Powerco CPP – Portfolio Overview Document

Portfolio Name	Putaruru-Tirau 33kV Cable
Expenditure Class	Capex
Expenditure Category	Growth & Security
As at Date	12 June 2017

Expenditure Forecast[1,2]	Pre CPP	FY19	FY20	FY21	FY22	FY23	Post CPP	CPP Period Total	Project Total
Pre-Internal Cost Capitalisation and Efficiency Adjustments[3] *(2016 Constant NZ$(M))*	$0.0	$0.0	$2.1	$4.1	$0.0	$0.0	$0.0	$6.2	$6.2
Post-Internal Cost Capitalisation and Efficiency Adjustments *(2016 Constant NZ$(M))*	$0.0	$0.0	$2.3	$4.4	$0.0	$0.0	$0.0	$6.7	$6.7

Description

Project need overview	The subtransmission network supplying Putaruru and Tirau does not meet desired security of supply standards. The Putaruru substation is supplied by a single 33kV line from Transpower's Hinuera GXP. The present load levels exceed the security levels at Putaruru substation.

Description

[1] Forecast expenditure is based on Powerco's financial year (i.e. FY18 is for the period April 2017 through March 2018). Expenditures do not consider general price level changes over time (i.e. are in real or constant terms).

[2] Only includes Growth & Security Expenditure. Some projects discuss and rely on the replacement of assets that are at "end of life". However, the replacement cost for these assets is accounted for in the Replacement Expenditure category.

[3] All other forecast expenditure / cost estimates in this POD are pre-internal cost capitalisation and efficiency adjustments, consistent with this forecast.

Project solution overview	Powerco is proposing to construct a new 33kV underground cable link between Putaruru and Tirau substations, in the Waikato Planning Area. The cable will be 13km long and connect to the respective 33kV buses at Putaruru and Tirau substations. The cable link is required to cater for the growth in electrical demand that has occurred and ensure that Putaruru substation meets its required security levels.

Need Identification

Background	Putaruru and Tirau are both situated in the South Waikato region, and form part of Powerco's Waikato planning area. Putaruru, with a population of 3,600, is a commercial centre with businesses supporting the dairy industry. Tirau is a smaller centre and contains a dairy factory. It has also exploited its position of being at the junction of several major highways to become a popular tourist stop. Putaruru substation is supplied by a single 33kV line from Transpower's Hinuera GXP. This line also connects to Tirau substation via a tee-connection at Tirau Junction. Another underground 33kV subtransmission cable connects Tirau substation to the Hinuera GXP.
Underlying Drivers and Investment Triggers	The Putaruru/Tirau area has a number of constraints including the following: 1. Putaruru substation is classed as AA+. This is N-1 with a switching time of 60 seconds. The present load level exceeds this security criteria as the loss of supply of the single 33kV line to Putaruru will result in a loss of supply to the Putaruru substation, for the duration of the outage. The 2016 actual demand at Putaruru substation is 11.6 MVA increasing to 12.5 MVA in 2036. There is limited backup of approximately 0.5 MVA available to the substation via the 11kV distribution network supplied from the neighboring substations of Tirau, Lake Road and Baird Road. Because of these limitations, the existing security class of Putaruru is A2. 2. Tirau substation is classed as AA+. This is N-1 with a switching time of 60 seconds. The present load level exceeds this security criterion as the loss of supply of the single 33kV cable between Hinuera and Tirau will result in a loss of supply to both Tirau and Putaruru substations, until supply is restored from the parallel Hinuera – Tirau 33kV overhead line circuit . The 2016 actual demand at Tirau substation is 9.3 MVA increasing to 10.3 MVA in 2036.
Timing of the need	Preparatory work for the 33kV cable link is presently underway - Powerco has begun investigating the potential routes. As a result of this, Powerco only expect to begin construction of the project in 2020.

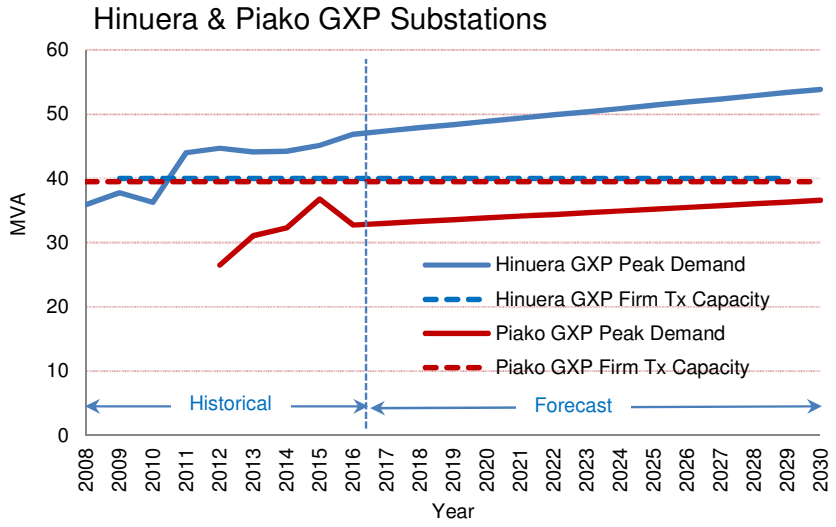
Demand Forecast | Waikato Area

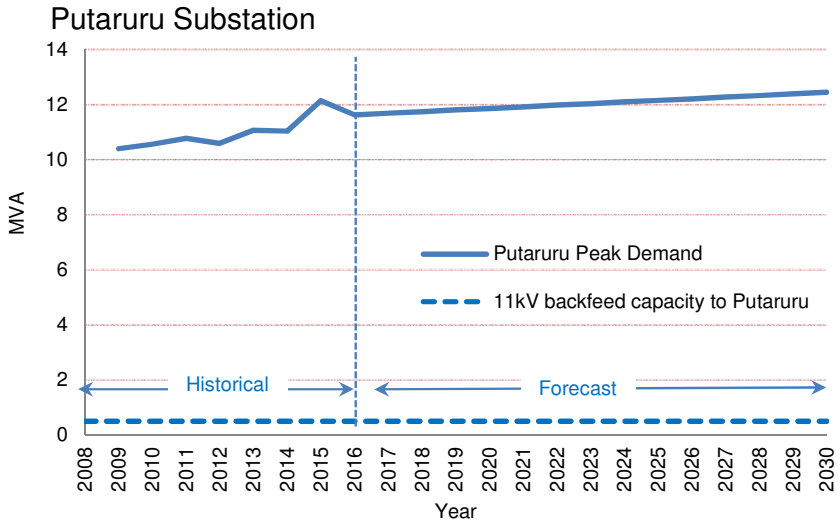
HINUERA AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Browne St	10.6	1.2%	9.9	10.0	10.1	10.3	10.4	11.0	11.6
Lake Rd	0.0	0.4%	5.9	6.0	6.0	6.0	6.0	6.1	6.3
Putaruru	0.0	0.5%	11.6	11.7	11.7	11.8	11.9	12.2	12.4
Tirau	0.0	0.5%	9.5	9.5	9.6	9.6	9.7	9.9	10.1
Tower Rd	0.0	1.5%	9.8	9.9	10.1	10.2	10.4	11.1	11.8
Waharoa	0.0	2.0%	7.8	8.0	8.1	8.3	8.4	9.2	10.0

WAIKATO AREA GXP			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	TX CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Hinuera GXP	40.0[4]	1.1%	46.9	47.4	47.9	48.4	48.9	51.4	53.9
Piako GXP	40.0	0.8%	32.7	33.0	33.3	33.6	33.8	35.2	36.6

Notes:

1. Class capacity is similar to Firm Capacity in that it represents the capacity that can be delivered following the first outage of any major equipment. Unlike Firm Capacity it considers the long term deliverable capacity after allowing for switching and network reconfiguration (11kV & 33kV) post-fault conditions.
2. All maximum demand values are in MVA.
3. Purple shaded cells indicate that the substation's Class Capacity has been exceeded and network enhancements should be considered.





[4]Transpower TPR, 2015. Hinuera Transformer, N-1 rating is n-1 capacity of 37/40 MVA (summer/winter)

Options Analysis | Long List of Project Options | High Level Assessment	
Assessment Process	A wide range of potential options are available for the resolution of electrical network constraints. However, depending on local conditions many of the options may not be suitable. On this basis a two tier Options Analysis is followed. In the first instance all potential options are considered against a set of high level criteria. Those options that are identified as having significant challenges and not favourable are not considered further. A significant issue that Powerco often faces is securing landowner easements and or public support for projects that the local community or landowners are opposed to. For this reason the costs associated with easements/consents are often difficult to estimate and the consenting/land-acquisition stage of a project can take a significant period. Given this fact, Powerco assesses the risk / likelihood of securing development rights for individual projects (within a realistic timeframe) during the high level assessment stage.
Long List of Options	The following table contains a list of the high level project options that are potentially available to resolve the specific network constraints that have been identified within the Putaruru/Tirau area. Maintaining the status quo (do nothing option) by allowing demand to grow and risks to increase is not a viable option. Both Putaruru and Tirau substations have well exceeded their respective capacity classes. This will mean a considerable reliability cost to Powerco during the study period. In addition both substations are operating below their required AA+ security levels. The non-network options below are not shortlisted due to the following: • Fossil fuelled generation (i.e. diesel generation) is technically viable but not shortlisted due to the cost and environmental/consenting challenges. During network contingencies on the feeders off Putaruru and Tirau substations there would be a shortfall of up to 12.5MW[5] that would need to be "made up" using stand-by generation. The capital cost of a 12.5MW[5] standby diesel generation plant is estimated to range from $18.8M to $23M[6,7]. Additional diesel generators would need to be installed as the demand for electricity increases. • Powerco has not identified any viable renewable generation options that would provide the required security of supply[8]. • Fuel switching and demand side response (DSR) are considered to be deferment strategies. Their viability is not considered to be certain given the large loads involved and the fact that the network security levels are already exceeded. • Powerco currently uses a mains-borne ripple control system to manage significant amounts of hot water cylinder load on its network.

[5] This is the present shortfall and this amount is predicted to increase in the future.
[6] Excludes the ongoing maintenance and operational costs.
[7] Diesel generation plant is estimated to range from $1,500/kW to $2,000/kW, depending on whether it is high, medium or low speed plant.
[8] Typical plant might involve wind turbines or photovoltaic arrays. Both of these generators have an intermittent output which cannot be relied upon unless there was significant penetration and diversity.

	During peak loading periods most hot water cylinders are turned off. The demand reduction however is not sufficient to resolve the major network constraint (i.e. the loss of the Tirau - Putaruru Line) • Energy storage is potentially viable but the costs are expected to be significant. For example, an emerging technology that could be employed is storage batteries installed in domestic premises. However, the capital costs associated with 12.5MW[5] domestic batteries with two hours capacity are estimated to be >$42M[9]. Alternatively, a grid-scale battery solution providing 12.5MW for two hours would, at current rates, cost >$25M. Many outages could be addressed within two hours and peak demand periods are also usually less than two hours duration. Storage solutions at this size however, would not provide sufficient back-up for extended outages lasting for several hours. Three network reinforcement options (Options 2, 3 and 4) were identified as potential solutions to the network constraints and issues. Option 2 involves the installation of a 13km long, 33kV (rating of 30MVA) underground cable running between Putaruru and Tirau substations. Option 3 involves the installation of a 13km long, 33kV (rating of 35MVA) overhead line running between Putaruru and Tirau substations. Option 4 involves upgrading the existing 11kV lines/network to provide back feed via the neighbouring zone substations of Lake Road, Tower Road and Baird Rd when Putaruru substation suffers a loss of supply. All three network reinforcements were shortlisted.

[9] The installed costs of domestic battery storage systems are currently around $10k - $12k for a 7kWh unit.

Long List of Options | High Level Assessment

Putaruru-Tirau 33kV Cable Projec Long list of projects and high level assessment			*Assessment Criteria*							
PROJECT FOCUS	**No.**	**PROJECT**	Safety	Fit	Feasible	Practical	GEIP	Security	Cost	**Short-list**
Network Reinforcement	1	Do Nothing - Status Quo	✓	✓	✓	✗	✗	✗	✗	✓
	2	Putaruru to Tirau 33kV Underground Cable	✓	✓	✓	✓	✓	✓	✓	✓
	3	Putaruru to Tirau 33kV Overhead Line	✓	✓	✓	✓	✓	✓	✓	✓
	4	11kV Feeder Upgrade / Enhancement	✓	✓	✓	✓	✓	✓	✓	✓
Non-network:	5	Demand Side Response (DSR)	✓	✓	✓	✗	✗	✗	✓	✗
	6	Distributed Generation (DG)	✓	✓	✓	✗	✓	✓	✗	✗

Key:

Safety	Health and Safety: Any significant implications in terms of Safety or Health - new products or compounds or practices, or requires difficult live line access etc.
Fit	Fit for Purpose: Does the option address the need appropriately and does it fit with other developments in the vicinity.
Feasible	Technically Feasible: Consider the complexity, future adaptability, and whether it aligns with company standards, strategies and policies.
Practicality	Practical to Implement: Are there potential environmental or property issues which may be insurmountable. Can it be achieved in the required time frame.
GEIP	Good Electricity Industry Practice (GEIP): Good practice (technically and environmentally) and in terms of AM practice (capacity, age, technological)
Security	Security and Reliability: Does the option provide adequate levels of security and appropriate reliability considering the demand, load type and future growth.
Cost	Some options will intuitively be known to be far more expensive than other options, and this may preclude them.

Options Analysis | Short List of Options

Option	Capital Cost[10]	Description
Option 2 ***(Putaruru to Tirau 33kV Underground Cable)***	$6.2M	• This option involves the installation of a 13km long, 33kV (rating of 30MVA) underground cable running between Putaruru and Tirau substations. The cable will be laid within road reserves as much as possible. • Some directional drilling alongside the State highways will be expected for the installation of the cable. Trenching and easement negotiation will need to take place. Some land acquisition may also be required.
Option 3 ***(Putaruru to Tirau 33kV Overhead Line)***	$6.0M	• This option involves the installation of a 13km long, 33kV (rating of 35MVA) overhead line running between Putaruru and Tirau substations. The installation of the line will be laid within road reserves as much as possible. • Appropriate consents and easements will need to be acquired and negotiated for this project.
Option 4 ***(11kV Feeder Upgrades/Enhancement)***	$6.7M	• This option involves upgrading the existing 11kV lines/network to provide back feed via the neighbouring zone substations of Lake Road, Tower Road and Browne Street. • The following enhancements will be required to provide the required 12.5 MVA backup capacity for the study period (until 2036). : - conductor upgrades - capacitors & voltage regulators for voltage support - automated/remote switching equipment installed at feeder open points to shorten outage times - construction of a new feeder out of Baird Road substation - installation of a higher capacity transformer at Tirau substation • Appropriate consents and easements will also need to be acquired and negotiated for this project.

[10] The total capital cost of each project. The costs do not consider the time value of money and do not include the economic value of other factors (i.e. network losses and consumer outage costs).

Option Analysis | Advantages vs Disadvantages

The following sections summarise the advantages/disadvantages associated with the short listed options. The intention being to also capture project risks and inter-dependencies.

Option	Advantages	Disadvantages
Option 2 ***(Putaruru to Tirau 33kV Underground Cable)***	• The network reliability improvements would be significant with the result that consumers are subjected to significantly less outages due to the dual 33kV supply. • Improve both substations security class to the required AA+ security level. • Will cater for demand growth past the 20 year study period.	• Some easement negotiation and also possible land acquisition required although most of the cable will be routed within road reserve.
Option 3 ***(Putaruru to Tirau 33kV Overhead Line***	• The network reliability improvements would be significant with the result that consumers are subjected to significantly less outages. • Improve both substations security class to the required AA+ security level. • Will cater for demand growth past the 20 year study period.	• The construction of a new overhead line will require more land easements to be negotiated or land to be acquired (than Option 2). The cost (and also risks of delays) for easement and consenting is likely going to be high as most of the route will traverse developed farm land.
Option 4 ***(11kV Feeder Upgrades/Enhancement)***	• Moderate improvement in network reliability.	• New 11kV feeders may need to traverse over sections of private land, which will present easement/consenting risks. • Complete backfeed via 11kV network difficult to maintain quality of supply with demand growth over time. • The installation of sufficient 11kV backfeed capacity will be costly and challenging with multiple circuits involved over substantial lengths and operationally complex (multiple automated changeover schemes). • Electrical losses will be considerably greater than with Options 2 and 3.

Preferred Option	
Preferred Option	**Option 2- Putaruru to Tirau 33kV Underground Cable**
Reasons for choosing Option	Option 2 is preferred for the following reasons: • The network reliability improvements would be significant with the result that consumers are subjected to significantly less outages • Improves Putaruru substation's security class to the required AA+ security level • It will cater for demand growth past the 20 year study period • Has the lowest land easement or acquisition requirements

Option 2| Detailed Costs[11]

Item	Description	Actual Cost	Projected Cost
A	Preliminary Works & Design		
A.1	Route Survey	-	$13,000
A.2	Thermal Resistivity Measurements	-	$45,000
A.3	Services Capture	-	$13,000
A.4	Design	-	$300,000
B	Cable works (3 sections)		
B.1	Tirau End	-	$877,400
B.2	State Highway 1	-	$2,628,200
B.3	Putaruru End	-	$1,898,600
C	Jointing and Thermal Backfill		
C.1	Jointing	-	$223,350
C.2	Thermal Backfill	-	$126,000
D	Traffic Management		
D.1	Traffic Management	-	$100,000

E	Committed/Historical Costs (A+B+C+D)	$0	
F	Future Projected Costs (A+B+C+D)		$6,224,550
G	Anticipated Final Cost (E+F)		**$6,224,550**

[11] Excludes Powerco's internal/overhead costs.

Option 2 | Implementation Plan

Project or Action	Start Year[1]	End Year[1]	NZ $'000[1]	Details / Comments
Line route investigations and establishment	FY20	FY21	$371	Investigative work to establish a credible route, including preliminary designs, route surveys.
Cable Works, Jointing and Thermal Backfill	FY20	FY21	$5,754	Cable works, trenching, thermal backfill
Traffic Management	FY20	FY21	$100	Traffic Management
Total Project Costs ➔	**FY20**	**FY21**	**$6,225**	**Includes Only Growth & Security Expenditure.**

Supporting Documents and Models

Planning documents ***Standards | Policies*** ***Reviews and Consultant reports*** ***Concept Designs | Estimates***	1. Putaruru-Tirau 33kV Cable Project Options Analysis_Final. 2. Putaruru-Tirau Options-Economic Evaluation_Final. 3. Tirau-Putaruru- CCE, Jacobs,VH00012-RPT-EEE-019, dated September 2015. 4. Powerco's 2016 Asset Management Plan (AMP). 5. Transpower's Annual Planning Report 2015 (APR). 6. Powerco Network Development Plan 2017 (NDP). 7. "*310S001 Security-of-Supply Classifications – Zone Substations*", Powerco Standard. 8. "*393S041 Zone Substation Transformer Ratings*", Powerco Standard. 9. "*393S035 Electrical network Conductor Rating Standard*", Powerco Standard.

Notes/Assumptions

Generic Assumptions in relation to Options Costs	• Costs are expressed in 2016 (real) dollars. • The capital costs fall within the Growth and Security expenditure categories only. • The capital costs only include Powerco's capital expenditure (not Transpower or other parties). • The costs include all costs associated with the proposed projects (or alternate options) regardless of whether those costs fall within the CPP period or not, although they do not include any sunk costs (committed already). • Reliability costs are the NPV of the Value of Loss Load calculation for each option
Specific Assumptions in Relation to Options Costs	• Cost estimation for the options has initially been achieved via a desktop study using Powerco's standard building block unit costs. The costs have then been refined by further investigations. • Property and consenting costs are usually a high risk area involving considerable uncertainty. Proposed underground cable is installed where possible in road reserve.

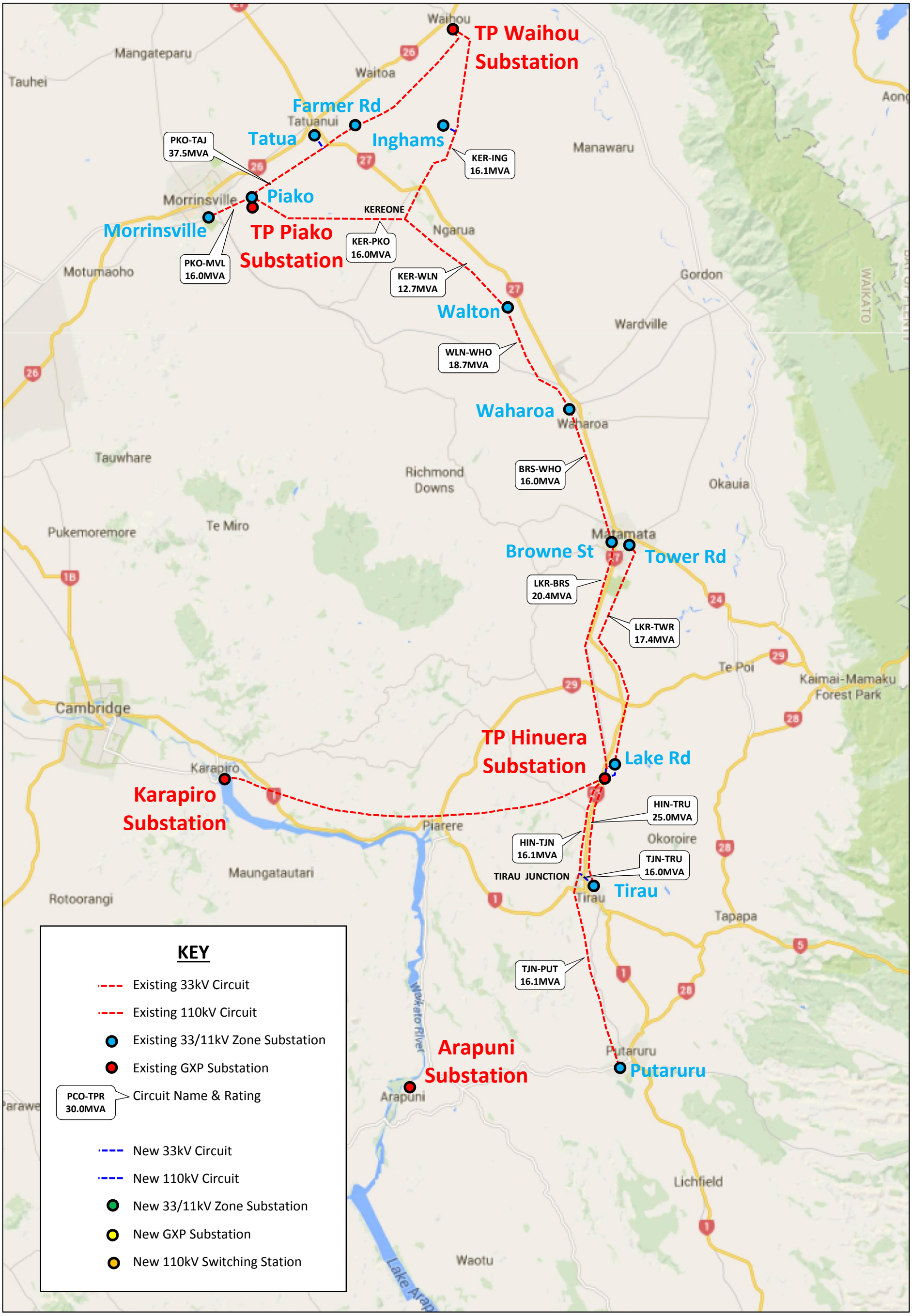


Figure 1: Existing Waikato Sub-transmission Network: Geographic Diagram

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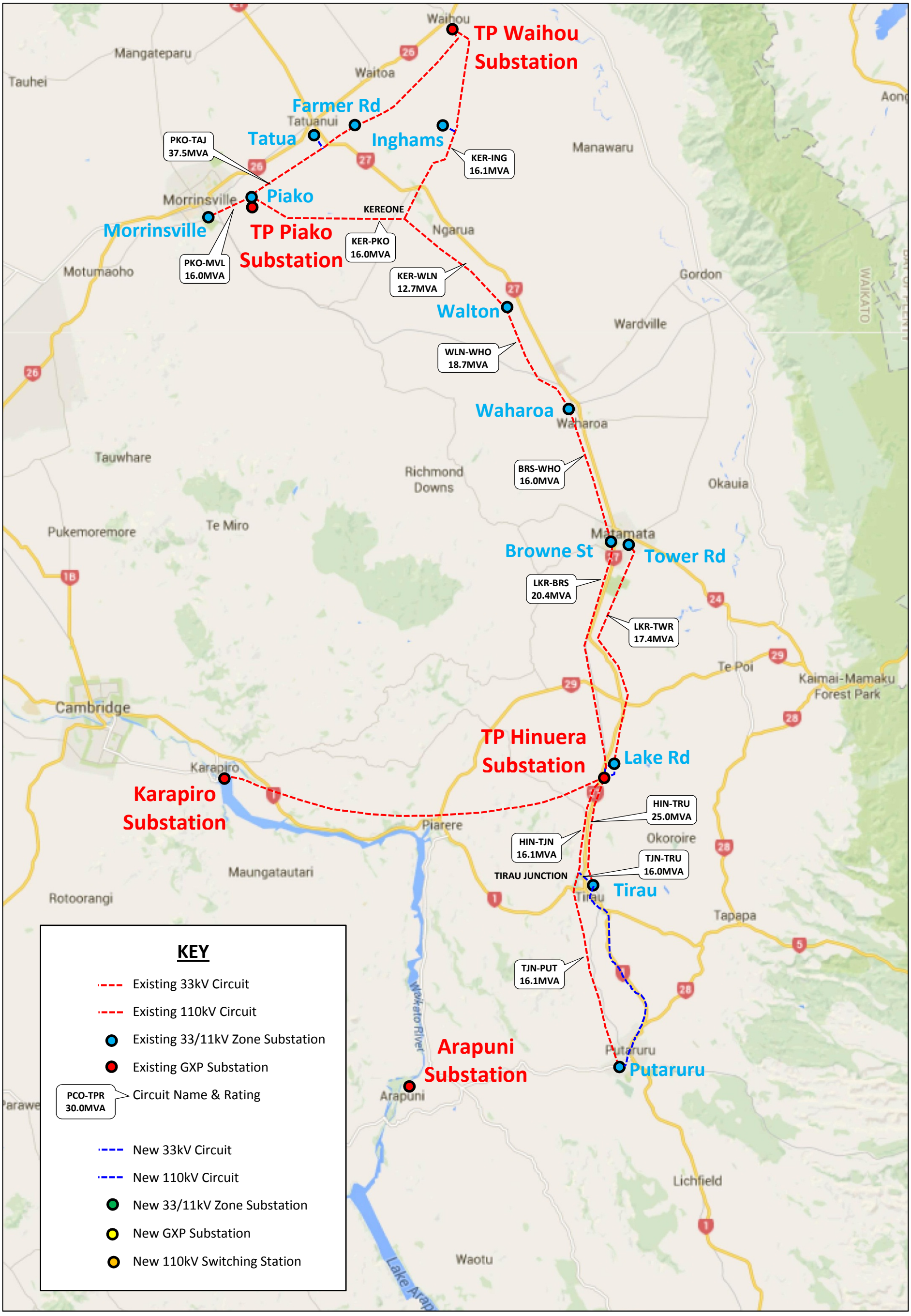

Figure 2: Option 2: New Putaruru-Tirau 33kV Cable : Geographic Diagram

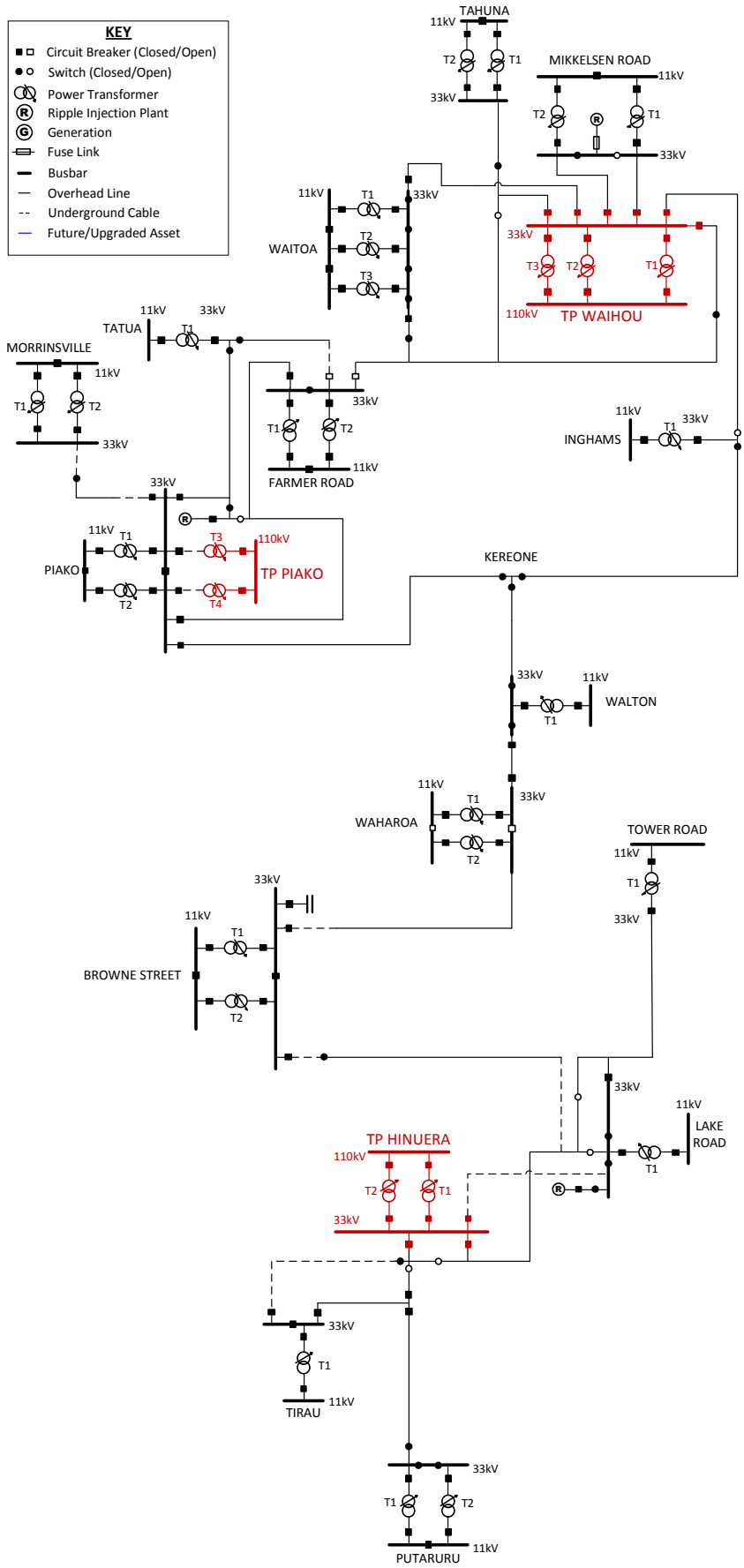

Figure 3 Existing Hinuera GXP Sub-transmission Network : Single-Line Diagram

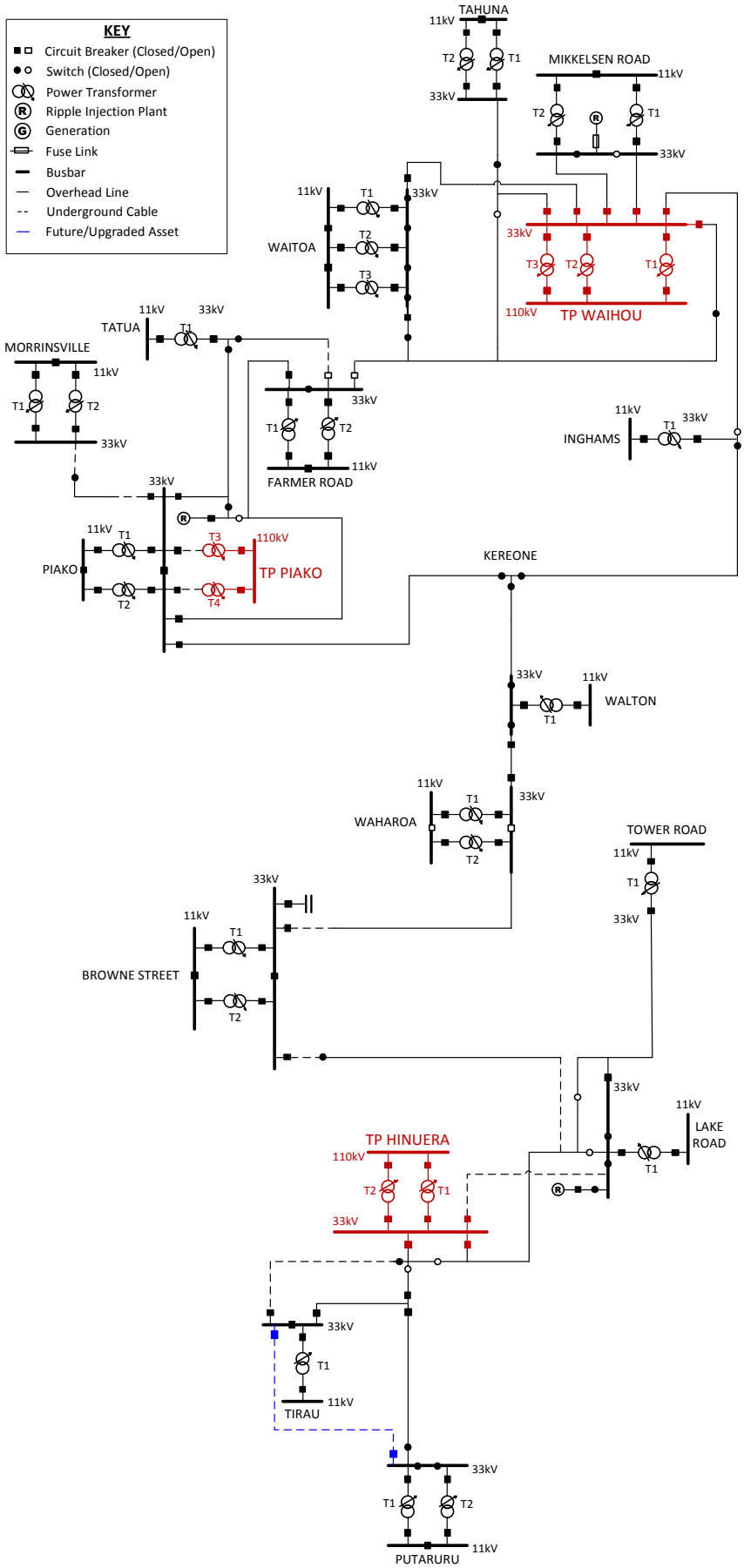

Figure 4 Option 2: Putaruru to Tirau 33kV Cable : Single-Line Diagram