TRANSPOWER

Listed Project Application

Ōtāhuhu – Whakamaru A&B lines reconductoring – Auckland wider region section

Attachment 1: Condition Assessment Report

December 2025

Purpose

This Attachment forms part of the Ōtāhuhu Whakamaru A&B lines reconductoring – Auckland wider region section – Listed Project Application.

The purpose of this Attachment is to provide an overview of the condition of the conductors in the wider Auckland section of the Ōtāhuhu–Whakamaru A and B (**OTA–WKM A&B**) lines.

To facilitate planning and delivery, we have divided the OTA–WKM A&B lines into more manageable sub-sections that can be staggered over RCP4, 5 and 6. The sections scheduled for replacement during RCP 4 is the section from Flatbush to Hūnua, which is shown as "Stage 2 – Wider Auckland Section" in Figure 1. For clarity, we will refer to the wider Auckland section as Stage 2 throughout this Attachment.

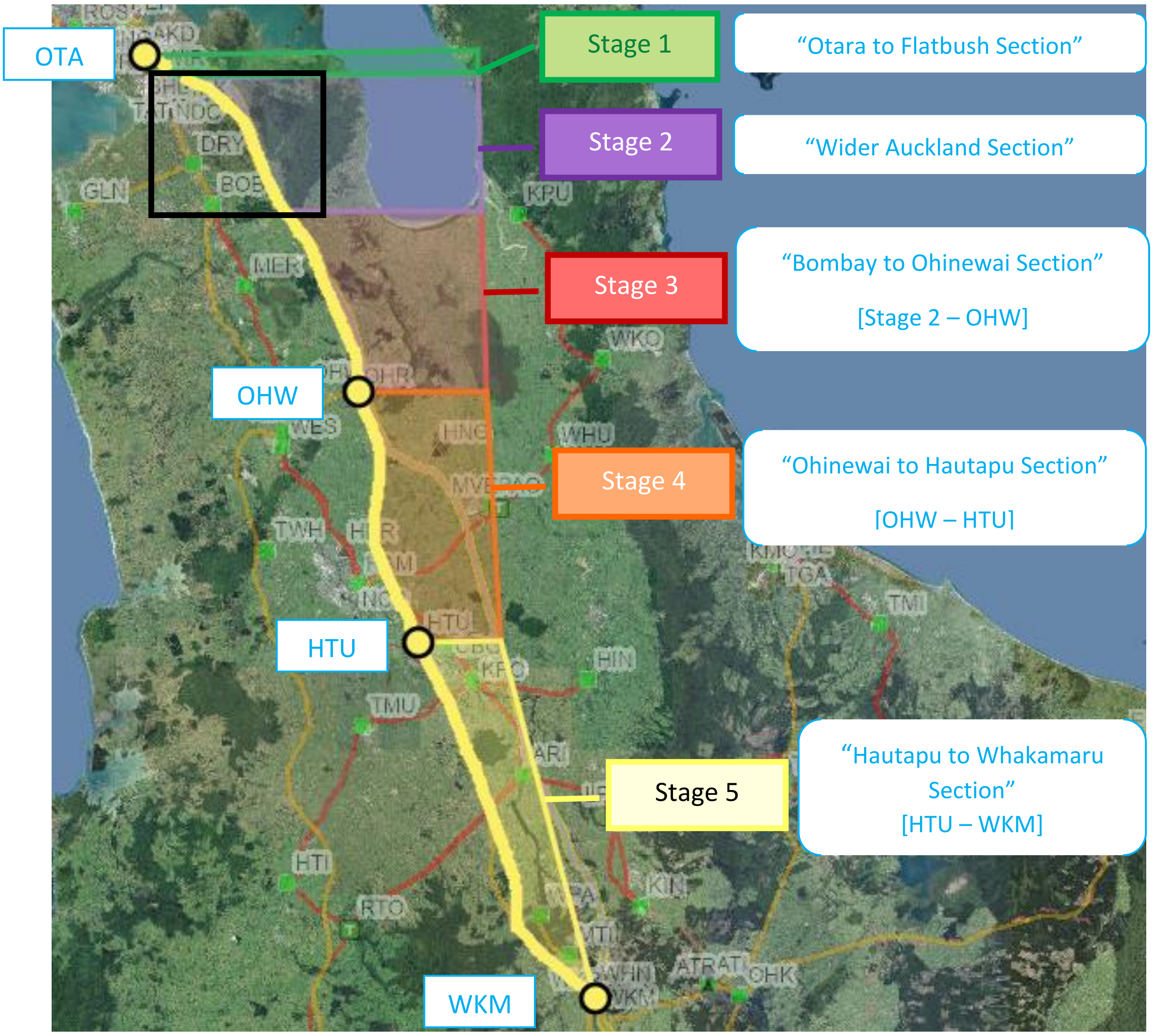


Figure 1. Sectionalisation of the OTA–WKM A&B Lines for Planning Purposes

Contents

1 Summary

This Attachment provides high level findings from Close Aerial Surveys (**CAS**), sample testing, and eddy current[1] testing in the Stage 2 section of the OTA–WKM A&B lines.

From these assessments, we have concluded that the conductor is at end of life, as localised repair can no longer provide effective lifetime extension. We propose working towards delivery of the reconductoring works in RCP4, consistent with our asset class strategy.

This Attachment provides additional context to the high-level findings for the proposed OTA–WKM A&B reconductoring project by summarising new condition information collected in the "Southern Section"[2] of the OTA–WKM A&B lines. Based on these findings, we have now assessed that the conductor throughout the whole line is at, or near, end of life, except the northern section which has already been reconductored.

For planning purposes, the southern section has been divided into three new sub-sections. Table 1 summarises the recommended replacement timing for each section (stage) of the line.

Table 1. Recommended Replacement Timing for Conductor on OTA–WKM–A and OTA–WKM–B

Line Section	Section Name	Structure #	Length (cct-km)	Estimated Replacement Timing (RCP)	Maintenance Approach	Timing Confidence
Stage 1	Otara to Flatbush	OTA – A0489 OTA – B0469	6.8[3] 5.8[4]	complete	No change.	-
Stage 2	**Wider Auckland**	**A0489 – A0407** **B0469 – B0391**	**31.2** **30.9**	**4**	**Increase defect management if works delayed.**	**High**
Stage 3	Bombay to Ohinewai (Stage 2 – OHW)	A0407 – A0310 B0391 – B0296	40.0 38.2	5 (early)	Increase defect management	High
Stage 4	Ohinewai to Hautapu (OHW – HTU)	A0310 – A0197 B0296 – B0185	41.9 (x2)	5 (late)	Increase defect management	High
Stage 5	Hautapu to Whakamaru	A0196 – WKM	71.4 (x2)	6	Collect condition information.	Low

1 This testing uses a magnetic field to induce an eddy current, which can be used to estimate conductor degradation by measuring the secondary magnetic field produced by the eddy current. This testing is performed while the conductor is in-situ on the line.

2 The "Southern Section" refers to stage 3, 4, and 5 in Figure 1. Note that while the lines are geographically close to OHW, there is no connection at OHW.

3 Excludes underground cable length.

4 See footnote 3.

(HTU - WKM)	B0184 – WKM	

2 Line Overview

OTA–WKM–A and OTA–WKM–B are 220 kV, single-circuit, steel-tower lines commissioned in 1952 and 1954 respectively. The lines run in parallel from Ōtāhuhu (**OTA**) to Whakamaru (**WKM**), traversing moderate and severe corrosion zones.

Since the previous condition report in 2020, reconductoring and undergrounding works have been completed in urban Auckland as part of the Otara to Flatbush section, shown as Stage 1 in Figure 1. Further south, the newly commissioned Hautapu GXP has been teed into both lines. Table 2 and Table 3 provide an updated overview of the OTA–WKM A&B lines, reflecting these recent works. As seen in these tables, around 96% of the overhead conductor strung on both lines remains as-built Goat ACSR-GZ[5], which is more than 70 years old. Since the 2020 condition report, we have prioritised completing further assessments of the "Southern Section" of both lines.

Table 2. OTA–WKM–A Overview

	Conductor	Earthwire
Conductor (YoM[6])	ACSR-AC-TW Curlew from OTA – TSC496 (2022) Underground 220 kV Cable TSC496 – TSC490 ACSR-GZ Goat TSC490 – T489 (2022) ACSR-GZ Goat T489 – T197 (1952) ACSR-AC Goat T197 – T196 (2022) ACSR-AC-TW Curlew T196A – HTU (2022) ACSR-GZ Goat T196 – WKM (1952)	SCACB OTA – T508 (2012, 2009 Gantry Spans) SCACD T199 – T193, inc. HTU (2024) SCACB WKM – T3 (2012)
Overhead Line Length	OTA – TSC496 Curlew Section: 5.9 cct km TSC490 – T489 Goat (2022): 0.58 cct km T489 – T197 Goat (1952): 111.1 cct km T196A – HTU Curlew Section: 0.32 cct km T197 – T196 Goat (2022): 0.30 cct km T196 – WKM Goat (1952):71.5 cct km	SCACB OTA – T508: 0.81 cct-km SCACD T199 – T193: 2.45 cct-km SCACB WKM – T3: 0.77 cct-km
Corrosion zone	Severe: OTA – T428 Moderate: T428 – WKM	

5 The suffix -GZ and -AC signify the type of protective layer applied during manufacturing to the core steel to prevent galvanic corrosion between the steel core and the outer aluminum layers. Our older conductors were typically galvanized (GZ), whereas from the late 1980's we have used aluminum clad steel (AC) which has better corrosion resistance.

6 Year of manufacturer (YoM) is assumed to be the line commissioning date for lines where the YoM was not recorded. This is the case for both the OTA–WKM A&B lines. Some spans of conductor will have been exposed to the environment for a few years prior to commissioning, during the construction process.

	Conductor	Earthwire
Operating Voltage	220 kV	
Line Configuration	Single Circuit	
Predominant structure type	Steel tower	

Table 3. OTA–WKM–B Overview

	Conductor	Earthwire
Conductor (YoM)	ACSR-AC-TW Curlew from OTA – TSC496 (2022) Underground 220kV Cable TSC496 – TSC490 ACSR-GZ Goat TSC490 – B0469 (2022) ACSR-GZ Goat B0469 – B0185 (1952) ACSR-AC Goat B0185 – B0184 (2022) ACSR-AC-TW Curlew B0184A – HTU (2022) ACSR-GZ Goat B0184 – WKM (1952)	SCACB OTA – B0491 (2009) SCACD B0181 – B0187, inc. HTU (2024) SCACB WKM – B0003 (2012)
Overhead Line Length	OTA – TSC496 Curlew Section: 5.2 cct km TSC490 – B0469 Goat (2022): 0.62 cct km B0496 – B0185 Goat (1952): 111.0 cct km B0185 – B0184 Goat (2022): 0.33 cct km B0184A – HTU Curlew Section: 0.27 cct km B0184 – WKM Goat (1952): 71.4 cct km	SCACB OTA – B0491 (1.1 km) SCACD B0181 – B0187, inc. HTU (3.1km) SCACB WKM – B0003 (0.8 km)
Corrosion zone	Severe: OTA – B0410 Moderate: B0410 – WKM	
Operating Voltage	220 kV	
Line Configuration	Single Circuit	
Predominant structure type	Steel tower	

3 Stage 2 Conductor Condition Assessment

Table 4 presents a summary of the condition assessments carried out on the Stage 2 section of the OTA–WKM A&B lines, including the year in which the condition assessments were performed.

Table 4. Summary of condition assessment conducted for the Stage 2 section of the OTA–WKM A&B lines

	Pre 2015	2015	2016	2017	2018	2019	2020
Visual Inspection	x						
Close Aerial Survey			x				x
Destructive Sample Testing	x						
Eddy Current Testing	x		x				

3.1 Close Aerial Survey

CAS is used to identify conductors that are at or near end of life by identifying corrosion defects, particularly bulges and white powder[7] on the surface of the conductor. We know that conductors which are visually bulging (due to large deposits of white powder forming on the inner conductor layers) will have lost significant aluminium cross section and will have reduced mechanical strength. Usually, visible bulges develop after white powder is visible, so white powder is an effective leading indicator that an ACSR conductor is nearing end of life, indicating advanced corrosion of the steel core and sacrifice of aluminium cross-section.

3.1.1 Helicopter CAS (2016 Survey)

Prior to developing our annual RPAS[8] CAS programme, some of the northern sections of the OTA–WKM lines were inspected using our legacy helicopter-based survey method. The focus was predominately on spans in what became the Stage 1 section of the line, but we observed white powder defects in the Stage 2 section of the line where spans were surveyed. An example on span 475-476 is shown in Figure 2.

Figure 2. White powder defect in span A0475-0476 from 2016 helicopter inspection

[7] White powder refers to aluminum oxide corrosion in or on overhead conductors.

[8] Remotely Piloted Aerial System i.e., drones

3.1.2 OTA–WKM–A: T489 – T407 (2020 RPAS Survey)

The Stage 2 segment of OTA–WKM–A, spanning T489 to T407, remains strung with the original 1952 Goat ACSR-GZ conductor. Our annual programme of CAS inspections using RPAS identified widespread white powder defects throughout the section of line. Examples of these defects are shown in Figure 3.

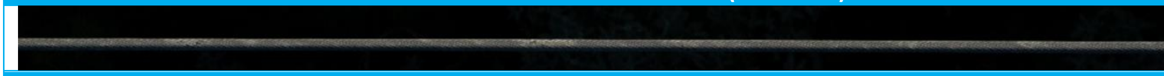
Figure 3. Example of white powder defects found on the Stage 2 section of the OTA–WKM–A line

3.1.3 OTA-WKM-B: B0469 – B0391 (2020 RPAS Survey)

The Stage 2 section of OTA–WKM–B, from B0469 to B0391, is strung with the original 1954 Goat ACSR-GZ conductor. CAS inspections have identified widespread white powder defects throughout this section of line, examples of which are shown in Figure 4, indicating advanced corrosion of the steel core and sacrificing of aluminium cross-section.

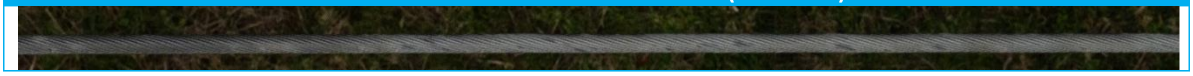
Figure 4. Examples of white powder defects found on the Stage 2 section of the OTA–WKM–B line

B0467-0468 White Powder Defect (2020 CAS)



B0419-0420 White Powder Defect (2020 CAS)

B0408-0409 White Powder Defect (2020 CAS)



3.2 Sample Testing (2006)

In 2006, samples were collected from the length of the OTA–WKM–A and OTA–WKM–B lines during an investigation into increasing the maximum operating temperature of the lines from 50°C to 75°C. The focus of this testing was to determine the condition of any grease present in the conductor and provide a condition assessment of the conductor.

The results of mechanical testing, and the presence of grease, are shown in Table 5. At the time of testing, all samples had sufficient strength to remain in service. Two observations are relevant for understanding the current conductor condition. First, the ungreased ACSR-GZ core steel had a calculated breaking load much greater than required, which increased the strength of the overall conductor sample. Second, in the Stage 2 section of the line, there was a mixture of greased and ungreased conductor strung on both lines, with northern samples being greased and southern samples being ungreased. As the OTA–WKM A&B lines both had ungreased samples, with similar mechanical test results, it is likely these conductors are made to the same specification or came from the same manufacturer.

Table 5. Sampling conducted in 2006 on the Stage 2 section of the OTA–WKM–A&B lines

Line	Span or Tower	% RTS[9] From Strand Testing	% CBL[10] outer Al Layer	%CBL inner Al layer	%CBL steel core layer	Grease
A	472-473	112.7%	106.7%	104.9%	99.0%	Y
A	472	118.1%	107.6%	107.6%	105.4%	Y
A	400-401	126.4%	113.8%	107.5%	114.9%	N
A	401	126.4%	109.8%	103.5%	117.0%	N
B	491-492	116.8%	106.3%	106.2%	104.4%	Y
B	491	111.1%	103.8%	100.9%	98.5%	Y
B	451-452	125.4%	104.2%	101.7%	117.8%	N
B	451	123.5%	104.4%	98.1%	115.9%	N

3.3 Eddy Current Testing (2016)

Figure 5 and Figure 6 show the estimated coating loss in spans which were included in the 2016 eddy-current testing programme. Overall, the OTA–WKM–A line has more advanced coating loss than the B line, including some localised areas of very high coating loss in spans 471-473 which could indicate grease defects. On both the OTA–WKM A&B lines, there were a few spans with widespread coating loss, such as the right phase of 430-431 on the B line and the left phase of 451-452 on the A line. As eddy-current testing is only performed on a handful of spans, there are likely a number of spans with similarly widespread coating loss.

9 Rated Tensile Strength
10 Calculated breaking load

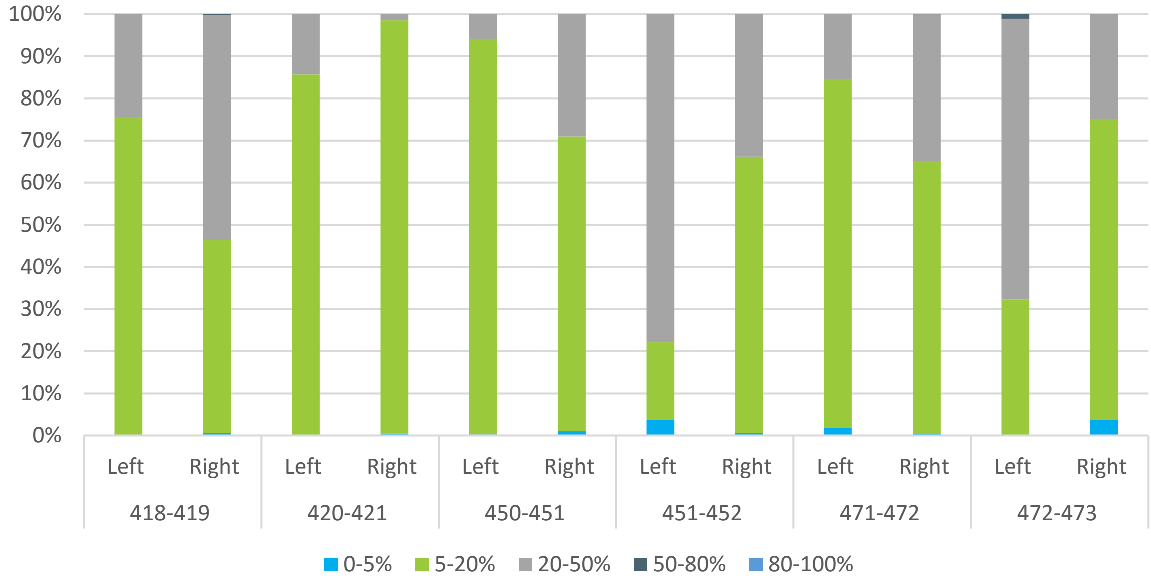


Figure 5. Estimated coating loss by span and phase (left or right) in Stage 2 section of the OTA–WKM–A line

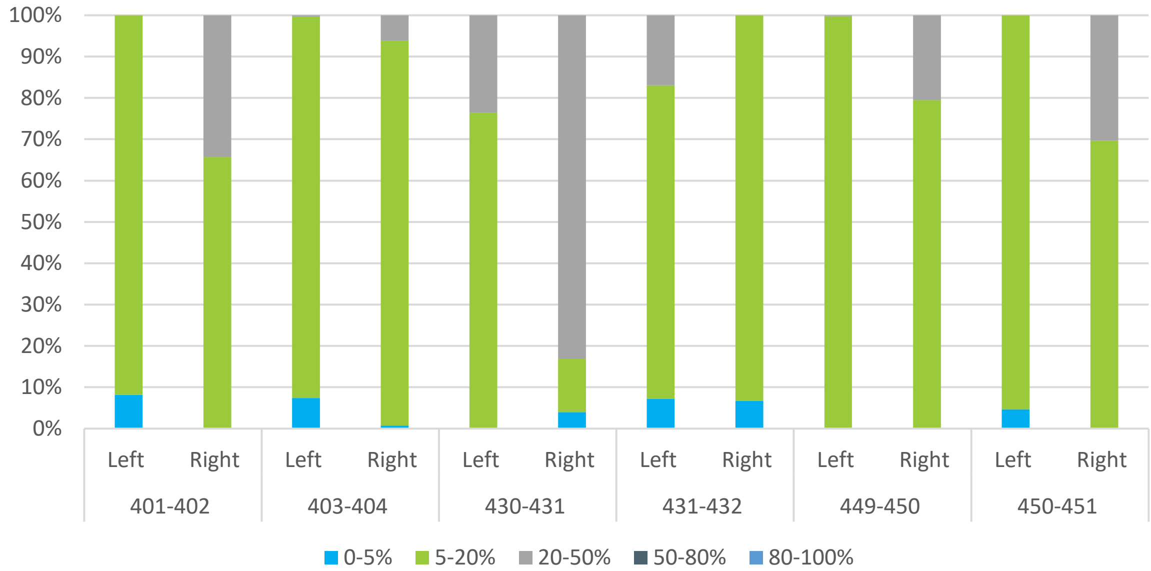


Figure 6. Estimated coating loss by span and phase (left or right) in Stage 2 section of the OTA–WKM–B line

4 Other Stages – Condition Overview

Stage 1 (Otara to Flatbush section) has already been reconductored or undergrounded; as near new assets we have no immediate asset health concerns for the overhead conductor. Our focus since adding the Stage 2 section (Wider Auckland) to our RCP4 Replacement and Refurbishment (R&R) plan has been to understand the condition of the OTA–WKM lines south of Stage 2, in what was formerly the “Southern Section” of the lines. Table 6 provides an overview of the condition information we hold on the Stage 3 – 5 sections of the line, with recently collected information indicated in green.

Table 6. Condition information held on Stages 3, 4 and 5. A green cross indicates that this is new information and has been collected since our last condition report was written (2020).

Stage	Section Description	Visual	CAS	Eddy Current	Sample (2006)	Sample (2024)
3	Bombay – Ohinewai	X	X	X	X	X[11]
4	Ohinewai – Hautapu	X	X	X	X	
5	Hautapu – Whakamaru	X		X	X	

In the Stage 3 – 5 sections of the OTA–WKM lines, from the 2006 sampling programme we know that the A line is predominately ungreased Goat ACSR-GZ, whereas the B line is a mixture of greased and ungreased Goat ACSR-GZ.

Based on our condition information, we have concluded that the ungreased Goat conductor on both lines is near or at its end of life in the Stage 3 and 4 sections of the line. This is because we have detected white powder throughout the line, and subsequent sample testing on the A line (ungreased conductor) has shown the core steel has lost most of its zinc galvanising layer, reducing its effectiveness. Therefore, the internal aluminium layers are now sacrificing due to galvanic corrosion between the core steel and aluminium, as seen in visual examination of the samples and the loss of strength in the aluminium layers.

Figure 7 and Figure 8 show CAS images of two white powder defects which were cut from the line and sent for sampling in 2024. Overall, these samples had sufficient mechanical strength due to the high contribution of strength from the steel core, but the aluminium layers had significantly reduced breaking strength, indicating loss of section due to galvanic corrosion (Table 7). During testing, these two defects were confirmed as bulges; these had not been previously identified as such, either because they were small bulges which were misclassified during the CAS inspection, or because they developed to bulges since the CAS inspection. We were also able to see that the core steel had no galvanising along the length of the sample, as seen in Figure 9.

Figure 7. White powder defect on span A0364-0365[12]

Figure 8. White powder defect on span A0386-0387[13]

11 Samples taken from A-line only.

12 This defect was cut out and sent for destructive testing in 2024.

13 See footnote 12.

Table 7. The overall conductor result obscured a concerning level of degradation in the aluminium layers.

Span	% CBL of outside Al layer	% CBL of inside Al layer	% CBL of core Fe strands
A0364 – 0365	86.74%	69.22%	107.5%
A0386 – 0387	82.60%	71.63%	117.1%

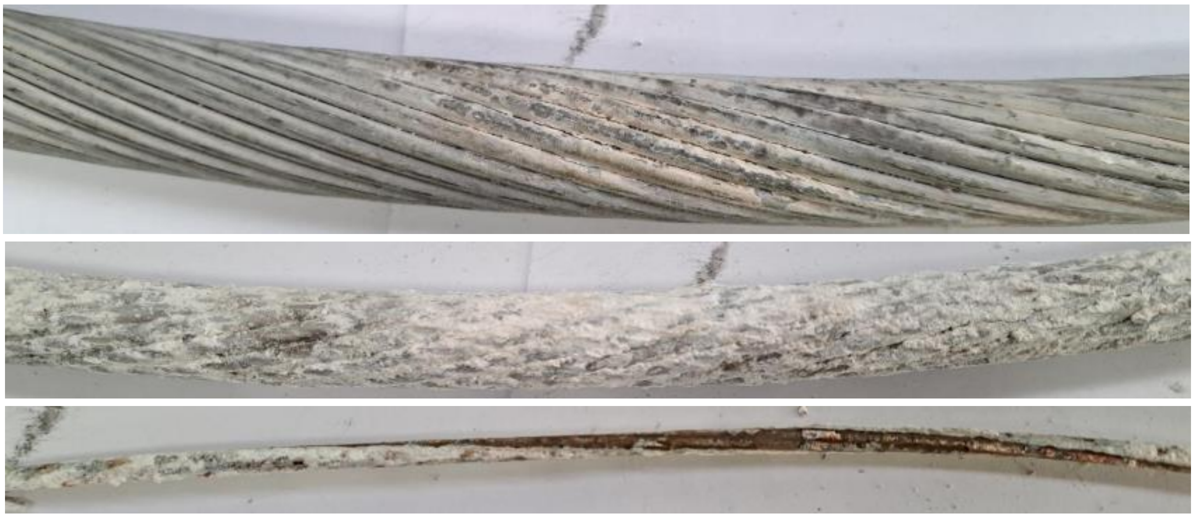


Figure 9. From top to bottom: outer layer bulge, inner layer corrosion, and core steel corrosion in the A0386 – 0387 span

Our expectation is that ungreased conductor in the Stage 5 (Hautapu – Whakamaru) section of the line will be shown to be near end of life once we have collected more detailed condition information from CAS and sampling in this section.

5 Summary and Recommendations

Considering condition information collected from the across Stage 2 – 4 of the OTA–WKM lines, we are confident that the Goat ACSR-GZ conductor in the OTA–WKM–A (T489–T407) and OTA–WKM–B (B0469–B0391) Stage 2 sections is at end of life. This is evidenced by coating loss identified in 2016 during eddy-current testing, and CAS inspection identifying white powder throughout Stage 2 on both lines.

The recently collected condition information from the Stage 3 and Stage 4 sections of the OTA–WKM lines strongly indicates that within these sections, the conductor is also at end of life. We are now planning reconductoring within those sections during RCP5. Increasing the scope of this project to include the Stage 3 and 4 sections is not feasible, due to the lead time. The status of the Stage 5 section of the line remains uncertain until we collect more detailed condition information.

Both samples retrieved from the Stage 3 section of the A line (Figure 7, Figure 8) had sacrificed the zinc galvanising layer on the core steel and galvanic corrosion had occurred between the steel and aluminium layers (Figure 9), resulting in reduced breaking load due to loss of aluminium cross section (Table 7). We consider these samples to be representative of the condition of the ungreased conductor in the Stage 2 and 3 section of both lines, due to the proximity of the samples to the Stage 2 sections, the shared corrosion zone and environment, and the consistent mechanical testing result in 2006, which demonstrated that the ungreased conductor on both lines was in similar condition.

Our asset class strategy for conductor and accessories calls for the repair of localised defects and replacement of conductors where ongoing costs or risks are unacceptably high.[14] For ungreased ACSR-GZ conductor, the galvanised zinc coating on the steel core is the only method preventing corrosion between the steel core and aluminium layers. Once this layer is depleted, there is no possibility that localised repair will significantly increase the life of the conductor asset. Without intervention, continued loss of aluminium section increases the risk of asset failure, particularly from "burn-down", a thermal runaway failure mode where increased impedance due to loss of aluminium section reduces mechanical strength in the remaining conductor. In line with our asset class strategy, we propose to replace the ungreased Goat ACSR-GZ conductor in the Stage 2 section of the OTA–WKM lines, as localised repair will not adequately mitigate asset failure.

CAS inspection revealed white powder defects near spans that we suspect are greased, based on grease identified in historical 2006 sampling. This indicates that the spans strung with greased ACSR-GZ conductors are also approaching end of life. We know that poorly greased conductors (which contain defects such as "grease holidays") have a comparable or slightly shorter expected lifetime than ungreased conductors (Table 8). Given the age of the greased conductor on the OTA–WKM lines, it is likely that such quality controls in manufacturing were not reliably implemented, and grease defects will exist in the conductor. As the ungreased conductor on the line is at end of life, it is unsurprising that poorly greased conductor on the same line is also reaching end of life.

Table 8. Expected life of ACSR-GZ in moderate and severe corrosion zones (FL 03.01 Conductor and ACS strategy)[15]

Conductor Type	Grease	Moderate	Severe
ACSR-GZ	Greased	69	51
	Grease Holiday	44	31
	Ungreased	49	35

It could be that some sections of greased conductor remain in reasonable condition where grease quality is higher, however attempting to defer replacement of greased conductor on both lines is not practical, as:

- We do not know which spans are strung with ungreased or greased conductor. The 2006 sampling only took samples from 1.5% of all spans across both lines, often near strain towers. Planning targeted intervention based on condition information and the presence of grease is infeasible without a much larger and widespread sampling programme to determine if a span is strung with greased or ungreased conductor.
- Splitting reconductoring works across different regulatory periods could create repeated disruptions for landowners and reduce project efficiency. Due to the close proximity of the lines, we will use the same wiring site for both lines in most cases. Establishing/dismantling these sites twice would duplicate staging effort and cause perverse outcomes for landowners too. This could undermine our social license to operate and could result in

14 Transpower's Asset Class Strategy: Conductors and Accessories (FL 03.01), page 44.

15 Poorly greased conductor has a similar or shorter expected lifetime than ungreased conductor. Note that in all cases, the conductor on the OTA–WKM lines has already exceeded it's expected lifetime.

increased financial costs such as duplicated compensation payments and restoration costs where changes or damages to the properties occur.

Looking ahead, delaying reconductoring will increase the number of replacements needed in RCP5 and RCP6, which would add to operational uncertainty at a time when there is already growing demand for lines work across our three main need drivers: R&R, enhancement and development (E&D), and customer works.

Therefore, we propose delivering the OTA-WKM Stage 2 reconductoring in RCP4 as planned. We note that delivery of reconductoring works on the OTA–WKM A&B lines concurrently is in line with the asset class strategy for conductors, where we ensure that multiple works are carried out simultaneously at one site.[16]

With our improved understanding of the condition of the conductor on the entirety of the OTA–WKM lines, we can now foresee that we will likely have a rolling reconductoring programme across RCP4, 5 and 6, working from the North to the South of the lines. Table 9 provides an overview of our planned replacement timings based on our improved understanding of the condition of Stages 3, 4 and 5, as discussed in Section 4.

Table 9. Proposed replacement timing for conductor on OTA–WKM–A and OTA–WKM–B

Line Section	Section Name	Structure #	Length (cct-km)	Estimated Replacement Timing (RCP)	Maintenance Approach	Timing Confidence
Stage 1	Otara	OTA – A0489 OTA – B0469	6.8[17] 5.8[17]	-	No change.	-
Stage 2	**Wider Auckland**	**A0489 – A0407** **B0469 – B0391**	**31.2** **30.9**	**4**	**Increase defect management if works delayed.**	**High**
Stage 3	Bombay to Ohinewai (Stage 2 – OHW)	A0407 – A0310 B0391 – B0296	40.0 38.2	5 (early)	Increase defect management	High
Stage 4	Ohinewai to Hautapu (OHW – HTU)	A0310 – A0197 B0296 – B0185	41.9 (x2)	5 (late)	Increase defect management	High
Stage 5	Hautapu to Whakamaru (HTU - WKM)	A0196 – WKM B0184 – WKM	71.4 (x2)	6	Collect condition information.	Low

16 Transpower's Asset Class Strategy: Conductors and Accessories (FL 03.01), page 41.
17 Excludes underground cable length.

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