**1.7**	**n/a**	**2.0**
BCR (excl. WEBs)	**1.1**	**1.2**	**n/a**	**1.3**

Source: PwC analysis