CENTRAL PARK – WILTON B RECONDUCTORING

LISTED PROJECT APPLICATION

Transpower New Zealand Limited
February 2017

Keeping the energy flowing




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Executive Summary

This document is our application to the Commerce Commission seeking approval to increase our Base Capex Allowance for the costs of our proposal to reconductor the Central Park – Wilton B line.

The Central Park–Wilton B line is a 12.5 km 110 kV double circuit line between our Central Park and Wilton substations. Conductor condition assessment has determined that the conductor requires replacement in the near future.

Our Central Park substation has the largest grid offtake in the Wellington region and is essential for supply to the southern and eastern suburbs and much of central Wellington.

Meridian's West Wind windfarm is also connected to the grid via a double tee onto the Central Park–Wilton B line.

In assessing our RCP2 proposal the Commerce Commission determined that additional information was required for some projects and introduced a new category of "Listed Projects" which are Base Capex projects required to follow a commensurate Major Capex Proposal process for approval.

This is our first Listed Project application.

Proposal at a Glance	
What:	Replace the existing conductors on the Central Park to Wilton B line with AAAC Sulphur rated to operate at 70°C.
When:	Commence work in Q1 2019 and complete by Q2 2019
How much:	Our cost estimate for this project is $11.3 million. Uncertainties mean it may cost up to $12.4 million.

This investment is in the interests of our customers and electricity consumers because it will deliver a resilient, cost effective transmission service. Security of supply to Wellington Electricity and energy output from West Wind is contingent on the Central Park – Wilton B line being maintained and fit for service.

The work will be completed by winter 2019.

1 The proposal

This proposal concerns the Central Park – Wilton B line, a 12.5 km 110 kV double-circuit line between our Central Park and Wilton substations. Conductor condition assessment has determined the conductor requires replacement in the near future.

The line was first commissioned in 1978. It is presently strung with duplex Zebra ACSR/GZ conductor between Wilton and tower 26 (11.7 km), with the last five spans to Central Park being strung with simplex Chukar ACSR/GZ conductor. The five Chukar spans into Central Park have been reconductored previously and the latest condition assessment data indicates that it has 10+ years' service remaining. This proposal concerns reconductoring the line (which is a part of the core grid) between Wilton and tower 26 only.

The components in the box below are the grid outputs to be delivered by the project.

Grid Outputs

- Decommissioning and removing the existing duplex conductor on the Central Park – Wilton B line between Wilton and tower 26
- Procuring, installing and commissioning conductor with like-for-like capacity
- Expenditure outgoings up to, $000:

Year	Amount
2016/17	280
2017/18	307
2018/19	1,089
2019/20	10,749
Total	**12,425**

with commissioning occurring in 2019/20 year.

Reconductoring of the entire Central Park – Wilton B line was put forward in our RCP2 proposal with a provisional estimate of $24m (inclusive of the Chukar section and a temporary bypass). The Commerce Commission (Commission) determined that additional information was required and introduced a new category of "Listed Projects" which are Base Capex projects required to follow a commensurate Major Capex Proposal process for approval.

Largely because we are not reconductoring the Chukar section now, the expected cost of the project (including contingencies, inflation and interest) has reduced to $11.3 million once commissioned. We are seeking approval to increase our Base Capex Allowance by an amount we are calling the Listed Project Capex Allowance (LPCA). The LPCA includes a contingency to allow for uncertainties in the project costs that are outside of our control, and also includes interest during construction (IDC). The LPCA for this project is $12.4 million.

We plan to complete this work by winter 2019.

2 The Need

The Central Park – Wilton B line is a 12.5 km 110 kV double-circuit line between our Central Park and Wilton substations.

Central Park, Wilton and the lines between the two are shown diagrammatically in Figure 1 and photographically in Figure 2.

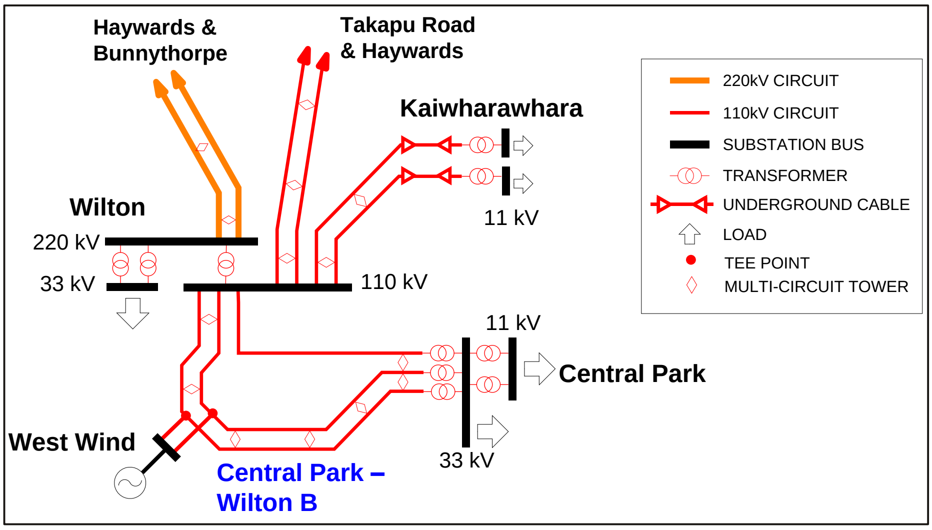


Figure 1 – Network diagram of Central Park and Wilton

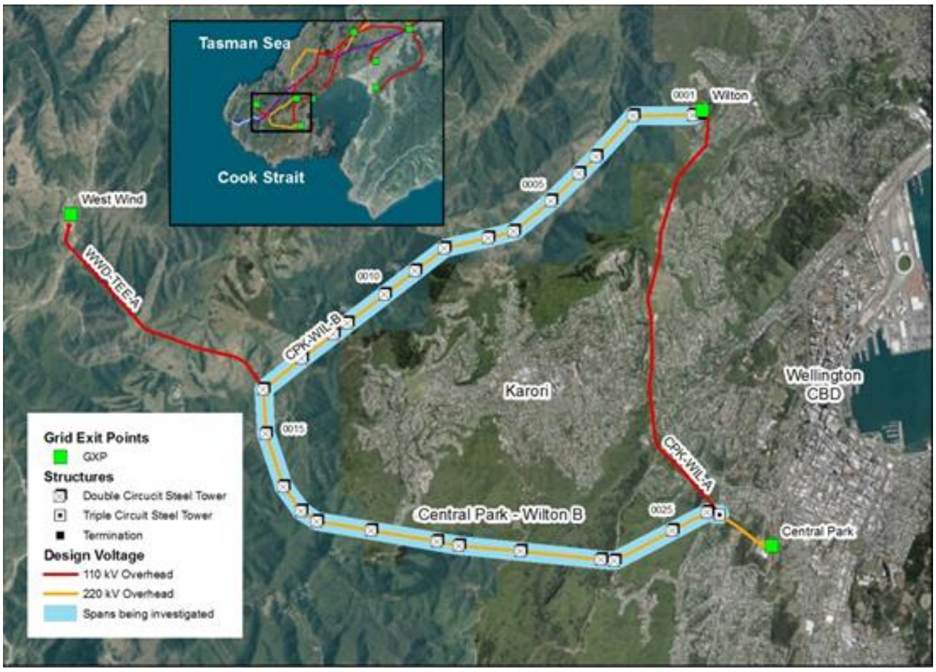


Figure 2 – Aerial photograph showing Central Park - Wilton B line

Central Park substation is an essential part of Wellington's electricity infrastructure. It feeds Wellington Electricity's distribution network and supplies the southern and eastern suburbs and much of central Wellington.

The Central Park – Wilton B line also connects the 143 MW West Wind wind farm to the grid via a double tee connection approximately 5.8 km from Wilton.

Our electricity demand forecast for the Central Park substation (see Figure 3) shows it will be used long term, with only modest demand growth expected out to 2042.

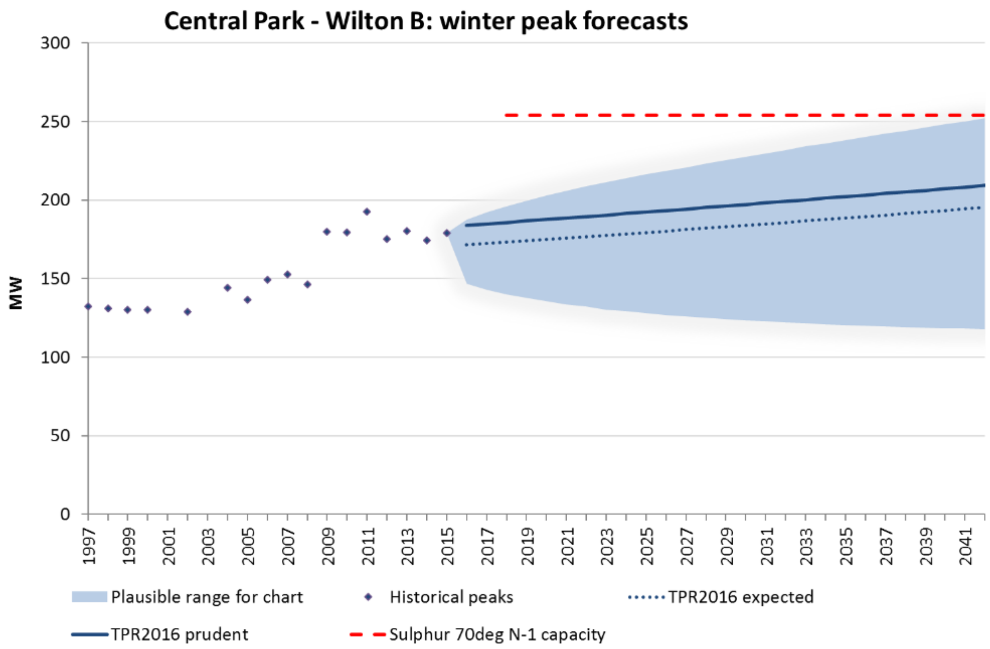


Figure 3 – Central Park electricity demand forecast

2.1 Asset condition

The Central Park–Wilton B line is presently strung with duplex Zebra conductor for all but the final five spans into the Central Park substation which is strung with a simplex Chukar conductor. Zebra and Chukar are both types of aluminium conductor with steel reinforcing (ACSR). The line is in a highly corrosive environment through the presence of airborne salts as the coast is nearby.

Conductor condition assessment has shown that the Zebra section of the line has reached replacement criteria and requires replacement in the near future, in accordance with Transpower's Fleet Strategy: TP.FL 01.00 conductors and insulators.

Conductor condition assessment has been undertaken using several different methods:

- Cormon Testing (using "Eddy Current" technology to estimate the remaining thickness of zinc or aluminium coating)
- Close Aerial Surveys to identify evidence of bulges/defects or areas requiring further monitoring known as "markers"

- Destructive metallurgical testing to investigate the effects of dog bone spacer damage

The Cormon test results indicate the overall condition of the conductor on this line is very poor with approximately 44% of the spans showing signs of complete galvanising loss on the steel core wire. These spans can all be expected to show visible signs of bulging and loss of aluminium cross section in the next few years.

The visual inspection identified 20 defects and 110 markers, while the two metallurgical testing samples from 2009 exceeded the 15% aluminium loss criteria. The number of defects found, and more importantly markers, clearly demonstrates that the conductor on this line is reaching end of life.[1]

For comparison, the Central Park–Wilton A line conductor is not due for replacement until after 2040.

2.1.1 ACSR conductor failure

Aluminium conductor steel-reinforced cable (ACSR) is a specific type of high-capacity, high-strength stranded conductor. The outer strands are aluminium, and the centre strand is steel. Extensive study has now found that ACSR/GZ conductors are prone to accelerated corrosion in salt laden areas as the galvanic cells are formed due to the dissimilar metals (steel, zinc and aluminium). The addition of grease between the zinc and aluminium creates a protective barrier against this.

Once the galvanised coating of the steel core has galvanically corroded it is found that the steel core wire does not corrode appreciably because the aluminium strands "sacrifice" themselves to protect the steel. Loss of strength therefore occurs from loss of aluminium section – noted by visible aluminium oxide build up, and in the worst case, bulging of the conductor.

The Central Park–Wilton B conductor has been found to have widespread corrosion of the steel core wire and aluminium strands due to 'grease holidays'; (sections that did not receive grease during manufacture) and dog bone spacer damage due to the design of some original conductor spacers.

[1] Refer to Attachment A for a full asset condition report.

Figure 4 - Conductor bulge due to grease holidays (CPK-WIL B Span 14-15)

Figure 5- Example of dog done spacer damage as seen on the BPE-WIL A line

Experience from previous testing and inspections has established that a galvanised core Zebra conductor of this era has an estimated life of 40 years in a highly corrosive environment. The Central Park–Wilton B line was commissioned in 1978 so the conductor has performed as expected.

Until the Zebra conductor is completely replaced, on-going repairs and inspections will be required to ensure the risk of a conductor failure is appropriately managed. This is likely to be in the form of isolated conductor defect removal and close aerial inspections.

The four Chukar spans into Central Park have been reconductored previously and the latest condition assessment data indicates that it has 10+ years' service remaining. This section of line will be difficult to reconductor as it is a triple circuit with the same towers and it is necessary to keep at least one circuit in service.[2] Limited outage

[2] We are trialling new catenary reconductoring systems on another project shortly which would make it possible to reconductor the Chukar section with at least one circuit in service.

windows restrict the ability to reconductor both Chukar and Zebra sections at one time. The triple circuit configuration and difficulty getting outages mean that they are effectively two separate work packages. Consequently, given this and the remaining 10 years of life, the Chukar section has been deferred and is now not included in scope of this project.

3 Options, costs and benefits

3.1 The options

3.1.1 Long list of options

We initially compiled a long-list of options which fell into four broad categories:

- dismantling and not replacing
- do nothing
- piecemeal replacement
- non-transmission solutions
  - new generation
  - demand side alternatives
- transmission solutions
  - "like for like" conductor replacement
  - different capacity conductors (ranging from 165MVA to 313MVA)
  - dismantling and enhancing the A line
  - a new line and/or duplexing
  - underground cable instead of overhead lines

A public long list consultation and non-transmission solution request was issued in April 2015 and received one response, from Wellington Electricity, which was generally supportive of reconductoring. Their short term load forecast projections were lower than ours, but they noted that a conservative approach to future demand would be prudent over the asset lifespan.

3.1.2 Short list of options

A shortlist of options was then derived by applying screening criteria.

We have included our assessment of the long-list to short-list process, in preparing this application, as Attachment B, and have summarised the key points below.

- × **Dismantling** the line was considered in the full long list to demonstrate the benefit of keeping the line. The limited capacity of the existing A line as an alternative supply to Central Park would result in lost load which is valued well in excess of the reconductoring cost[3]. We have estimated the value of this lost load to be between $30m and $60m (depending on the demand scenario). Customers would also be exposed to N security conditions which is not consistent with the Grid Reliability Standards. This option was not taken forward to the short list.

3

- × **Do nothing** is not a viable option. Our asset condition assessment has determined that the Zebra section of the line has reached replacement criteria so it cannot be left as-is.
- ✓ **Piecemeal replacement** where the existing line is maintained with the worst sections progressively replaced ie a piecemeal replacement over a longer period of time. This was carried forward to the short list as our Base Case.
- × **Non-transmission solutions** are not plausible. We are not aware of any new (large scale) generation planned in the area nor of any large enough demand side options (our consultation process raised no alternative options).
- ✓ **Transmission solutions** considered reconductoring options. We evaluated a range of potential conductors for the B line as well as enhancing the A line (and dismantling the B line).
  - × The A line could be upgraded, however this would require a lengthy implementation timeframe (more than 5 years) to acquire property rights, and the costs of upgrading would likely be in excess of $40m, so this option was not taken forward to the short list.
  - ✓ Full replacement of the Zebra sections of the B line.

Reconductoring options

The B line is currently duplex Zebra with excess transfer capacity for the foreseeable future (using our latest demand forecasts).

A range of conductors were evaluated during the long-list evaluation which is described in Attachment B. A concept design study was undertaken for a range of simplex conductor types, considering the loads on structures, modelling the clearances and swing distances, but not foundation strengths or construction access requirements.

Some of the smaller conductors have higher levels of conductor swing, which may incur injurious affection as an additional project cost. Also, as there are forestry areas under this line, higher swing would require increased clearances which will have measurable implications. For these reasons, the smaller conductors including Selenium, Phosphorous and Nobelium were not included on the short list.

Goat was removed because it doesn't meet future load growth scenarios, and has a greater swing range than Zebra.

Chukar was excluded because it has a greater tower load requiring foundation strengthening.

Sulphur and Zebra conductors met all requirements and so along with the Base Case formed our short list.

Simplex Sulphur AAAC @ 70ºC has a rating of 238 MVA, so use of this conductor in simplex configuration will not reduce the overall line rating and this conductor could also be thermally upgraded at some later stage, if required.

Simplex Zebra ACSR @ 90ºC has a rating of 217 MVA and would also meet our prudent demand forecast to 2040, although this conductor has no flexibility to be further thermally upgraded.

As demand will be adequately supplied by a simplex configuration we have only considered simplex options further. An advantage of replacing duplex conductor with simplex is that tower loadings will lower and so no tower strengthening is required for these options.

Table 3-1: Summary of long list and shortlist options

Long list option	Selected for shortlist?
Piecemeal replacement Chukar (@75°C)	✓
Zebra (@90°C)	✓
Goat (@75°C)	✘
Sulphur (@70°C)	✓
Selenium (@90°C)	✘
Phosphorous (@90°C)	✘
Nobelium (@90°C)	✘

3.2 The costs and benefits

3.2.1 Key assumptions, constraints, risks

The following main assumptions have been made in developing this business case:

- Generation from the West Wind wind farm will not increase substantially for the foreseeable future.
- Winter demand forecasts for Central Park are shown in Figure 3 above. Growth above a 250 MW peak is considered unlikely before 2040.
- Construction outages during summer, (lower loading) period will be available to carry out the work.

3.2.2 The Costs

The expected "P50[4]" costs (in current (2016) dollars) of the short-listed options are shown below in Table 3-2.

The last row shows the expected cost of each option expressed as a Present Value (PV) to account for phasing of the work over the next few years. Since the Base case option involves expediture over a longer time period, the PV results in a larger cost discount.

[4] The P50 cost represents the central point of our forecast range. There is a 50% probability of the costs being less than this (and 50% probability they will be higher).

Table 3-2: P50 Project costs, excluding inflation and IDC

P50 costs $m	Base case	Sulphur 70°C	Zebra 90°C
Line capacity, MVA	235	238	217
Surveys and testing	1.2		
Investigation		0.6	0.6
Design & prep work	0.6	1.4	1.4
Construction - labour	12.7	5.2	5.3
Construction - Material & plant	2.4	1.9	1.7
Other construction costs[5]	0.4	1.5	1.5
Total Cost	17.2	10.5	10.4
Present Value	$11.9	$9.1	$9.0

3.2.3 The Benefits

The only benefit considered in this analysis are the expected difference in the value of transmission losses over the analysis period with the different conductors, compared to the Base case. We have expressed transmission losses as another cost.

These were assessed using a power flow model and are shown as their present value in Table 3-3. This shows that the Base Case has the highest benefit (lowest loss PV).

Table 3-3: Benefit comparison

PV of P50 costs $m	Base case	Sulphur 70°C	Zebra 90°C
Losses	1.5	1.7	2.1

4 Selecting the proposal

This section covers:

- selection of the proposal
- the robustness of the proposal against changes in assumptions

4.1 Selection of the proposal

4.1.1 Economic assessment

[5] These are the “Category Two” costs described in Section 9. The costs shown in this table are the mid-point of the (minimum to maximum) range.

Details of the economic assessment can be found in Attachment G. The key results are summarised below.

We have expressed all elements of the economic analysis as costs and have shown the economic result as a whole-of-life cost. The option which minimises whole-of-life cost is our preferred economic option. Minimising whole-of-life cost is equivalent to maximising net benefit. These results are shown in Table 4-1 which contains the Present Value (PV) of the P50 costs.

Table 4-1 –Expected net market benefits

PV of P50 costs $m	Base case	Sulphur 70°C	Zebra 90°C
Reconductoring cost	11.9	9.1	9.0
Transmission losses	1.5	1.7	2.1
Present Value of whole-of-life costs	13.4	10.8	11.1
Difference from Base case	0.0	-2.6	-2.3
Net benefit ranking	3	1	2

Sulphur 70°C, is our preferred economic option, with the lowest whole-of-life PV cost. Zebra 90°C is only $300,000 more, so in a manner consistent with the Investment Test, these are similar. We have considered a range of unquantified benefits to help differentiate between the options.

4.1.2 Unquantified benefits

Our assessment shows the relativity between the options and in general, considers the short to medium term. Our qualitative assessment is described in Table 4-2 below. The benefit for each option has been qualitatively ranked between ✓ and ✓✓✓, where ✓✓✓ means more benefit than ✓. Of the full list of unquantified benefits we consider, the following are relevant to this analysis:

Optionality to further upgrade – how easy will it be to further increase capacity if required? This benefit recognises the inherent optionality in some options from being able to increase capacity if our demand and/or generation assumptions prove to be inaccurate.

Minimises disruption – to what extent will the local community be disrupted by the implementation of an alternative? Replacing conductor and working on towers creates disruption and often inconvenience to the local community. Over time, lower capacity or incremental upgrades are more disruptive to communities because we will have to undertake our upgrading activities more often.

Aligns long term grid development – to what extent is the option consistent with our longer term vision for the grid. Our longer term vision requires us to make the best utilisation possible of existing transmission corridors.

Asset life – to what extent will the options differ in expected life? Sulphur AAAC conductor will be expected to last longer than Zebra ACSR in this relatively harsh environment, which is not recognised in our analysis.

Table 4-2: Qualitative assessment – unquantified benefits (UQB) and overall preferred option

Item	Base case	Sulphur 70°C	Zebra 90°C
Ranking based on quantified benefits (QB)	3	1	2
Unquantified differences (UQB):			
• Optionality to further upgrade	✓	✓✓✓	✓
• Minimises disruption	✓	✓✓✓	✓✓✓
•			
• Aligns long term grid development	✓	✓✓✓	✓✓✓
• Asset life	✓✓	✓✓✓	✓✓
Total	5	12	9
Ranking based on unquantified benefits (UQB)	3	1	2
Overall ranking QB + UQB	3	1	2

The Sulphur 70°C option minimises whole-of-life cost and also has an advantage over Zebra 90°C as it is AAAC and is likely to perform better in this corrosive environment. Being strung at 70°C it also has the potential to be thermally upgraded in the future should this be necessary.

Based on evaluation of the short list options, reconductoring with Sulphur 70°C is our preferred option.

4.2 Robustness of the preferred option

Our preferred option has been tested against a range of sensitivities. The future is uncertain and so it is important it is “stress tested”. By adjusting key variables we see how robust the preferred option is to changes in assumptions.

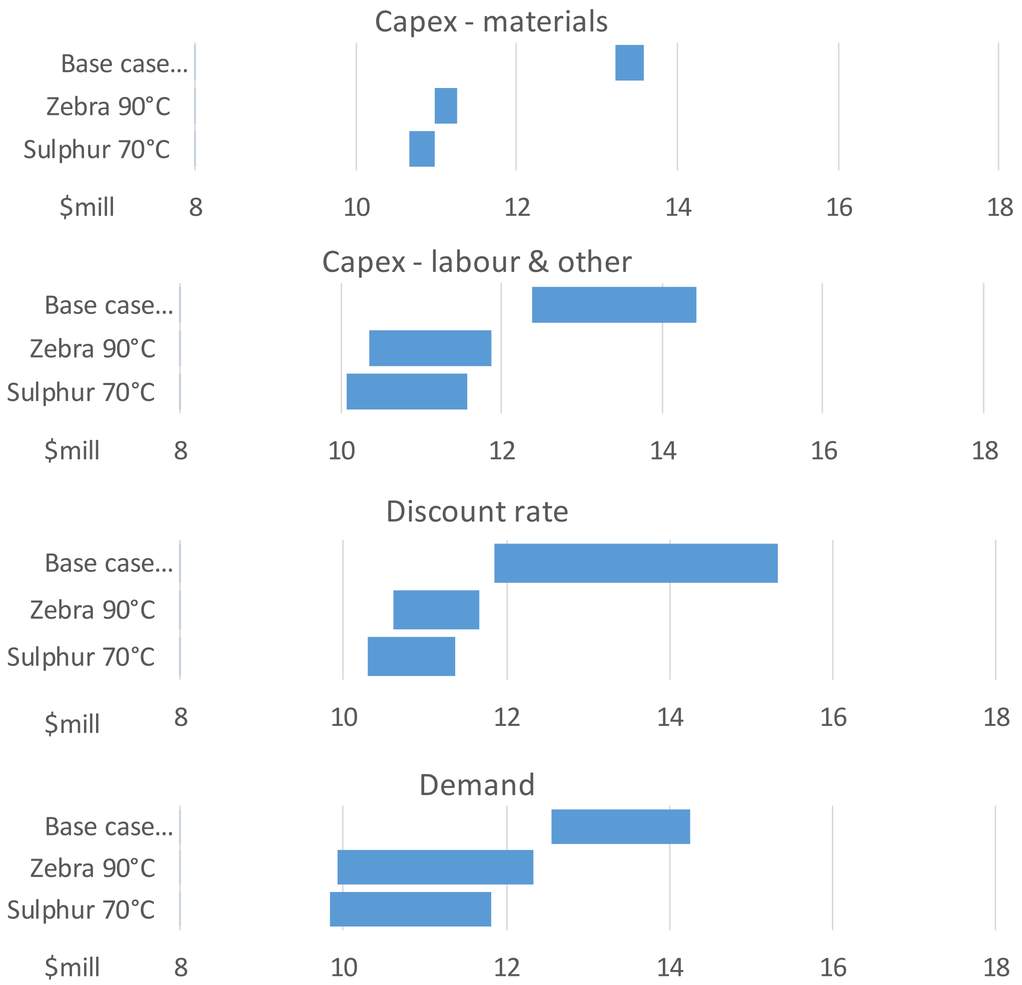
For this project we have considered the results of our analysis with:

- high and low demand (P97.5 and P2.5)
- changes in capital costs (+/- 10%)
- changes in discount rates (+/- 3%)

The results of the sensitivity analysis are in Figure 6, which shows the range in the expected project costs. The costs are the Present Value (PV) in $2016 (December).

The project is most sensitive to demand and the labour capital costs. All options have similar PV ranges, although the base case option is more sensitive to labour costs while the Zebra 90°C and Sulphur 70°C options are most sensitive to demand. The discount rate has an amplified effect on the Base case option, since this has costs out to 2027.

Figure 6 Sensitivity of project costs (PV $2016)

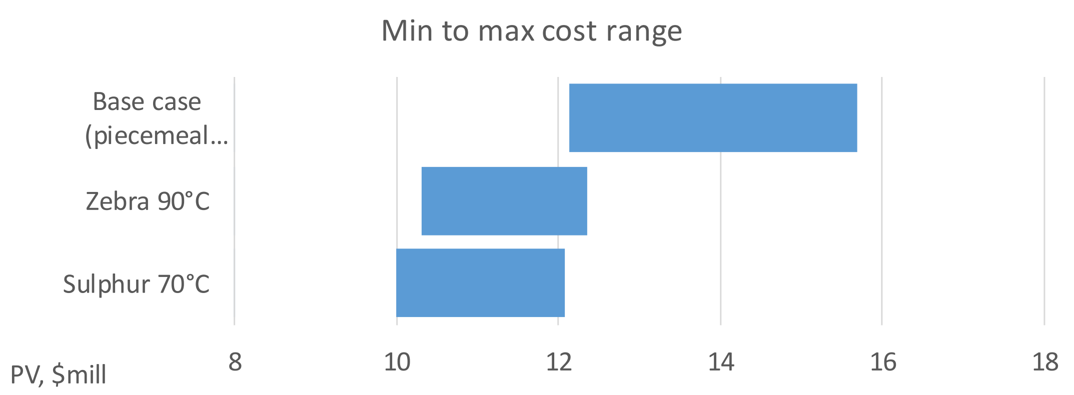


There is uncertainty with all short-listed options but our sensitivity analysis indicates that our preferred option remains preferred more often than other options.

We have further stress tested our preferred option by considering the uncertainty surrounding our cost estimates for each option. Sulphur and Zebra costs are based on the “Solution Study Report Plus” (SSR+) study and are estimated to have an accuracy range of +/- 10%. However, the Base case option was a desktop estimate, hence a wider range of +/- 20%. The following chart shows the resulting PV range (taking the minimum and maximum costs for each option).

The Base case PV range does overlap our preferred option at the extreme ends of each distribution. However, a high cost for Sulphur combined with an extreme low cost for Base case is a more unlikely outcome, considering that each option has similar cost drivers (for example if the re-conductoring work is more difficult than expected then labour costs will be higher for all options).

Figure 7 Cost risk range (PV $2016)



In our view these sensitivities demonstrate that Sulphur 70°C is sufficiently robust under sensitivity analysis and it therefore becomes our proposal.

4.2.1 EDGS scenarios

We have not considered EDGS scenarios, since there is no new generation planned for this region. However, we have considered the effect of solar PV and electric vehicles on demand at Central Park. This is discussed in more detail in Appendix A.3.

The uncertainty around the uptake of solar PV and other technologies such as electric vehicles will be implicit in our range of demand forecasts. We have a 2042 peak demand forecast range of between 120MW and 250MW, which includes this uncertainty.

5 Timing

Due to the length of the lines (together about 11.7 km), we are planning a 4-month delivery programme to replace the conductor, starting in February 2019. This time of year is likely to provide the most settled weather patterns that are required for construction.

6 Good electricity industry practice

The proposed replacement of the conductor on the Central Park - Wilton B line removes safety risk and better utilises existing assets. Overall the proposal reflects good electricity industry practice by being consistent with good international practice, demonstrating economic management, and improving safety.

7 Stakeholder engagement

We have engaged with both community and industry stakeholders during our investigation.

Table 7-1: Stakeholder engagement to date

Date	Activity
April 2015	Request for Information and Long List of Options
January 2016	Wellington Electricity (WE) submission
September 2016	Transpower response to WE submission
December 2016	Consultation on our draft Listed Project Application
February 2017	Two responses received

In April 2015 we published a Request for Information (RFI) and Long List of Options for this project.

We received one submission from Wellington Electricity, which was generally supportive of reconductoring. Their short term load forecast projections are lower than those of our APR for CPK, but they note that a conservative approach is prudent over the asset lifespan.

In December 2016 we published our draft Listed Project Application which can be found at https://www.transpower.co.nz/central-park-wilton-investigation-consultation.

This comprised of five documents:

- The main document which described our short list of options and the Listed Project Capital Allowance being requested
- Attachment A Condition Assessment
- Attachment B Options and Costing report
- Attachment C Wellington Electricity submission Jan 2016
- Attachment D Transpower reply to WE submission Jan 2016
- Attachment E Annual costs and assumptions

We received two responses – one from Wellington Electricity and one from Meridian. Both supported our proposal and asked that we liaise with them as the project progresses in order to minimise the effect on their own operations, which we will do.

8 Listed Project Capex Allowance

8.1 The difference between Base capex and a listed project

If this project is approved by the Commission, an amount will be added to our RCP2 Base capex allowance. We have called this the Listed Project Capex Allowance (LPCA).

We have derived our proposed LPCA in a manner consistent with it being a standalone project, on the basis that our existing Base capex allowance was approved for other works, not including this project.

The Listed Project category was developed because although reconductoring projects are Base capex, they have characteristics which do not make them suitable for the Commission's approach to other Base capex. The Commission approves Base capex assuming that the work is predictable and routine. They approve a pool of money with full substitutability (we can substitute other projects to those included in our RCP submission) and they approve the estimated P50 cost for that pool of projects. Reconductoring jobs are large projects, containing works which are unpredictable in terms of both timing and cost. In many instances, we do not confirm the actual scope of a reconductoring project until it actually starts, being when we physically visit and inspect every tower site. It is not until then that we understand the more uncertain requirements (such as access tracks, tower footings, etc) and can finalise the works required.

8.2 Our approach for this project

This reconductoring project is unusual in that we have determined that no tower or foundation strengthening will be required, since we are replacing a duplex conductor configuration with a lighter weight simplex conductor. This reduces the scope uncertainties considerably.

We have broken our cost estimate into two categories.

1. The first category ("SSR+" costs) contains the bulk of the work and contains those elements whose cost can be estimated reasonably well. There is still some scope uncertainty and for those elements where work is tendered out, uncertainty around the cost. A new approach was used for this project, to refine this cost as much as possible without undertaking detailed design. For this project, we believe the cost accuracy of these elements is +/-10%. It is unlikely we will be able to achieve this for most reconductoring projects. The expected P50 cost of this category is $9 million and $9.9 million is the maximum expected cost, before financing costs, inflation and exchange rate uncertainty are added.

2. The second category ("other construction costs") contains cost items which are uncertain in that, apart from some minimum amount of expenditure, the cost could be anywhere between the minimum and maximum cost we have determined. The cost for these items does not conform to a regular distribution. Some are binary ie we will either spend $0 or the maximum amount and some are not binary, but we do not know where the cost will end up within each range. These costs are not easily predictable, nor easily controlled by ourselves and the final level of cost is not dependent on being efficient or otherwise. The minimum expected cost of this category is $1.0 million and $1.9 million is the maximum expected cost, before financing costs, inflation and exchange rate uncertainty are added.

An overall minimum and maximum cost summary for each category is shown in Table 8-1.

The biggest uncertainty for the category two costs relates to weather conditions when the reconductoring occurs.

Wind speeds of greater than 80 km/hour will curtail work, and analysis of local wind data suggests these wind conditions will prevail around 12% of the time, although this is variable year to year. We would expect to lose at least 13 work days due to wind speed, with a likely range between 9 and 17 days (based on historical meteorological data from NIWA). We would also expect some down time due to heavy rainfall and have assumed a further 5 days for this. We have allowed a total of 22 days for these weather related uncertainties in our LPCA.

Table 8-1 –Cost range estimates

$thousand	Minimum	Maximum
Category One (2016$):		
SSR+ costs	8165	9858
Category Two (2016$):		
Weather delays	560	880
Wiring site access	131	184
Access - Track overlay (General)	68	137
Culverts - General	12	18
Security - General	62	187
Trail management - General	87	144
Property	0	100
Conductor treatment to mitigate noise risk	20	100
Existing conductor repair before using as pull wire	25	50
Replacement of attachment points	0	135
Category Two subtotal (2016$):	966	1935
Category One + Two (2016$)	9131	11793
Inflation	391	532
Exchange rates	-156	156
IDC	357	426
Total cost estimate (2019$)	9723	12906

8.3 Deriving the LPCA for this project

To determine the LPCA for this project we have taken a different approach for the two cost categories.

For the first category we consider it would be reasonable to include an uncertainty allowance which is at a P90 level for the estimated cost range. We have undertaken a significant amount of work to refine the cost as accurately as possible, which means a

P90 estimate only reflects an uplift of only $0.5 million (6%) on our expected cost estimate. This is a small margin for a project of this size and we believe is an appropriate balance between providing perverse incentives to take shortcuts (in terms of project management) and having an allowance which discourages efficiency.

As already mentioned, this is an unusual project (in terms of the relative scope certainty) so we would not consider approval for this uncertainty allowance to set a precedent for other listed projects.

For the second category we consider it would be reasonable to include a P100 (maximum) uncertainty allowance. These are costs which are unpredictable, and some costs, such as weather-related costs, are out of our control. If they all occur at the maximum level, we should not be penalised.

In all circumstances, we can only recover the actual cost of the project from our customers.

A summary of our LPCA calculation, including financing costs, inflation and exchange rate uncertainty is shown in Table 8-2.

As shown, the total LPCA we are applying for is $12.4 million. This reflects an uplift of 10% ($1.1 million) over our expected cost.

Table 8-2 –Deriving the LPCA

	Cost distribution type	Range of distribution (% or $000)	Point selected within distribution (probability)	Cost applied for ($000)
SSR+ costs (2016$)	Triangle	+/-10%	P90	9479
Other construction costs (2016$)	Undefined	$969	Max	1935
Inflation				511
Exchange rates				86
IDC				414
Total LPCA (2019$)				12425

9 CommunityCare Fund

Also included in the expected cost is an amount for our CommunityCare Fund programme. Transpower acknowledges that while there are clear benefits from electricity transmission, our work will impact on local communities and the use of recreational facilities that will be disrupted by the work.

10 Effect on transmission charges

If the Commerce Commission approves this investment proposal and we complete the conductor replacement as outlined, transmission charges will increase. Table 10-1 shows indicative increases, for information purposes. These transmission charge increases would be expected to reduce from 2021 on, as the asset is depreciated.

Table 10-1: Impact on transmission charges

Year	Consumers bill c/kWh
2018/19	0.002
2019/20	0.003
2020/21	0.003
2021/22	0.003
2022/23	0.003
2023/24	0.003
2024/25	0.003

A.1 Capex IM requirements

In the below table we outline how this application meets the requirements to be approved by the Commerce Commission under the Capex IM.

Table A.1-1 – Capex IM checklist

Capex IM section	Report cross reference
2.2.3 Listed Project	
(2) Listed project definition (a) (i) capex > $20 million (ii) to be commissioned in the regulatory period (b) replacement/ refurbishment (c) commencement date within the regulatory period (d) not already in base capex	*A.2 Changes in costs from prior estimates* Although the cost estimates are under $20m, at the time of applying for this to be a listed project there was an expectation cost would be greater than $20m.
3.2.4 Approval of base capex in addition to the base capex allowance	
(1) Due by June twenty-two months before the end of a regulatory period	Submission expected in February 2017 (due beforeJune 2018)
(2)(a) reason for project, technical evidence	*2 The Need* Attachment A
(2)(b) options considered	*3.1 The options* Attachment B
(2)(c) scope & grid outputs	*1 The proposal*
(2)(d) technical & costing info & risks	*3.2.2 The Costs* Attachments B & G
(2)(e) costs by year & assumptions	Attachment G
(2)(f) cost-benefit & sensitivity	*3.2 The costs and benefits* *4.2 Robustness of the preferred option*
(2)(g) consultation	*7 Stakeholder engagement*
(2)(h) Board & CEO sign-off	Attachment H
(4)(a) consultation process as per base capex	Attachments C, D, E, F and section 7
(4)(b) evaluated as per base capex criteria, incl Sched A where relevant: - follow Transpower policies & planning standards for grid / base capex; - cost-effective; - reasonable assumptions (method); - risk-based good asset management, - grid output dependencies - deliverability; - reasonable asset replacement models (inputs & method); - reasonable demand forecasts (inputs & method); - scope for efficiency gains	*2 The Need* Attachment A https://www.transpower.co.nz/sites/default/files/plain-page/attachments/Transpower%20National-Regional%20Peak%20Demand%20Forecasts%20Feb-2015%20Information%20Document.pdf
(5)(a) forecast CPI used for base capex in reg period; (b) forecast FX rates used for base capex for reg period; (c) percentage of foreign capex	Attachment G

A.2 Changes in costs from prior estimates

In our RCP2 submission we provided an indicative cost of $24m, around $13m higher than our current $11m estimate (P50). There are a number of drivers of this cost reduction:

- The scope of the project has been reduced substantially
  - Reconductoring of the last 0.8km section of the Central Park – Wilton B line is not included in this project.
  - By-pass cabling is not now required, which was needed for reconductoring the difficult last 0.8 km section
  - Simplex conductors are being installed (we previously assumed duplex)
- Underlying costs estimates for all re-conductoring projects have been revised down
  - Since the initial estimates were made, a number of re-conductoring projects have been undertaken, including Bunnythorpe to Haywards, which has enabled us to obtain a clearer view of "typical" costs

The below table shows the impact of each of these cost drivers.

Table A.2-1 – Cost changes between April 2015 and November 2016

$ million	Materials	All other costs & risk contingency	Total cost
0.8km last section of Chukar (excl cabling)	-0.35	-2.12	-2.47
By-pass cabling	-2.06	-3.63	-5.70
Installation of duplex vs simplex	-0.67	-2.23	-2.91
Other revisions (eg. more accurate costs)	-0.19	-1.93	-2.12
Total revisions	-3.27	-9.92	-13.20

A.3 Demand and generation assumptions

The Capex IM requires we consider demand and generation scenarios (potential future demand and generation configurations) in our analysis. This is relevant in a general sense because, if new generation were to be built in the right location, at the right time, the need for investment in transmission could be reduced or even eliminated.

We are required to base our scenarios on the Electricity Demand and Generation Scenarios (EDGS) from the Ministry of Business Innovation and Employment (MBIE).

However, no new generation is planned for this area and we assume that Meridian's West Wind generation continues operating at current capacity levels.

It is likely that any potential new generation will be small-scale embedded generation, such as roof-top solar PV on residential and commercial premises.

In the tables below we show the solar PV MW capacities and Electric Vehicle demand based on the EDGS scenarios. It shows the national total, and also the amount we could expect to see in Central Park (pro-rated assuming 3% of the national load). The range between the highest and lowest forecasts of Solar in Central Park by 2050 is 37.9MW, whilst for EV's it is 11.7MW. Unless there was widespread adoption of batteries, we would not expect the Solar PV capacity to materially influence the residential winter peak loads, which typically occur when the sun is not shining.

Table A.3-1 2016 final EDGS Solar Power Assumptions – installed capacity (MW)

	National		Implied in Central Park area	
	2025	**2050**	**2025**	**2050**
Minimum	196.4	526.7	5.8	15.5
Average	228.9	954.3	6.7	28.1
Maximum	261.3	1813.7	7.7	53.3
Range (Max-Min)	64.9	1287.0	1.9	37.9

Table A.3-2 2016 final EDGS Electric Vehicle Assumptions – average MW demand

	National		Implied in Central Park area	
	2025	**2050**	**2025**	**2050**
Minimum	16.5	122.5	0.5	3.6
Average	34.4	218.6	1.0	6.4
Maximum	54.2	521.2	1.6	15.3
Range (Max-Min)	37.7	398.7	1.1	11.7

The uncertainty around the take-up of solar and other technologies such as electric vehicles will be implicit in our range of demand forecasts. In the following section we have a 2042 peak demand range of between 120MW and 250MW, which includes the uncertainty from uptake of solar PV and electric vehicles.

Given that the EDGS demand forecasts do not drill down to the regional level, and that the new generation build scenarios are of little relevance for this project, we have not directly used the EDGS scenarios in this analysis.

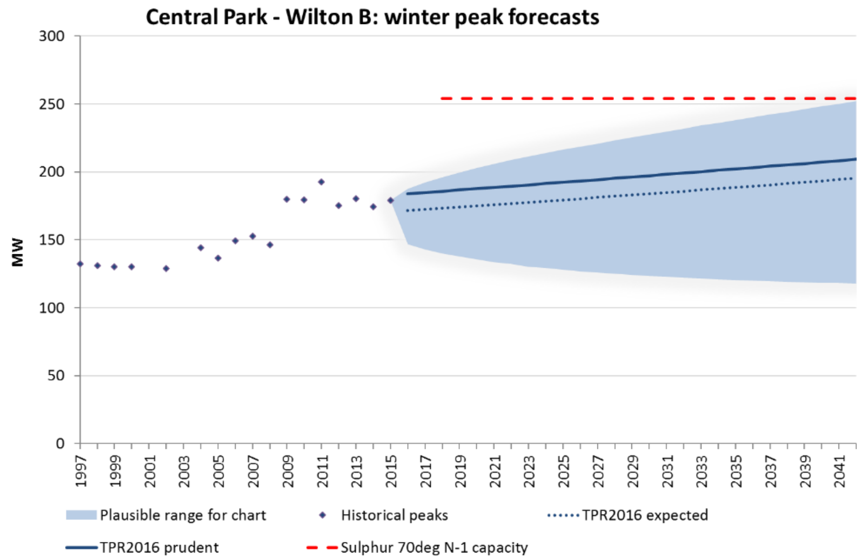
1.1 Demand

The peak demand forecast assumptions used are from our 2016 Transmission Planning Report. They were developed using MBIE energy growth forecasts, combined with input from our customers.

Prudent peak forecasts are developed using our estimate of the P90 (90th percentile) of our demand forecast growth rates for the first 5 years, but then the forecast reverts to grow at the P50 (50th percentile, or expected) rate. Our expected forecast is the P50 of our demand forecast range.

Central Park demand peaks in winter. Winter demand forecasts for Central Park are shown below. The prudent and expected forecasts are our official forecasts. The plausible range is approximate. In particular, the upper range is speculative and Wellington Electricity may opt for other solutions (eg a new grid exit point) if the load did grow in this manner.

Figure 8: APR 2015 Winter Peak Forecasts for Central Park



A.4 Peak demand forecasts

This table shows the forecast expected and prudent peak demand for the Central Park GXP in MW from our 2015 forecast. The prudent peak is taken as the P90 (such that there is a 10% of the probability of exceeding this level) peak in the first 5 years with subsequent growth assumed to be at the same rate as the expected forecast.

Table A.4-1: Central Park expected and prudent demand forecasts, MW

	Central Park Expected (MW)	Central Park Prudent (MW)
2016	172	184
2017	172	185
2018	173	186
2019	174	187
2020	175	188
2021	176	189
2022	177	190
2023	178	190
2024	179	191
2025	179	192
2026	180	193
2027	181	194
2028	182	195
2029	183	196
2030	184	197
2031	185	198
2032	186	199
2033	187	200
2034	188	201
2035	189	202
2036	190	203
2037	191	204
2038	192	205
2039	192	206
2040	193	207
2041	194	208
2042	195	209

A.5 Attachments

Further information supporting this application is included in the following attachments:

Attachment A – Condition assessment of the Central Park - Wilton B lines

This document provides some background as to why the conductors on the Central Park - Wilton B lines need to be replaced.

Attachment B –Options and Costing report

This document describes how the long list of options was reduced to a short list of options. It also provides detail of how the short list options were costed.

Attachment C – Wellington Electricity submission Jan 2016

Attachment D – Transpower reply to WE submission Sep 2016

Attachment E – Wellington Electricity submission Jan 2017

Attachment F – Meridian submission Jan 2017

Attachment G – Annual costs and assumptions

Attachment H – Board approval and CEO certification

