Powerco CPP – Portfolio Overview Document

Portfolio Name	Whangamata Reinforcement
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))*	$1.6	$5.7	$1.0	$0.1	$0.1	$0.3	$9.3	$7.1	$18.1
Post-Internal Cost Capitalisation and Efficiency Adjustments *(2016 Constant NZ$(M))*	$1.7	$6.1	$1.1	$0.1	$0.1	$0.3	$9.3	$7.7	$18.6

Description

Project need overview	Whangamata is presently supplied via a single 33 kV subtransmission line which is historically subjected to frequent faults. An outage on this line causes a total loss of supply at Whangamata until the fault is fixed. During high load periods, the line is thermally constrained and low subtransmission voltage occurs at Whangamata. Maintenance work is challenging due to a lack of sufficient alternative supply. As a result, Whangamata cannot comply with Powerco security of supply standards.

Proposed solution

Project solution overview	Powerco propose to install a new 33kV line from Waikino GXP to Whangamata which will enable Whangamata to meet security of supply standards. Due to expected long lead-times involved in securing a line route, construction of the line is not envisioned to start before 2024. In the interim, Powerco intends to install a feeder-based energy storage solution supported by standby

[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 may 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.

	diesel generators to provide backup supply to critical loads in the Whangamata central district during emergencies. This presents an ideal opportunity to trial the application of energy storage in combination with local generation, in close consultation with the local community .

Need Identification

Background	Powerco's Waikino area encompasses the southern end of the Coromandel Peninsula and a small section of the eastern Hauraki Plains. The subtransmission network consists of a 33kV network of lines that supplies four zone substations (Whangamata, Waihi, Waihi Beach and Paeroa). Refer to Figure 1 and Figure 5. The subtransmission network is supplied from the Waikino 110/33kV GXP situated in the Karangahake Gorge. The area is characterised by rugged and hilly terrain covered in native bush, making line access difficult in some places. Seasonal weather extremes and cyclones impact heavily on line security. The population is highly seasonal in places like Whangamata and Waihi Beach, and the demand profile is very peaky. The largest individual consumer is Waihi Gold (~9MW) located at Waihi.
Drivers and Investment Triggers	The existing supply networkto Whangamata has a number of constraints/issues as follows: • During 2015 the peak demand on the Whangamata substation was ≈11MVA. The substation is equipped with two 33/11kV transformers (5MVA and 8.8MVA). The 11kV backup to the Whangamata substation is ≈0.8MVA and in the event of a transformer outage consumer load would need to be permanently shed. The present substation capacity does not meet the requirements of Powerco's Security-of-Supply Standard, which recommends that the Whangamata substation should be afforded a security class of AA+[4]. • The substation is supplied via a single 33kV overhead line from the Waihi substation. In the event of a line outage significant consumer load would need to be permanently shed (until the fault was fixed). The present substation capacity does not meet the requirements of Powerco's Security-of-Supply Standard, which recommends that the Whangamata substation should be afforded a security class of AA+[4]. • A significant portion of the existing 22km Waihi-Whangamata overhead 33kV line is equipped with Raccoon conductor and built to operate at a 50°C conductor temperature (summer rating of 10.7MVA at 1.0p.u. voltage). The Whangamata load peaks over public holiday periods and the line is both voltage and thermally constrained[5] during these times. In an effort to manage line overloading and delivery voltages Powerco has progressively installed 4 x 0.75MVAr, 11kV capacitor

[4] AA+ : Supply may be lost in the event of the outage of one major element of the sub-transmission network. Supply is restored automatically within 15 seconds by switching at sub-transmission or distribution level (Powerco - Standard 310S001 – Security of Supply Classification – Zone Substations).

[5] During peak network loads the 33kV delivery voltages drop significantly with the result that the zone transformers reach maximum tap position.

	banks (3 fixed units, 1 switched) and as a result the substation usually operates at a leading power factor. Operational management through small load transfer of Whangamata load over to Waihi substation is used to relieve loading on the line. Ripple control is also used to control hot water loads during peak times to provide some relief to the overloads. • Loading typically peaks during summer and winter holiday periods, during which the Waihi-Whangamata line is loaded to ≈100% (33kV deliver voltages of 0.9p.u.). • During 2015 the combined diversified peak demand of the Whangamata, Waihi and Waihi Beach substations was ≈27.6MVA. These three substations collectively rely on two 33kV lines that run between the Waikino GXP and the Waihi Substation. The lines have been thermally upgraded in response to a step change increase in customer load, but the N-1 limit may still be exceeded in the future with growth in demand. • The Waikino GXP is currently loaded above the N-1 capacity of the transformers (37/39 MVA summer/winter). • To avoid outages live-line maintenance is required on the single Whangamata circuit. For some maintenance activities live-line work is not possible and consumers are exposed to planned outages during light loading periods. • The Waihi-Whangamata 33kV line has a history of relatively poor reliability. During the period between 2002 through 2009 Whangamata experienced ten line outages with durations greater than 30 minutes. Five of the line outages exceeded 4 hours. • Whangamata has a population of ≈3,870 usual residents (2013 Census) that occupy 36% of the dwellings[6]. During summer holiday periods the population swells to >10,000 with the result that the electrical demand increases significantly, placing significant stress on network equipment. Estimated population potentially exceeds 50,000 during popular events such as the annual Whangamata Beach Hop.
Timing of the need	The existing electrical supply network into Whangamata has well exceeded Powerco's security requirements and the network constraints need to be addressed. The preferred solution is being progressed by Powerco and landowner consultation is well underway.

[6] Data referenced from Thames Coromandel District Council "Community Profile" webpage. http://www.tcdc.govt.nz/Visiting-or-moving-to-the-Coromandel/Our-Peninsula/Community-Profile/

Demand Forecast[7] | Waikino Area

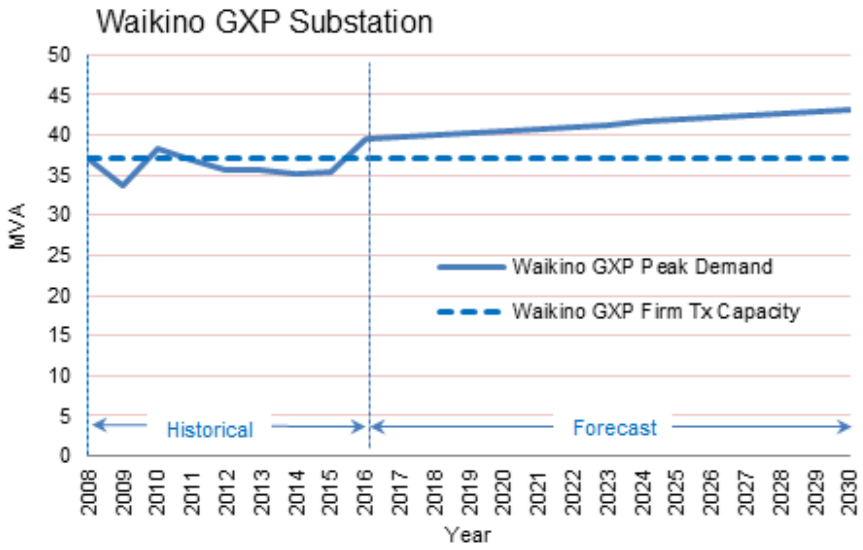
WAIKINO AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Paeroa	6.0	0.4%	8.3	8.4	8.4	8.4	8.5	8.6	8.8
Waihi	16.0	0.7%	18.3	18.4	18.5	18.6	18.7	19.4	20.0
Waihi Beach	3.3	1.3%	5.9	5.9	6.0	6.1	6.2	6.6	7.0
Whangamata	0.0	0.4%	10.5	10.5	10.6	10.6	10.7	10.9	11.1

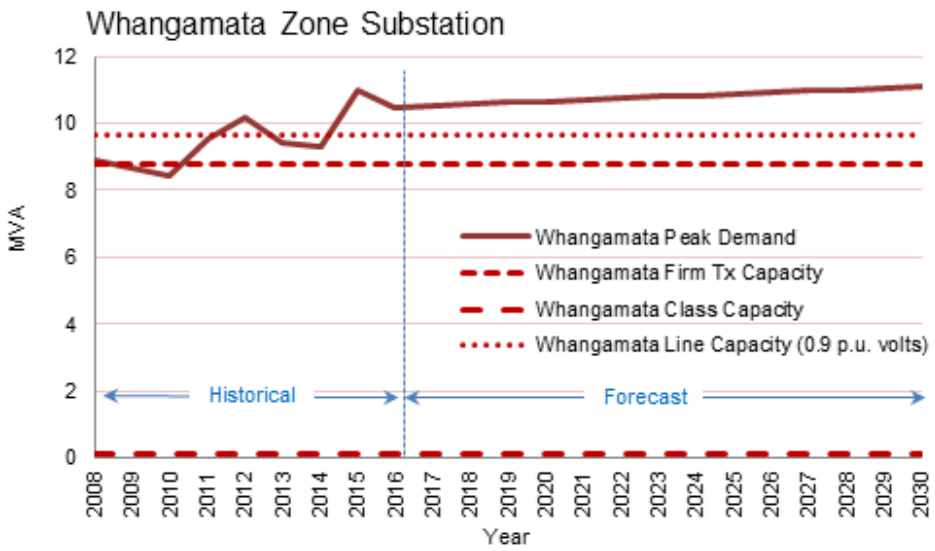
WAIKINO AREA GXP			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	FIRM TX CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Waikino GXP	37.0	1.4%	39.5	39.7	40.0	40.3	40.5	41.8	43.2

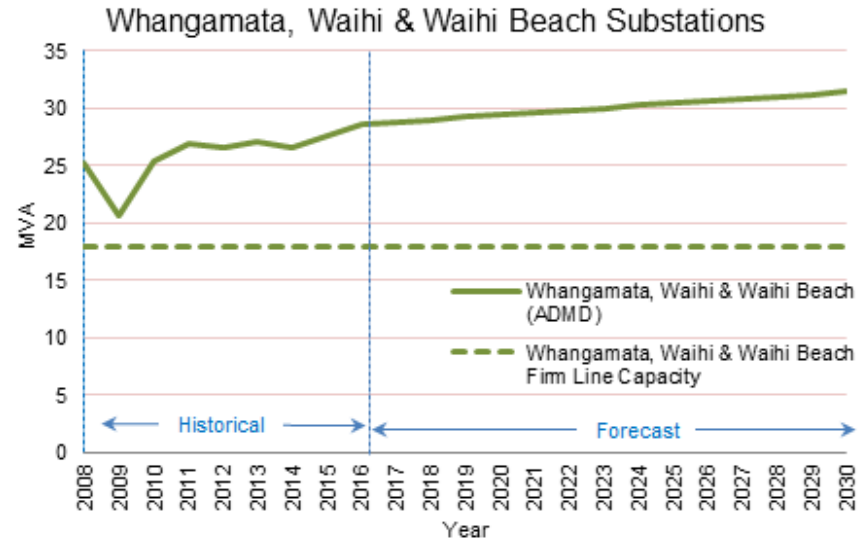
Notes:

1. Class capacity is similar to Firm Capacity and 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 in the context of 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. The Waikino GXP is equipped with 2 x 30MVA, 110/33kV transformers. Transpower have indicated the units have a rating of 37MVA/39MVA (summer/winter).

[7] Powerco's Asset Management Framework (AMF) outlines the input information and basis of its Demand Forecast.


Waikino GXP Substation
MVA
Year
Waikino GXP Peak Demand
Waikino GXP Firm Tx Capacity
Historical
Forecast


Whangamata Zone Substation
MVA
Year
Whangamata Peak Demand
Whangamata Firm Tx Capacity
Whangamata Class Capacity
Whangamata Line Capacity (0.9 p.u. volts)
Historical
Forecast


Whangamata, Waihi & Waihi Beach Substations
MVA
Year
Whangamata, Waihi & Waihi Beach (ADMD)
Whangamata, Waihi & Waihi Beach Firm Line Capacity
Historical
Forecast

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 can have fatal flaws. 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. As a result of the process a short list of viable options is identified for further analysis.
Long List of Options	The following table contains a list of the high level project options that are potentially available to resolve the electrical supply issues into Whangamata. The three non-network options (Nos. 1, 2, & 3) are not shortlisted on the following basis: • The option to do nothing (No.1) is not considered prudent as existing single supply 33kV line is constrained and Whangamata supply suffers from poor reliability issues. • Fuel switching and demand side response (DSR), while suitable for demand management or peak reduction solutions, are not feasible in a situation where the root problem is inability to maintain any supply following the failure of a single major network component. Hot water heater control is usually significant during peak loading periods (i.e. hot water cylinders switched off) when there is no supply issue, and a number of residents have upgraded their hot water heaters to gas (bottles). The network expansion options considered involve the construction of lines/cables at both sub-transmission and distribution level. The option to upgrade the backup 11kV distribution lines/cables into Whangamata (No.10) was also shortlisted, even though it would not deliver Whangamata the required security level and would require significant lengths of 11kV cable/line to be upgraded/installed (at high cost), but is included for comparison purposes. The installation of energy storage devices (i.e. batteries potentially coupled to photovoltaic or other generation sources) at consumer level is possible. However, this technology is in the early stages of development (products coming to market) and the costs are significant for a sizeable widespread solution required to provide Whangamata with the desired security of supply. Hence, the economically feasible approach with energy storage here would be to invest in a (relatively) small-scale capacity solution—sized enough to support only critical loads in the Whangamata CBD during outage emergencies—while still pursuing the long-term solution to secure Whangamata at a sub-transmission level in future. In total, six upgrade options (No. 4, 5, 6, 7, 8 & 9) were shortlisted for investigation.

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Long List of Options | High Level Assessment

Whangamata Reinforcement		*Long list of projects and high level assessment*	*Assessment Criteria*							
PROJECT FOCUS	**No.**	**PROJECT**	Safety	Fit	Feasible	Practical	GEIP	Security	Cost	**Short-list**
Do Nothing	1	Allow the electrical demand & risk of consumer non-supply to increase	✓	✗	✗	✗	✓	✗	✓	✗
Non-network:	2	Fuel switching to reduce electrical demand	✓	✓	✗	✗	✓	✓	✗	✗
	3	Demand Side Response (DSR)	✓	✓	✗	✗	✓	✓	✗	✗
	4	Second 33kV overhead line - Waikino to Whangamata	✓	✓	✓	✓	✓	✓	✓	✓
	5	New 33kV underground cable - Waihi to Whangamata	✓	✓	✓	✓	✓	✓	✗	✓
Network	6	New 66kV overhead line - Tee onto Kopu-Tairua 66kV line	✓	✓	✓	✓	✓	✓	✗	✓
Reinforcement	7	Reconductor Waihi-Whangamata 33kV line - install backup generation	✓	✗	✓	✓	✓	✓	✗	✓
	8	Upgrade 11kV backfeed capability	✓	✗	✓	✓	✓	✓	✗	✓
	9	Energy Storage initially, deferred second 33kV Waikino to Whangamata	✓	✓	✓	✓	✓	✗	✗	✓

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[8]**	**Description**
Option 4: ***Second 33kV overhead line – Waikino to Whangamata Refer Figure 2 & Figure 6***	$11.8M	This option involves the use of an existing 33kV line that runs between the Waikino GXP and Golden Cross[9] coupled with the construction of new 33kV line from Golden Cross to Whangamata (as illustrated to Figure 2 & Figure 6). The following network enhancements would be required: • Re-commissioning (by Transpower) of an existing 33kV circuit breaker at the Waikino GXP. • Re-commissioning of an existing ≈9km, 33kV line that runs between the Waikino GXP and the decommissioned 33/11kV Golden Cross substation[10]. Presently, a significant section of the old 33 kV line operates at 11 kV, as part of an 11kV feeder that emanates from the Waihi substation (WHI-6 Waitewhata feeder) supplies a set of 11/0.4kV distribution transformers (pumping load at Golden Cross). The ongoing supply of these pumps would require either the extension of the 11kV network (≈2km) or supply via 33/0.4kV transformers. • The construction of a new ≈15km, 33 kV line from Golden Cross, over rugged terrain and through Department of Conservation land, to a location close-in to the Whangamata substation (a second existing 33kV line runs for a short distance from the Whangamata substation and is presently bonded into the Waihi-Whangamata 33kV line). • Installation of two 33kV line circuit breakers and a bus-section breaker at the Whangamata substation.
Option 5: ***New 33kV underground cable – Waihi to Whangamata Refer Figure 3 and Figure 7***	$14.8M	For this option, a new 33 kV cable would be constructed in the road reserve from the Waihi substation to the Whangamata substation (refer to Figure 3). From the Waihi substation the 33kV cable would follow State Highway SH25 into the Waihi township, take the shortest route possible along residential roads, until it meets SH25 again heading northwards towards Whangamata. The cable would continue north along SH25 to join up with the existing ≈3km second overhead circuit out of the Whangamata substation. Significant traffic management costs are expected for laying the cable, both within the Waihi township and along the winding SH25 road between Waihi and Whangamata. The following network enhancements (in addition to the cable) would be required: • Installation of two 33kV line circuit breakers and a bus-section breaker at the Whangamata substation. • Installation of 33kV line circuit breaker bay at the Waihi substation.

[8] 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).

[9] Also known as Coeur Gold.

[10] This substation was decommissioned some time back when the Golden Cross mining operation closed down.

Option 6: ***New 66kV overhead line – Tee onto Kopu-Tairua 66kV line Refer to Figure 4 and Figure 8***	$22.3M	This option involves bringing additional sub-transmission capacity into the Whangamata substation from the adjacent Kopu Area (to the north Waikino Area) and the installation of a new 66/11kV substation (refer to Figure 4 and Figure 8). The following network enhancements would be required: • The construction of a new ≈13km, 66kV line from the existing Kopu-Tairua 66kV line to a new substation site located north of Whangamata. Approximately 8km of the new 66kV line would be overbuilt above existing 11kV distribution lines. However, the remaining ≈5km section would need to traverse across native forest (gap in the 11kV network). Landowner negotiation/compensation would be required to build the line. • The construction of a new 66/11kV substation on a site to the north of Whangamata (Whangamata North Zone Substation). The substation would initially be equipped with a single 12.5/17MVA transformer and 4 x 11kV feeders. The substation would off-load the existing Whangamata substation. The Whangamata load would be split between the two zone substations (60/40 split with the existing substation supplying more) with each having a security of supply class of AA[11]. Automated 11kV distribution switches would need to be installed to meet the 45 minute restoration requirement associated with class AA[11].
Option 7: ***Reconductor Waihi-Whangamata 33kV line – install backup generation***	$18.0M	For this option diesel generation would be leased to provide electrical supply to Whangamata whilst the existing Waihi-Whangamata 33 kV line is taken out of service for re-conductoring. The re-conductoring work would be carried out progressively over multiple sections in order to minimise planned outages/SAIDI and network risk. Reconductoring would remove the existing loading constraints on the line and improve the 33kV delivery voltages at the Whangamata substation. The upgraded single 33kV line supply network would not afford the Whangamata load with a security class of AA+[4]. Given this fact backup generation with a continuous output of >6 MW for 6 hrs (i.e. 36MVAhr) with quick-start-up capability would need to be leased and integrated into the Whangamata substation to provide emergency supply to the Whangamata township in the event that a 33 kV line outage occurs. Typical containerised diesel plant would involve 4 x 2,500kVA units or 6 x 1,675MVA units and would require a significant expansion of the substation.
Option 8: ***Upgrade 11 kV backfeed capability***	$16.9M	In this option, the basis is to establish 11 kV interties with Tairua substation north of Whangamata in order to establish another diverse backfeed supply into Whangamata from the TAI-3 Hikuai feeder. Extensive reconductoring would be required on the TAI-3 feeder as well as the main trunk of the WGM-3 Opoutere feeder in order to lift the thermal capacity. With the long distances involved supplying Whangamata load from Tairua, voltage regulators and switched capacitors are required across the 11 kV network to support power transfer. Despite the large spend expected to beef up the 11 kV infrastructure, the Whangamata load will still not comply with AA+[4] security class requirements. At best, the upgrades will give around 4 MVA of backup capacity from Tairua, to pick up the loads around Opoutere and Onemana villages plus a limited part of the Whangamata CBD.

[11] AA : Supply may be lost in the event of the outage of one major element of the sub-transmission network. Supply can be restored within 45 minutes by switching at sub-transmission or distribution level (Powerco - Standard 310S001 – Security of Supply Classification – Zone Substations).

Option 9: ***Energy storage and diesel generation, Waikino—Whangamata 33kV line deferral*** ***Refer to Figure 9***	$18.1M	With this option, the motivation is to do something to mitigate the reliability costs in the interim while the Waikino—Whangamata 33 kV line (Option 4) build is delayed due to consenting issues. While the line is being held up, the driver is to install a battery-based energy storage generation system (ESS) with enough capacity to support critical loads in the Whangamata CBD predominantly covered by the WGM-5 Port Rd 11 kV feeder. The capacity of the battery system is to be sized sufficiently to support the feeder following a loss of 33 kV supply until diesel backup generators can be brought online—through remote intervention—and synchronised with the battery system to provide baseload generation. Replacement of existing 11 kV ABSes on certain parts of the network around the CBD with remote-operable switches are to shorten the response time required to reconfigure the network for emergency situations when the battery-generation system is needed. This helps to efficiently manage and utilise the ESS. Upon completion of the Waikino—Whangamata 33 kV line, the ESS and diesel generators will be recovered from site, and then relocated for use on other parts of the Powerco network where the need can be justified. While the ESS and diesel system is in operation at Whangamata, Powerco will make the most of the opportunity to trial demand-side management concepts (e.g. peak lopping and dynamic voltage support) in order to better understand the impact that this technology has on the wider network.

Options 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 4: ***Second 33kV overhead line – Golden Cross to Whangamata Refer Figure 2 & Figure 6***	• The lowest capital cost of the options identified. • Provides diversity of supply into Whangamata (two independent line routes). • Makes use of an existing stranded 33kV line and associated line circuit breaker. • Helps address constraints on the Waikino – Waihi circuits.	• Second circuit is of overhead line construction over rough terrain and would have reliability commensurate with a rural/remote overhead line. • Long lead-time to construction start due to access and consenting issues through DoC land. Estimated construction start cannot be before FY24.
Option 5: ***New 33kV underground cable – Waihi to Whangamata Refer Figure 8***	• Provides diversity of supply into Whangamata (two independent supply routes). • The 33kV cable would not be subject to weather etc. and significantly improve reliability.	• There is limited space along the windy Waihi-Whangamata road along which the cable would need to be installed. The traffic management and health & safety issues during construction would be significant. • The cable terminates at the Waihi substation and thus the project would not address the existing upstream constraint on the Waikino - Waihi circuits. • Locating a cable fault would take a significant amount of time.
Option 6: ***New 66kV overhead line – Tee onto Kopu-Tairua 66kV line Refer to Figure 8***	• Provides diversity of supply into Whangamata (two independent supply routes from two independent GXPs). • Delivers additional zone substation redundancy and diversity due to installation of a second zone substation. • Reduces the number of ICPs & load on the 11kV feeders and thus the SAIDI impact of individual feeder faults.	• Most expensive option (highest capital cost). • The new 66kV line would need to traverse across a significant section of native forest. • The connection of a Tee onto the existing Kopu-Tairua 66kV line would result in a complex protection system (i.e. three terminal protection scheme). This is expected to reduce the reliability of the existing Kopu-Tairua 66kV supply network (and supply to Tairua). • The Whangamata load would not be afforded an (N-1) no-break supply. • The land for the Whangamata North substation would need to be secured (land purchase and consultation).

Option 7: ***Reconductor Waihi-Whangamata 33kV line – install backup generation***	• Makes use of the existing 33kV line, which reduces the line easement costs. • Avoids having to install a second circuit into Whangamata.	• Expensive option with significant ongoing operational costs (diesel generator lease costs). • Makes use of fossil fuel generation and would require the installation of a large diesel tank on the Whangamata substation site. • Significant expansion of the Whangamata substation site would be required (land purchase). • The Whangamata load would not be afforded an (N-1) no-break supply.
Option 8: ***Upgrade 11 kV backfeed capability***	• Avoids having to install a second circuit into Whangamata. • Reduces the number of ICPs & load on the 11kV feeders and thus the SAIDI impact of individual feeder faults.	• Expensive option to upgrade significant stretches of the 11 kV network, and to create a new 11 kV link between the Tairua and Whangamata networks. • The Whangamata load would not be afforded an (N-1) no-break supply.
Option 9: ***Energy storage and diesel generation, Waikino—Whangamata 33kV line deferral***	• Practical and feasible to install a small-scale storage solution backed up by diesel generators to support critical CBD loads while consenting work carries on to secure a line route for a future Waikino—Whangamata 33 kV circuit. • Provides opportunity to work with the local community to develop a solution that would adequately address their needs, while potentially avoiding major network reinforcement • Gives Powerco the opportunity to trial the capabilities of energy storage solutions to do peak-lopping/voltage support etc., while allowing a major investment project to be deferred by at least four years • Energy storage assets can be re-used at other sites after the 33 kV line is constructed.	• Expensive option with significant ongoing operational costs (diesel generator costs). (Costs will be offset if the storage and generation assets can be re-used elsewhere after FY25.) • Makes use of fossil fuel generation and would require the installation of a large diesel tank on the Whangamata substation site. • Expansion of the Whangamata substation site would be required (land purchase) to accommodate batteries, inverters, diesel generators and fuel storage. • The Whangamata load would not be afforded an (N-1) no-break supply until the 33 kV line is completed post FY25.
Shared Features	• All options utilise known technology and proven designs. • All options improve reliability of supply to Whangamata.	• All options involve the installation/upgrade of significant lengths of sub-transmission cable/line and/or significant land for substation expansion. There are relatively long lead times to secure the necessary consents/easements/etc. before construction can begin.

Recommendation	
Preferred Option	The preference is to proceed with Option 9: Energy storage and diesel generation, Waikino—Whangamata 33 kV line deferral.
Reasons for choosing Option	Despite not being the lowest capital cost, Option 9 is chosen because it gives Powerco the ability to improve supply until the line route for the Waikino—Whangamata line is finalised with DoC for the line to be constructed in the future. It also offers an ideal opportunity to trial the application of energy storage in combination with local generation, in close consultation with the local community – which could be the basis of similar solutions in future at other n-security supply areas. Option 4 is expected to be the least expensive but would take significantly longer to consent/secure a route through DoC land. In contrast, Option 6 is expected to be the most expensive due to 66 kV line route consenting and land for the new substation site on the northern side of Whangamata. Option 5 is cheaper than Option 9 but would not remove the existing (N-1) line constraint between Waikino and Waihi. Option 7 is not a favourable option due to the fact that the capital costs are expected to be relatively high and there would be a significant amount of ongoing operational costs (leasing diesel generators). Furthermore, it does not complement the National Policy Statement for Renewable Electricity Generation (NPS REG) that reinforces the NZ Government's renewable electricity target of 90% of electricity from renewable sources by 2025. Option 8 does not provide security of supply adequate enough for Whangamata considering the capital costs involved, and therefore does not prove to be cost effective.

Option 9| Detailed Costs[12]

Item	Description	Actual Cost	Projected Cost
A	Property & Consent Costs		
A.1	Land/easement/legal/consent payments to date	$401,856	
A.2	Land/easement/legal/consent/compensation going forward		$3,222,847
A.3	Purchase land to expand Whangamata Substation site		$200,000
B	Investigation and Reporting Costs		
B.1	Preliminary Line design costs to date (sunk cost)	$426,933	
B.2	Surveying costs to date (sunk cost)	$30,456	
B.3	Supporting studies for DG & ESS Implementation		$100,000
C	Substation Costs		
C.1	Whangamata substation costs (33kV CB etc.)		$450,000
C.2	11kV modifications required at Golden Cross		$331,000
C.3	Battery Storage System and Diesel Generators for backup		$6,376,360
C.4	Communications upgrade		$100,000
C.5	Network automation on 11 kV feeders		$360,000
C.6	Fuel storage		$100,000
D	Line and Cable Costs		
D.1	Detailed line design cost		$300,000
D.2	Line construction costs - with stay wires		$5,663,953
E	Committed/Historical Costs (A+B+C+D)	$859,245	
F	Future Projected Costs (A+B+C+D)		$17,204,160
G	Anticipated Final Cost (E+F)		**$18,063,405**

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

Option 9 | Implementation Plan				
Project or Action	Start Year[1]	End Year[1]	NZ $'000[1]	Details / Comments
Project costs to date	-	FY14	$859	Costs that have already occurred.
Future land/easements/compensation/legal	FY17	FY24	$3,223	Costs associated with easements for the line that traverses across DoC land in addition to an environmental monitoring program.
Land purchase for Whangamata substation expansion	FY18	FY18	$200	Costs for purchasing land adjacent to Whangamata substation to facilitate energy storage equipment.
Supporting analytical studies for Energy Storage System and Backup Diesel Generators	FY18	FY18	$100	To carry out power systems analysis work on integration of battery storage and diesel generators on the network for use during 33 kV outage events.
Enabling works at Whangamata Substation	FY24	FY24	$450	Costs associated with the establishment of a second incoming line breaker bay.
Enabling works at Golden Cross	FY24	FY24	$331	Costs associated with transferring the existing Golden Cross supply transformers from the existing 33kV line to the existing 11kV line. An additional length of 11kV line/cable needs to be installed.
Battery System and Diesel Generators	FY18	FY20	$6,376	Costs associated with battery system and diesel generators
Communication Systems Upgrade	FY18	FY18	$100	Costs associated with communications network upgrade to facilitate integration and remote operation of battery system and diesel generators
Network Automation on 11 kV feeders	FY18	FY19	$360	For upgrade of existing 11 kV manual air break switches to remote switches
Fuel Storage	FY19	FY19	$100	Costs associated to include a diesel fuel storage facility on Whangamata substation site

Detailed design for new 33kV line	FY24	FY24	$300	Costs associated with the detailed engineering design of the proposed new 33kV line.
Construction of new 33kV line	FY24	FY25	$5,664	Line construction costs for 33 kV circuit from Golden Cross to Whangamata
Total Project Costs ➔	**-**	**FY25**	**$18,063**	Includes Only Growth & Security Expenditure.

Supporting Documents and Models	
Planning documents ***Standards | Policies*** ***Reviews and Consultant reports*** ***Concept Designs | Estimates***	1. Waikino to Whangamata 33kV – Golden Cross Realignment – Concept Design. AECOM dated 22 July 2013. 2. Whangamata Subtransmission Upgrade Options Analysis. 3. Whangamata Supply Improvement Options Analysis. 4. Couer Gold Enabling Works for Whangamata Line, dated 22-04-2015. 5. Whangamata Substation Enabling Work for Whangamata Line, dated 17-04-2015. 6. Powerco's Demand Forecast. 7. Powerco's 2016 Asset Management Plan (AMP). 8. Powerco's Annual Planning Report (APR). 9. "*310S001 Security-of-Supply Classifications – Zone Substations*", Powerco Standard. 10. "*393S041 Zone Substation Transformer Ratings*", Powerco Standard. 11. "*393S035 Electrical network Conductor Rating Standard*", Powerco Standard. 12. Whangamata Energy Storage + Diesel Generator Implementation – Engineers Estimate. AECOM dated 3 Nov 2016.

Notes/Assumptions	
Generic Assumptions in relation to Options Costs	• Costs are expressed in 2016 (real) dollars. • The costs quoted are to construct the network and do not include economic factors (i.e. costs of non-supply) • 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.
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. The preferred option (No.9) involves a 33kV overhead line traversing a significant distance across Coromandel forest owned by DoC, and the siting of containerised batteries and diesel generators at Whangamata substation. The cost estimates for the line component are based on Powerco's present understanding of the costs that DoC expects to receive to approve access/consents.

Figure 1 Existing Waikino/Whangamata Sub-transmission Network: Geographic Diagram

Figure 2 Option 4 and Option 9: Second 33kV overhead line – Golden Cross to Whangamata: Geographic Diagram

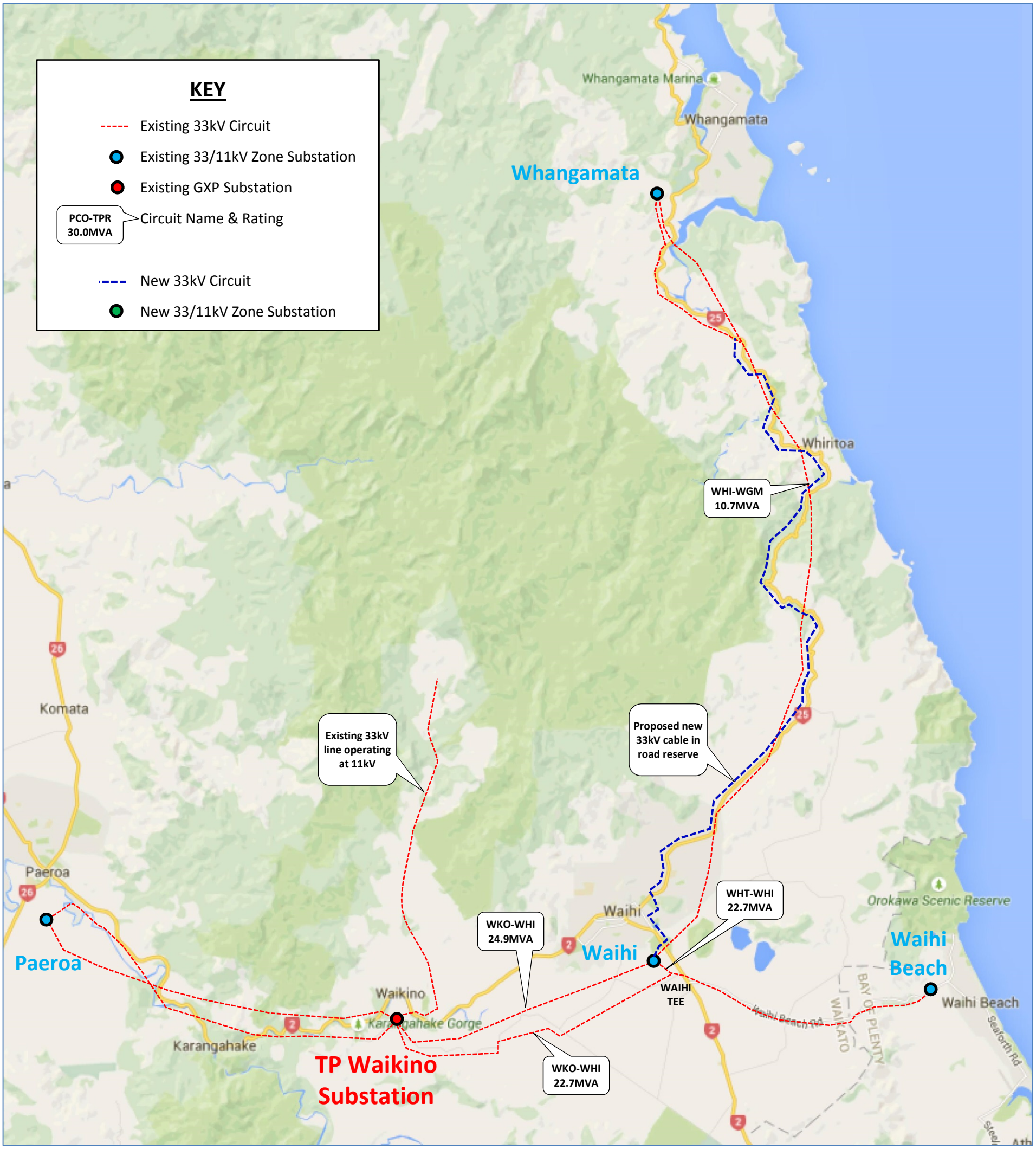

Figure 3 Option 5: New 33kV underground cable – Waihi to Whangamata: Geographic Diagram

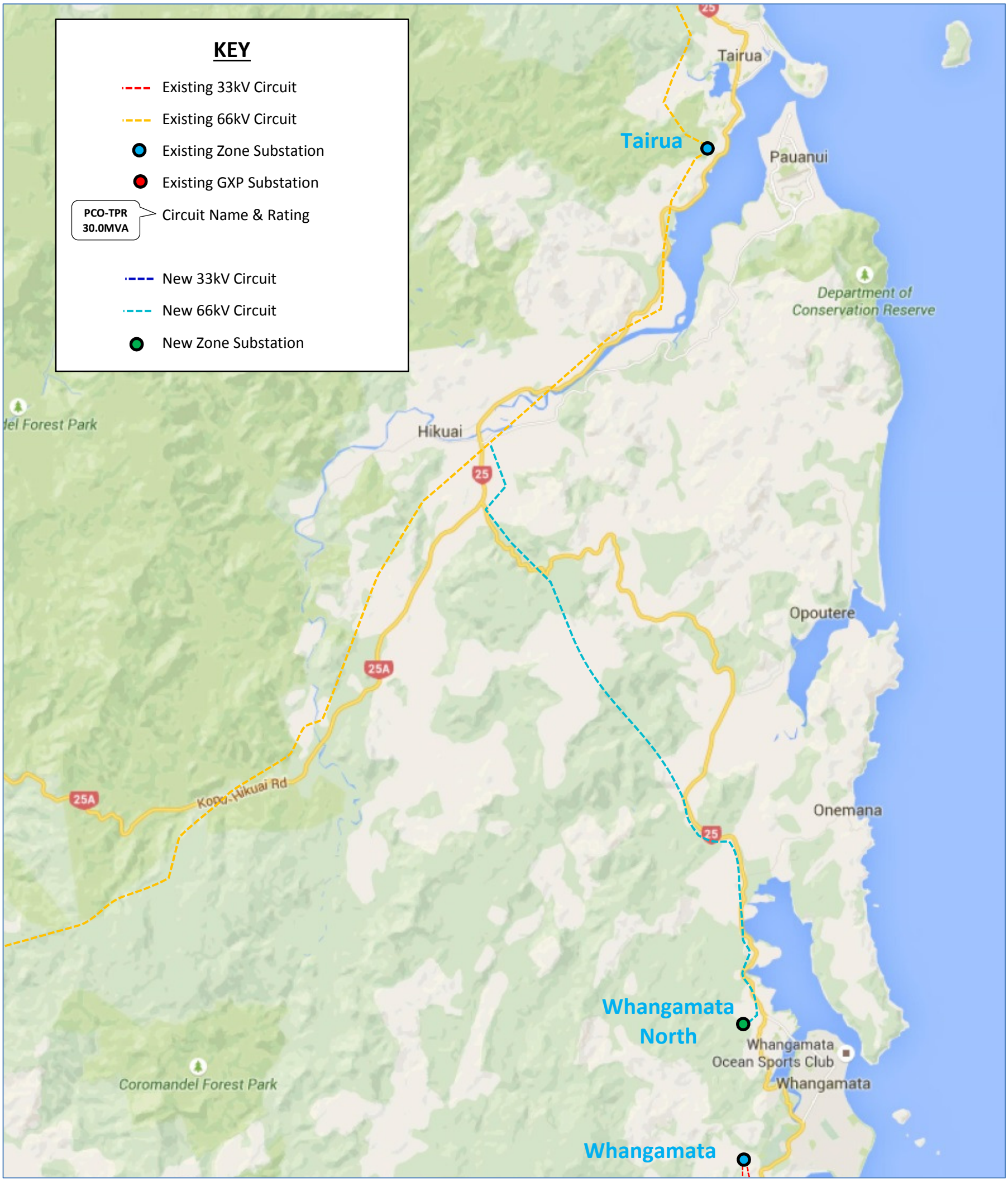

Figure 4 Option 6: New 66kV overhead line – Tee onto Kopu-Tairua 66kV line: Geographic Diagram

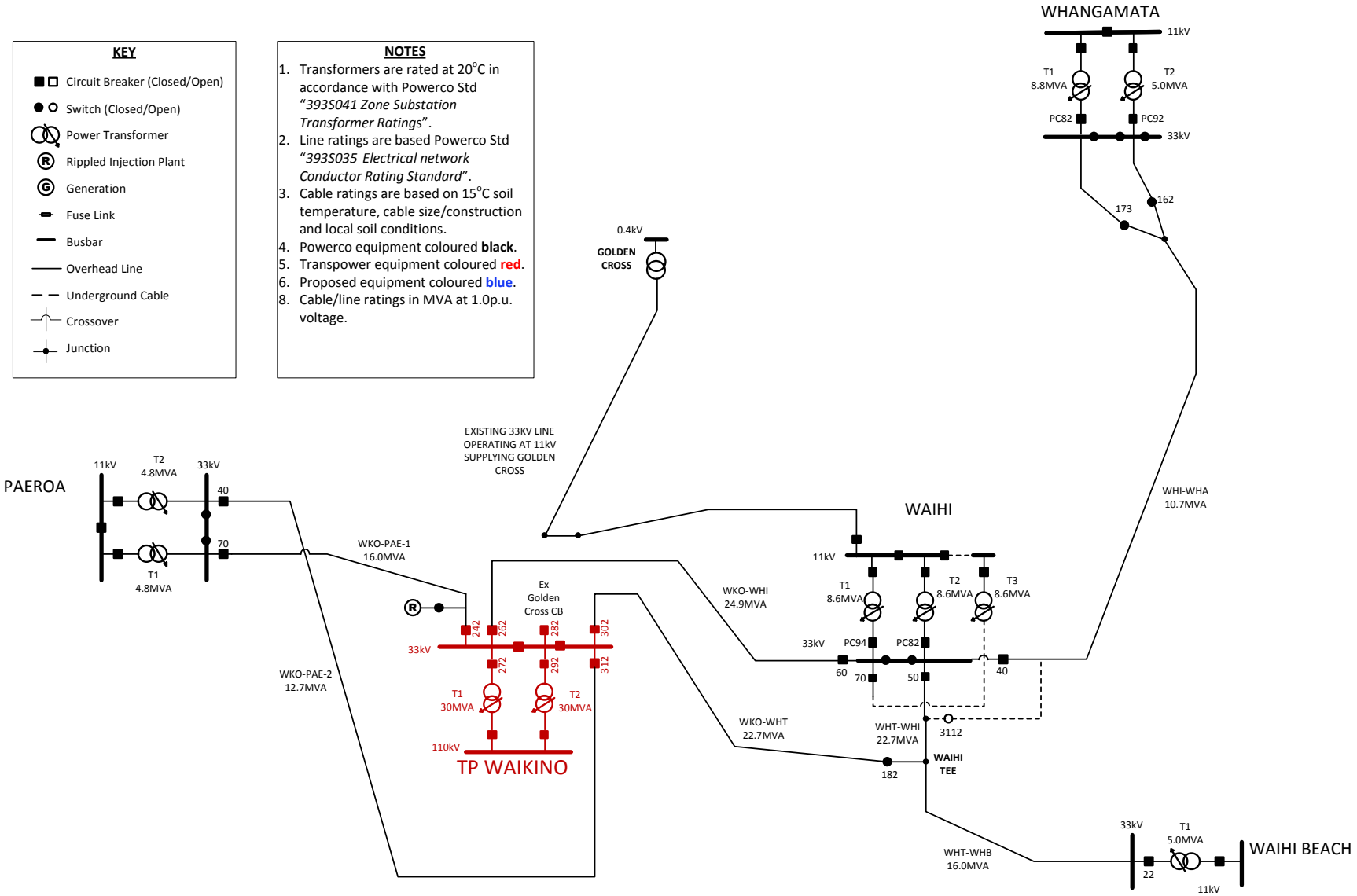

Figure 5 Existing Waikino Area Sub-transmission Network: One-Line Diagram

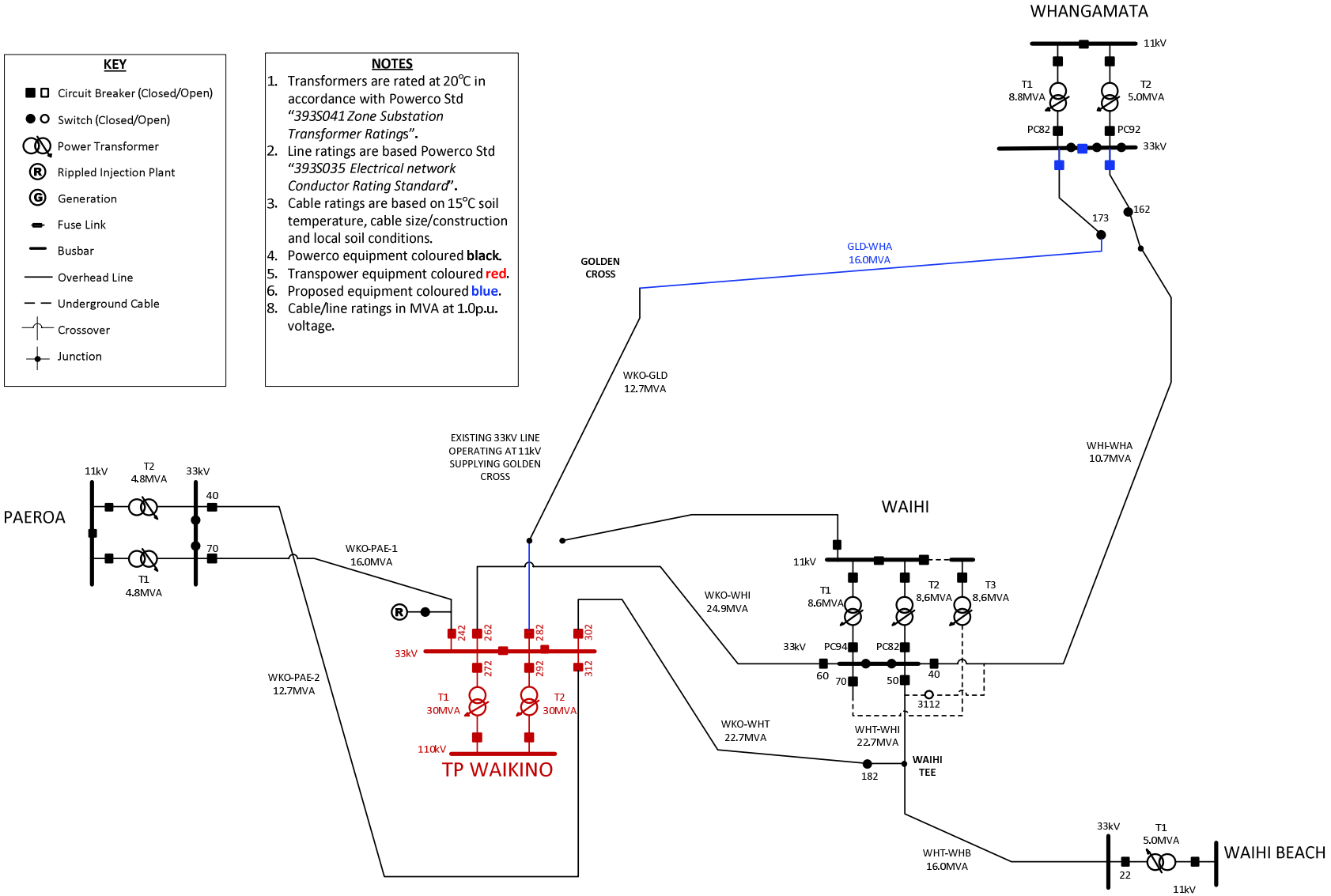

Figure 6 Option 4: Second 33kV overhead line – Golden Cross to Whangamata : One-Line Diagram

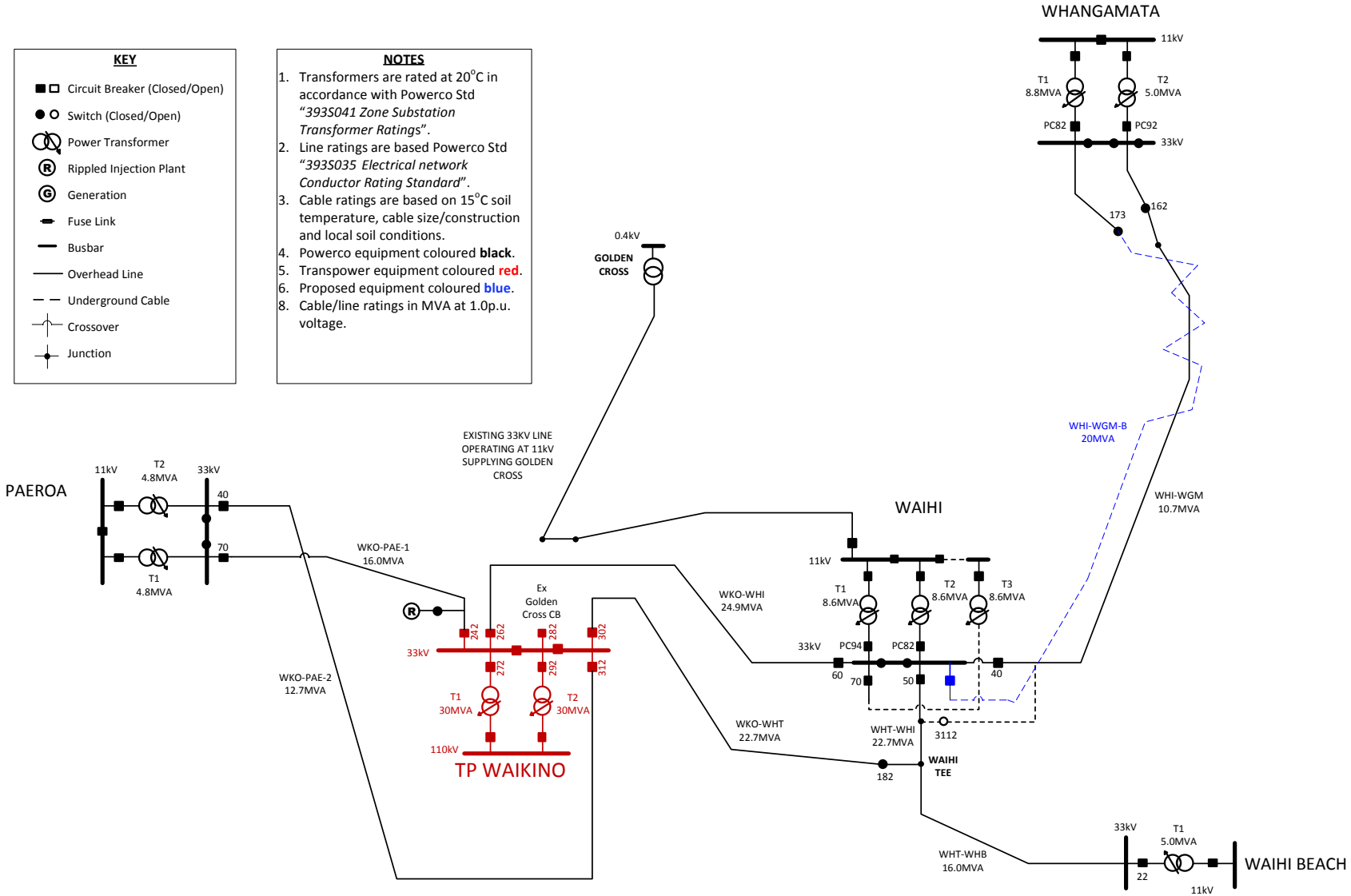

Figure 7 Option 5: New 33kV underground cable – Waihi to Whangamata: One-Line Diagram

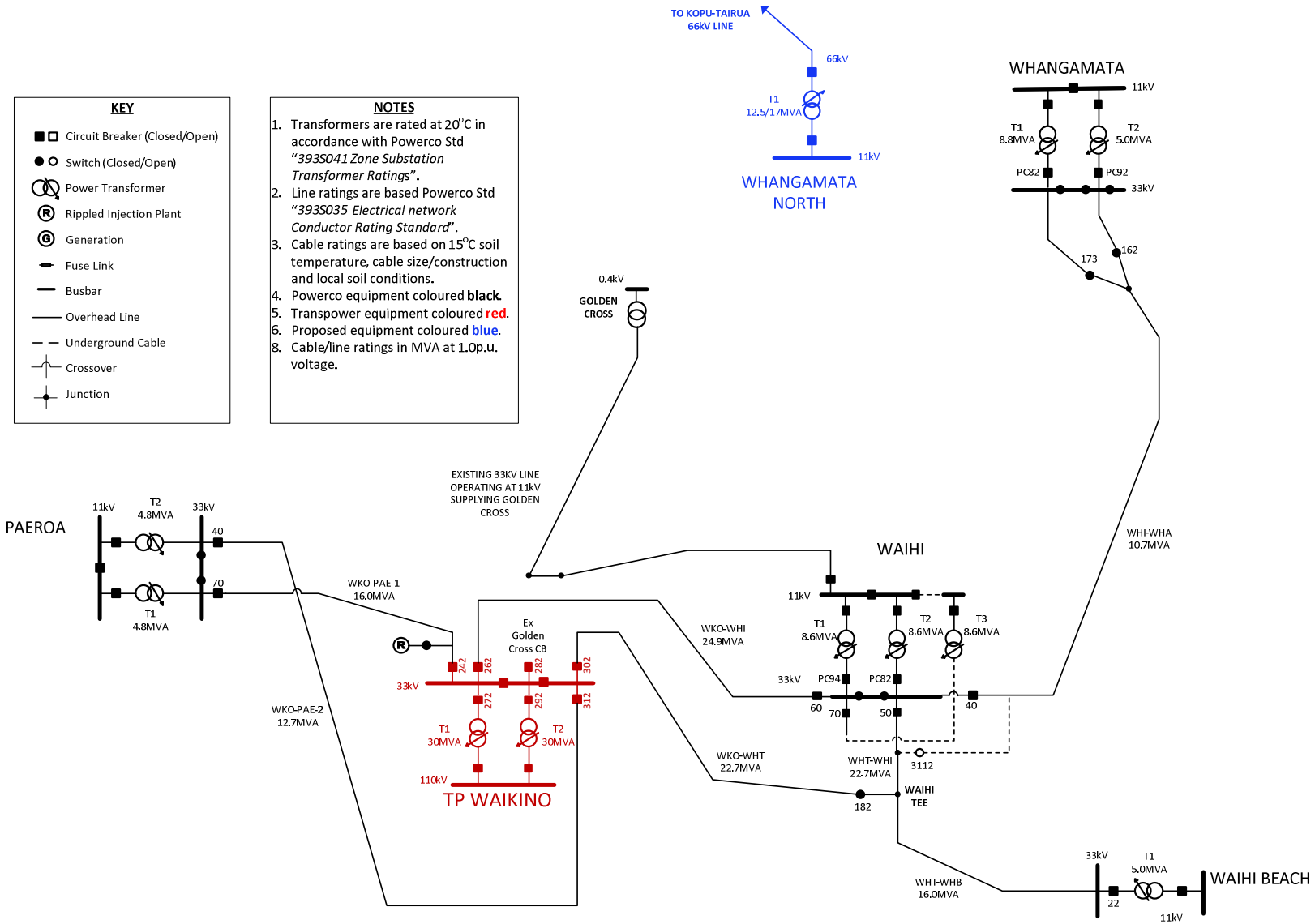

Figure 8 Option 6: New 66kV overhead line – Tee onto Kopu-Tairua 66kV line: One-Line Diagram

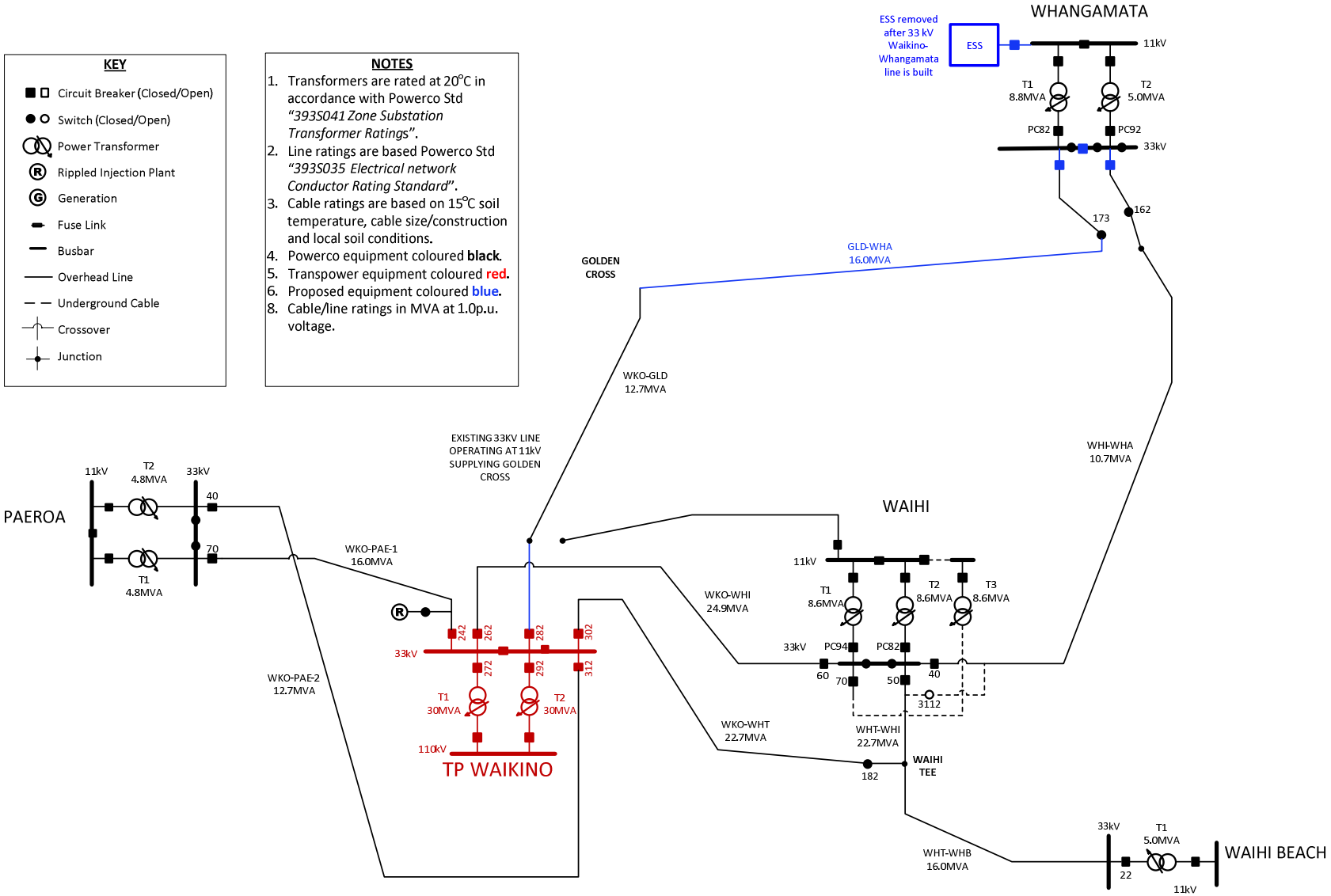

Figure 9 Option 9: Energy Storage + Diesel Generation at Whangamata, deferred Waikino—Whangamata 33 kV Line: One Line Diagram