Powerco CPP – Portfolio Overview Document

Portfolio Name	Kaimarama – Whitianga Sub-transmission Enhancement
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	$0.2	$0.2	$1.3	$2.0	$2.2	$0.0	$5.9	$5.9
Post-Internal Cost Capitalisation and Efficiency Adjustments *(2016 Constant NZ$(M))*	$0.0	$0.2	$0.2	$1.4	$2.1	$2.2	$0.0	$6.1	$6.1

Description

Project need overview	The 66kV subtransmission network that supplies Whitianga, Coromandel (and Tairua under contingency) cannot meet Powerco security of supply standards due to capacity constraints during high load periods. Coromandel is supplied on a spur off a hard tee connection at Kaimarama and does not have its own dedicated 66kV supply circuit. Historically, the area has always been exposed to long duration outages particularly during extreme weather conditions.

Proposed solution

Project solution overview	Powerco propose to install a new, ≈4km, 110kV-capable underground cable between Kaimarama & Whitianga on road reserve of State Highway 25. This will resolve the capacity constraint between Kaimarama and Whitianga supplying load to the three substations. It will also create a new dedicated 66kV circuit for Coromandel through the removal of the hard tee connection at Kaimarama. The existing 66kV bus

[1] Forecast expenditure is based on Powerco's financial year (i.e. FY19 is for the period April 2018 through March 2019). Expenditures do not consider general price level changes over time (i.e. are in real or constant terms) and do not include AMG costs.

[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.

	structure at the Whitianga substation would be upgraded to accommodate and terminate the new cable. The new circuit would initially be operated at 66kV. The project would be designed to accommodate Powerco's ongoing future strategy to extend the 110kV network from the Kopu GXP to Whitianga, thereby enhancing security of supply to the region in the process.

Need Identification

Background	Powerco's Coromandel Area encompasses the Coromandel Peninsula[4] and north-eastern section of the Hauraki Plains. The sub-transmission network consists of a 66kV network of lines/cables that supplies six zone substations (Kerepehi, Matatoki, Thames, Coromandel, Whitianga and Tairua) (refer to Figure 1 & Figure 4). The sub-transmission network is supplied from the Kopu 110/66kV GXP (located to the south of the Thames township). The area is characterised by rugged, bush-covered terrain, making line access difficult and seasonal weather extremes and cyclones impact heavily on line security. The population is highly seasonal and the demand profile is very peaky. The demand on most zone substations peaks in summer, when the temperatures are higher and lines sag more. The largest individual consumers are located in the Thames area; namely A & G Price (≈3.2MW), Thames Toyota (≈0.4MW), Thames Timber (≈1.8MW) and CHH-Kopu (≈1MW).
Drivers and Investment Triggers	The Coromandel Area has a number of constraints which include the following: 1. The combined 2015 peak demand on the Coromandel, Whitianga & Tairua substations was 28.4MW. During a contingent event on the 66kV line between Kopu and Tairua, sections of the remaining 66kV line between Kopu and Whitianga would be overloaded during peak loading conditions on the Coromandel/Whitianga/Tairua substations. This project focuses on the line section that runs between Kaimarama and Whitianga (≈4 km of Raccoon conductor between Kaimarama & Whitianga) which will be overloaded in this situation supplying all three substations. The existing supply network to the three substations does not meet the requirements of Powerco's Security-of-Supply Standard, which recommends a (N-1), no break supply network, security class AAA[5] for the combined load of Whitianga/Tairua/Coromandel. 2. The combined 2015 peak demand on the Coromandel & Whitianga was 20.2MW. During System Normal, the Kaimarama to Whitianga section will overload supplying the two substation loads at peak load. As a result load would need to be shed in order to maintain acceptable 66kV delivery voltages to the zone substations. The existing arrangement does not afford a AA+ security of supply requirement for Whitianga as current resupply arrangement involves field crew manually switching an ABS at Kaimarama to restore supply. In addition to the above constraints the sub-transmission network in the Coromandel Area has a long history of poor reliability performance due to the long overhead lines that traverse across rugged terrain coupled with the existing configuration that involves a

[4] A rugged, forested, coastal peninsula, with five towns that have a combined population around 15,000. The economy is mostly based on tourism with little heavy industry.

[5] AAA – Supply is uninterrupted in the event of the outage of one major element of the sub-transmission network. Load can be transferred to other substations without interruption by switching on the network if necessary to avoid exceeding ratings (Powerco - Standard 310S001 – Security of Supply Classification – Zone Substations).

	number of 66kV tee connections. More specifically, the Coromandel Area's sub-transmission network is Powerco's worst performing area in terms of SAIDI. A particular issue is the fact that the Coromandel substation is supplied via a 66kV line that tees off the Tairua-Whitianga 66kV line. The implementation of a robust electrical protection system on this three terminal network has been found to be difficult and a number of significant trips/events have meant that Powerco has been reluctant to operate the Kopu-Whitianga-Tairua-Kopu 66kV lines in a closed ring configuration. The simplification of the existing sub-transmission network such that the ring can be operated closed is expected to deliver significant benefits to the consumers in the Coromandel Area and result in a reduction of Powerco's SAIDI. Note that the above list is not a complete list of the network constraints within the Coromandel Area and Powerco has additional PoDs/plans/projects to address these other constraints. In particular refer to items 9 & 10 in section titled Reference Documents.
Timing of the need	The proposed new 110kV capable cable from Kaimarama to Whitianga is presently required. However, significant discussions with the relevant land owners have yet to begin and consents have yet to be granted by the relevant council. As a result of this fact, Powerco only expect to begin the project in 2019 with targeted completion by 2023.

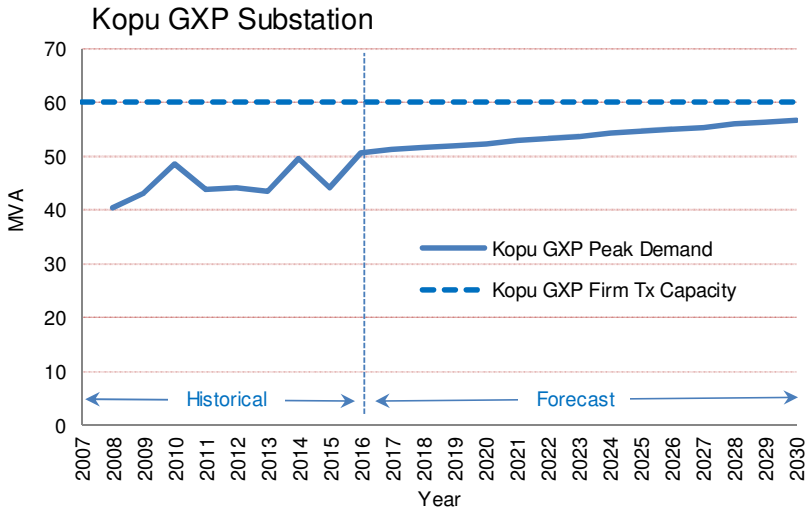
Demand Forecast | Coromandel Area

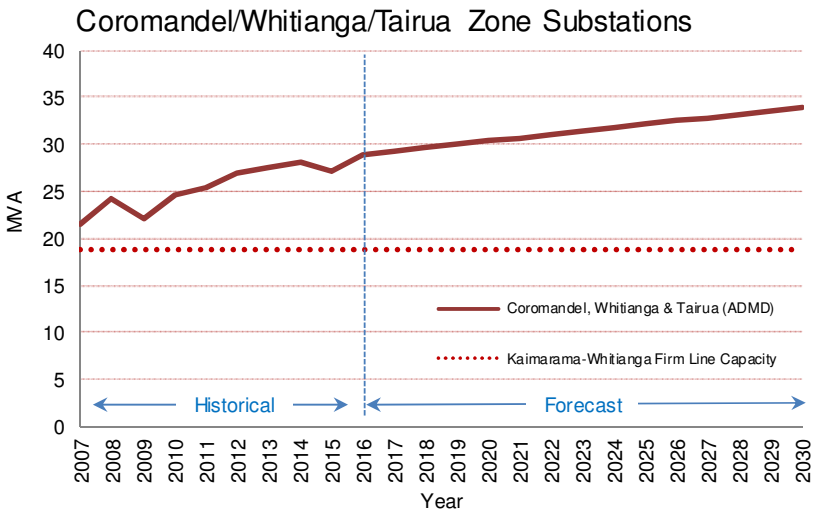
COROMANDEL AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	CLASS CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Coromandel	0.0	0.9%	4.7	4.8	4.8	4.8	4.9	5.1	5.3
Kerepehi	0.0	0.7%	10.1	10.2	10.3	10.3	10.4	10.8	11.1
Matatoki	0.0	0.9%	5.6	5.7	5.7	5.8	5.8	6.1	6.3
Tairua	7.5	0.7%	8.6	8.7	8.7	8.8	8.8	9.1	9.4
Thames T1 & T2	0.0	0.3%	13.4	13.5	13.5	13.5	13.6	13.8	13.9
Thames T3	6.9	0.0%	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Whitianga	0.0	1.6%	17.2	17.4	17.7	18.0	18.3	19.6	21.0

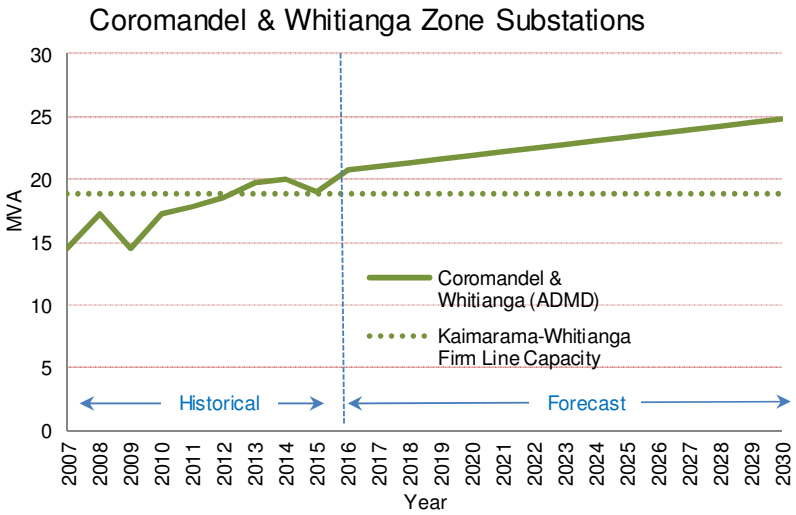
COROMANDEL AREA SUBSTATIONS			FORECAST MAXIMUM DEMAND [MVA]						
SUBSTATION	TX CAPACITY	GROWTH	2016	2017	2018	2019	2020	2025	2030
Kopu GXP	60.0	0.9%	50.6	51.1	51.5	52.0	52.4	54.6	56.8

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 & 66kV) 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.


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


Coromandel/Whitianga/Tairua Zone Substations
MVA
Year
Coromandel, Whitianga & Tairua (ADMD)
Kaimarama-Whitianga Firm Line Capacity
Historical
Forecast


Coromandel & Whitianga Zone Substations
MVA
Year
Coromandel & Whitianga (ADMD)
Kaimarama-Whitianga 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. A significant issue that Powerco often faces is the reality of trying to secure 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 Coromandel Area. The four non-network options (Nos. 2, 3, 4 & 5) are not shortlisted on the following basis: • Fossil fuelled generation (i.e. diesel generation) is technically viable but not shortlisted due to the cost and environmental/consenting challenges. Under network contingencies there would be shortfall of ≈10MW[6] that would need to be "made up" using stand-by generation. The capital cost of a 10MW[6] standby diesel generation plant is estimated to range from $15M to $20M[7,8]. • Powerco has not identified any viable renewable generation options that would provide the required security of supply[9]. • Fuel switching and demand side response (DSR) are considered to be deferment strategies. Their viability is not considered to be certain given the growth rates that the Coromandel Area has experienced and the fact that the network security levels are already well exceeded. The volume of small consumers (and lack of large consumers) further complicates the possibilities associated with fuel switching and DSR. • Powerco currently uses a mains-borne ripple control system to manage significant amounts of hot water cylinder load in the Coromandel Area. During peak loading periods most hot water cylinders are turned off. • 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 10MW[6] of domestic backup batteries are estimated to be >$15M[10]. An additional factor is that the current application of battery storage technology to power networks is very limited and it would be wise to undertake a trial before committing to a significant installation.

[6] This is the present shortfall and this amount is predicted to increase in the future.
[7] Excludes the ongoing maintenance and operational costs.
[8] 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.
[9] 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.
[10] The installed costs of domestic battery storage systems are expected to be >NZ$1,500/kW (vendors indicate equipment costs of ≈US$3.5k for a 7kW system).

	Six network reinforcement options were identified (Nos. 6 to 11) as potential solutions to the network constraints and issues. Options 8 and 10 were not shortlisted as they do not give any tangible enhancements to Coromandel's supply reliability since it retains the tee supply arrangement. The remaining four network reinforcement options (Nos. 6, 7, 9 & 11) were shortlisted on the basis that they resolve all the relevant constraints/issues. Note that the Kopu-Whitianga-Tairua-Kopu 66kV ring has a number of constraints and Powerco is planning two other significant projects on the 66kV ring (refer to items 9 & 10 in the section titled Reference Documents).

Long List of Options | High Level Assessment

Kaimarama-Whitianga Project		*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 inc	✓	✗	✗	✗	✗	✗	✓	✗
Non-network	2	Distributed Generation (DG) including peak lopping generation	✓	✗	✗	✓	✓	✓	✗	✗
	3	Fuel switching to reduce electrical demand	✓	✓	✗	✗	✓	✓	✗	✗
	4	Demand Side Response (DSR)	✓	✓	✗	✗	✓	✓	✗	✗
	5	Energy storage	✓	✓	✓	✓	✗	✓	✗	✗
Network Reinforcement	6	New Kaimarama-Whitianga 110 kV-capable overhead line	✓	✓	✓	✓	✓	✓	✓	✓
	7	New Kaimarama-Whitianga 110kV underground cable	✓	✓	✓	✓	✓	✓	✓	✓
	8	Reconductor Kaimarama-Whitianga 66kV lines	✗	✗	✓	✗	✓	✓	✓	✗
	9	New Whitianga-Coromandel 66kV overhead line	✓	✓	✓	✗	✓	✓	✗	✓
	10	Thermal upgrade Kaimarama-Whitianga 66kV lines	✗	✗	✓	✗	✓	✓	✓	✗
	11	Kaimarama 66kV Switching Station	✓	✓	✗	✓	✓	✓	✓	✓

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, safety)
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 Costs[11]	Description
Option 6: ***New Kaimarama—Whitianga 110kV Overhead Line***	**$5.0M**	This option involves the installation of a 110kV-capable overhead line between Kaimarama and the Whitianga substation that utilises the existing right-of-way of the 11 kV distribution line (WHT-4 Coroglen) (refer to Figure 2 & Figure 5). The line route— traversing private property for the most part—is easily accessible from the state highway SH25, see Figure 7 for concept. The line would be operated initially at 66 kV. In addition, the following enhancements are required: • Reconfiguration at Kaimarama to remove the tee and installation of a pole structure to enable a crossing point between the two Kopu—Whitianga and Tairua—Whitianga overhead circuits. Landowner consent/compensation would be required prior to installing the termination structure and in order to install the 110kV cable from the structure to the cable trench along SH25. • Modification of the transposition pole 52 where the Coroglen—Whitianga and the Whitianga—Coromandel circuits meet but are not electrically connected. • Modifications to the last structure of the existing 66kV double circuit into the Whitianga substation. • The extension of the existing 66kV outdoor buswork at Whitianga to include an additional 66kV circuit breaker bay and expansion of the switchroom. • As the line nears Whitianga, transition to underground cable (~900m) is probably likely if we cannot get access all the way through to Whitianga substation for the line. The proposed project would make allowance for the long term objective of upgrading the existing 66kV circuit from Kopu to Whitianga to 110kV and installing a 110/66kV transformer at Whitianga. Allowance would need to be made for a 66kV circuit to the future planned Matarangi substation. The Kopu-Whitianga-Tairua-Kopu 66kV ring would be capable of operation in a closed configuration when coupled with additional communications upgrade (PLC or fibre) to facilitate fast protection schemes and—combined with other proposed major projects in the region—would enhance security of supply for the Whitianga and Tairua substations to AAA[5] level. The Coromandel substation would be supplied via a dedicated 66kV spur line from the Whitianga substation.
Option 7: ***New Kaimarama—Whitianga 110kV Underground Cable***	**$5.9M**	This option—conceptually similar to Option 6—involves the installation of a 110kV-capable underground cable between Kaimarama and the Whitianga substation (refer to Figure 2 & Figure 5) rather than an overhead line. The cable would be installed in the road reserve adjacent to SH25 and would initially be operated at 66kV. The following additional enhancements would be required: • Reconfiguration to remove the Kaimarama tee and a 110kV overhead-underground termination structure installed. Landowner consent/compensation would be required prior to installing the termination structure and in order to install the 110kV cable from the structure to the cable trench along SH25.

[11] Project capital costs in 2016 NZ Dollars excluding Powerco internal cost capitalisation and IDC components. The values are not economic costs and do not factor in the "time value of money" or consider the costs of electrical loss reduction, reliability improvement, cost-of-non-supply or any other relevant factors. These other factors are considered in Powerco's options analysis.

		• Modification of the transposition pole 52 where the Coroglen—Whitianga and the Whitianga—Coromandel circuits meet but are not electrically connected. • Modifications to the last structure of the existing 66kV double circuit into the Whitianga substation. • The extension of the existing 66kV outdoor busbar at Whitianga to include an additional 66kV circuit breaker bay for the cable to terminate on to and expansion of the switchroom. The proposed project would make allowance for the long term objective of upgrading the existing 66kV circuit from Kopu to Whitianga to 110kV and installing a 110/66kV transformer at Whitianga. Allowance would need to be made for a 66kV circuit to the future planned Matarangi substation. This project is our preferred option as it is expected to meet the least public opposition and consenting difficulties. The Kopu-Whitianga-Tairua-Kopu 66kV ring would be capable of operation in a closed configuration when coupled with additional communications upgrade (PLC or fibre) to facilitate fast protection schemes and—combined with other proposed major projects in the region—would enhance security of supply for the Whitianga and Tairua substations to AAA[5] level. The Coromandel substation would be supplied via a dedicated 66kV spur line from the Whitianga substation.
Option 9: ***New Whitianga—Coromandel 66kV Line***	**$13.4M**	This option involves the construction of a new 66kV overhead circuit from Whitianga to Coromandel that will give Coromandel two supply circuits, securing the load at AAA as a result. The line will traverse rugged and challenging terrain between Kaimarama and Coromandel. Besides securing new easements for the proposed line, other additional requirements are: • Build the section between Kaimarama and Whitianga (~4 km long) at 110 kV-capable to connect to the 110 kV-capable Coroglen—Kaimarama line at Kaimarama. This resolves the thermal constraint of the existing Raccoon section between Kaimarama and Whitianga. • The existing Raccoon-conductored Kaimarama—Whitianga section that terminates at WHT CB70 utilised for the second Coromandel circuit. • Modifications to the last structure of the existing 66kV double circuit into the Whitianga substation. • The extension of the existing 66kV outdoor busbar at Whitianga to include an additional 66kV circuit breaker bay for the new line to terminate on to and expansion of the switchroom. • Extension of the 66 kV outdoor busbar at Coromandel and install a new 66 kV bay for a new line breaker.
Option 11: ***Kaimarama 66kV Switching Station***	**$6.3M**	This option involves the construction of a new 110kV-capable, full indoor, switching station based on gas insulated switchgear at Kaimarama (refer to Figure 3 & Figure 6) consisting of five 110kV-capable GIS feeder modules, a GIS bus coupler and a Line In-Line Out GIS stub module which will be used to connect to a future 110/66 kV transformer when conversion to 110kV is required. Land would need to be acquired at Kaimarama. The land would need to be purchased with sufficient space (around 650 m^2) to accommodate the future transformer housed indoors when the Kopu-Kaimarama line is upgraded to and subsequently energised at 110kV to facilitate growth. Cable incomers into the switching station would be configured as follows: • To supply the Whitianga substation via the existing two Raccoon conductor circuits, giving AAA security to Whitianga. • To supply the Coromandel substation via the existing single spur 66kV circuit.

		• The Kopu-Kaimarama-Tairua 66kV system would be operated in a closed configuration—with inclusion of future communication upgrades such as PLC signalling to enhance protection schemes—and would deliver the required security class of AAA[5] no-break supply to the Whitianga and Tairua substations. To allow the switching station to blend in with its rural surroundings, the building design concept to house the GIS equipment and future transformer shall resemble a barn-like building that is visually screened from the State Highway and adjacent property owners. See Figure 8 for conceptual photomontages of the GIS switching station. Widening of the road, to allow vehicles to pull off SH25 and turn into the entrance of the switching station, will also be required for improved access and safety.

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 6: ***New Kaimarama-Whitianga 110kV Overhead Line***	• Removes the existing capacity constraint between Kaimarama and Whitianga. • Removes the Coromandel teed supply at Kaimarama and enhances the region's security of supply. • Collocation of the future proposed 110/66kV substation & transformer with the existing Whitianga 66/11kV substation (minimises number of substations). • Relatively small amount of network modifications/enhancements required on private land. • Makes provision for the future upgrade of the Kopu-Whitianga line to 110kV. • Facilitates a Whitianga connection to the proposed 66kV circuit to the future Matarangi substation. • Undergrounding of existing 11kV distribution feeder (WHT-4 Coroglen) improves performance and reliability at the 11kV level.	• Significant uncertainty remains in relation to landowner/public acceptance of a 110 kV overhead line even though it utilises existing 11 kV distribution feeder line route. • Taller pole structures compared to the existing 11 kV overhead feeder poles required. Creates a visual impact from the road into Whitianga. • Width of existing 11kV easement has to be negotiated with landowners to obtain a wider corridor for the 110kV line. • There is a moderate risk that there will be public/landowner opposition to significant expansion of the Whitianga substation site. • The 110kV capable line would not be required if the electrical demand does not eventuate. However, this statement would apply to the existing overhead line between Kauaeranga and Kaimarama which was built for 110 kV operation in future. • Higher losses compared to cable.

Option 7: ***New Kaimarama-Whitianga 110kV Underground Cable***	• Removes the existing capacity constraint between Kaimarama and Whitianga. • Removes the Coromandel teed supply at Kaimarama and enhances the region's security of supply. • Collocation of the future proposed 110/66kV substation & transformer with the existing Whitianga 66/11kV substation (minimises number of substations). • Makes provision for the future upgrade of the Kopu-Whitianga line to 110kV. • Facilitates a Whitianga connection to the proposed 66kV circuit to the future Matarangi substation. • Relatively small amount of network modifications/enhancements required on private land. • Small visual footprint on the main road into Whitianga. • Lower losses compared to overhead line.	• Significant traffic management during cable construction on road reserve. • A number of bridge crossings to negotiate that may require civil and structural strengthening to support the cable. • No improvements for the 11 kV WHT-4 Coroglen feeder. • Finding the location of a cable fault and fixing it is longer compared to overhead. • Suitable safe locations on road reserve required for the cross-bonding link boxes and major section earthing terminal to allow safe access for maintenance.
Option 9: ***New Whitianga—Coromandel 66kV Overhead Line***	• Provides twin diverse supply circuits to Coromandel improving security of supply to Coromandel in the process. • No time pressure on field crew to restore supply to Coromandel following a Coromandel subtransmission fault.	• Significant landowner/public opposition is expected (i.e. significant property & consenting risk). • Most expensive among all considered options. • Tall pole structures required, which will create a visual impact from the road into Whitianga.
Option 11: ***Kaimarama 66kV GIS Switching Station***	• Does not require the construction of additional sub-transmission cables/lines. • Reduces the extent of the modifications required at the existing Whitianga 66/11kV substation. • Provides some additional diversity of supply (two substation sites (Whitianga & Kaimarama). • Potential to showcase Powerco's strengths and capabilities integrating new technology (GIS) into the network. • Smaller footprint of GIS versus traditional outdoor air-insulated substations (AIS). • Visually appealing compared to traditional outdoor substations. Possible focal point as a project that the local community can be proud of.	• Land required at Kaimarama on existing private property. Powerco no longer has designation on the old Kaimarama substation site. • Some landowner/public opposition is expected (i.e. property & consenting risk). • A future 66kV supply to the proposed new Matarangi substation would be via the existing Kaimarama-Whitianga 66kV double circuit or to come off Whitianga 66 kV bus directly. • Significant geotechnical and civil works required to provide a solid foundation for the GIS yard and protect it from flood risks from the nearby stream.

Shared Features	• Utilise known technology and proven designs. • Improves network reliability to the Coromandel, Whitianga and Tairua areas.	

Recommendation	
Preferred Option	**Option 7 - New Kaimarama-Whitianga 110kV Underground Cable**
Reasons for choosing Option	The cost of building Option 9 is significantly much higher compared to the other options so it drops out being the most uneconomical option. The cost differential between the remaining three shortlisted options (Nos. 6, 7 & 11) is small and Option 7 is preferred for the following reasons: • The risks associated with land/public opposition are the smallest as most of the cable is laid in road reserve. • The visual impact on the main road into Whitianga is lowest as cable is undergrounded. • Provision is made for the extension of 110kV into the Whitianga substation, which has space on site to accommodate future expansion. • It facilitates an improved supply network to the proposed future Matarangi substation, thereby aligning to the overall Coromandel supply upgrade strategy. • Lower electrical losses and operational costs compared to the overhead line (Option 6). Nonetheless, as the overhead line option (no. 6) is on par with the preferred cable option in terms of net benefit, Powerco firstly intends to approach all affected parties, consult with the community on the practicalities of the project before concluding if the project can realistically go ahead as planned. If the overhead line option fails this test, then Powerco's intention is to proceed with the cable option.

Option 7| Detailed Costs[12]

Item	Description	Actual Cost	Projected Cost
A	Property & Consent Costs		
A.1	Resource consents (Kaimarama & Whitianga poles)	-	$51,000
A.2	Easements (Kaimarmara poles & 110kV Cable)	-	$250,000
A.3	Building consent fees (Whitianga Substation)	-	$5,100
A.4	Preliminary design/landowner discussions	$41,031	-
B	Investigation and Reporting Costs		
B.1	None		
C	Substation Costs		
C.1	Whitianga substation enabling works	-	$1,294,562
D	Line and Cable Costs		
D.1	Kaimarama-Whitianga cable works	-	$4,088,173
D.2	Kaimarama line modifications	-	$178,500
E	Committed/Historical Costs (A+B+C+D)	$41,031	
F	Future Projected Costs (A+B+C+D)		$5,867,335
G	Anticipated Final Cost (E+F)		**$5,908,366**

[12] Excludes Powerco's internal/overhead costs

Option 7 | Implementation Plan				
Project or Action	**Start Year[1]**	**End Year[1]**	**NZ $'000[1]**	**Details / Comments**
Project costs to date	FY16	FY16	$41	Costs that have already occurred on Preliminary designs/Concept Costings
Future land/easements/ compensation/consents	FY19	FY20	$306	Costs associated with easements, compensation, designations etc. to secure cable route, modify existing lines & erect new substation buildings/structures
Whitianga substation enabling works	FY21	FY21	$1,295	Costs associated modifying the existing 66kV bus structure in order to accommodate new 66kV bay. Works would facilitate future 110kV plans and include a 110kV cable sealing end.
Kaimarama-Whitianga cable works	FY22	FY23	$4,088	Costs associated with the installation of a ≈4km, 110kV, underground cable from Kaimarama to the Whitianga substation.
Kaimarama line modifications	FY23	FY23	$179	Costs associated with the modifications of the overhead line structures at Kaimarama and the Whitianga substation, including a 110kV overhead to underground cable transition.
Total Project Costs ➔	**FY19**	**FY23**	**$5,908**	Includes Only Growth & Security Expenditure.

Supporting Documents and Models	
Planning documents ***Standards | Policies*** ***Reviews and Consultant reports*** ***Concept Designs | Estimates***	1. Kaimarama-Whitianga Capacity Improvement – Options Analysis, revised 08/09/2016. 2. Kaimarama-Whitianga 110kV Cable, CCE, VH00012-RPT-EEE-012, dated 8th May 2015. 3. Kaimarama-Whitianga 110kV Overhead Line Optioneering Analysis, dated 8th Apr 2016. 4. Powerco's 2016 Asset Management Plan (AMP). 5. Transpower's Annual Planning Report (APR), 2015. 6. "*310S001 Security-of-Supply Classifications – Zone Substations*", Powerco Standard. 7. "*393S041 Zone Substation Transformer Ratings*", Powerco Standard. 8. "*393S035 Electrical network Conductor Rating Standard*", Powerco Standard. 9. POD-G7 Kopu-Kauaeranga Project. 10. POD-G6 Kopu-Tairua Sub-transmission Enhancement.

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).
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 especially since the marginal cost difference between some options is small. • 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 Kopu GXP Sub-transmission Network: Geographic Diagram

Figure 2: Option 6 and 7 - Kaimarama-Whitianga 110kV Line or Cable: Geographic Diagram

Figure 3: Option 11 - Kaimarama GIS Switching Station: Geographic Diagram

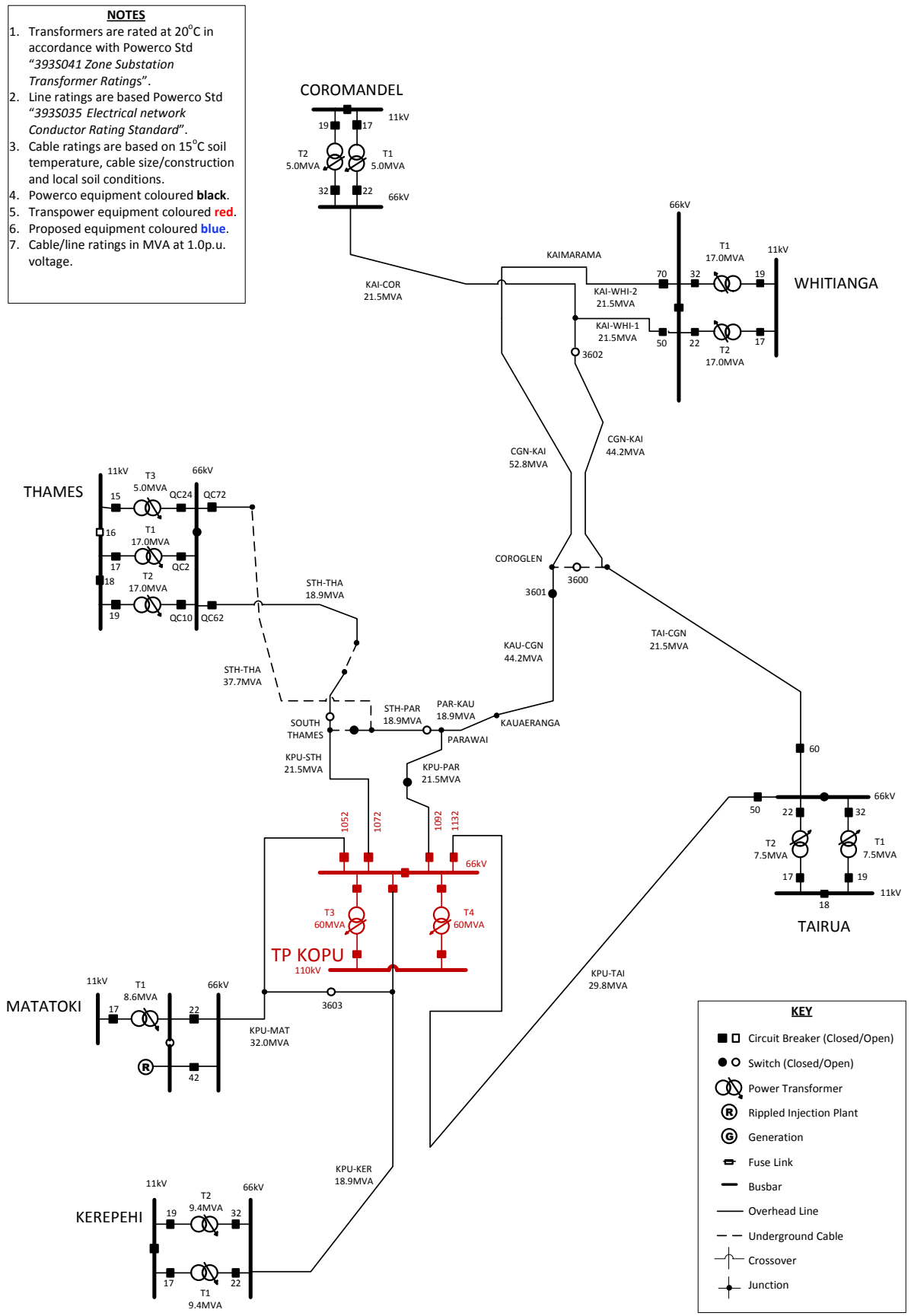


Figure 4: Existing Kopu GXP Sub-transmission Network: One-Line Diagram

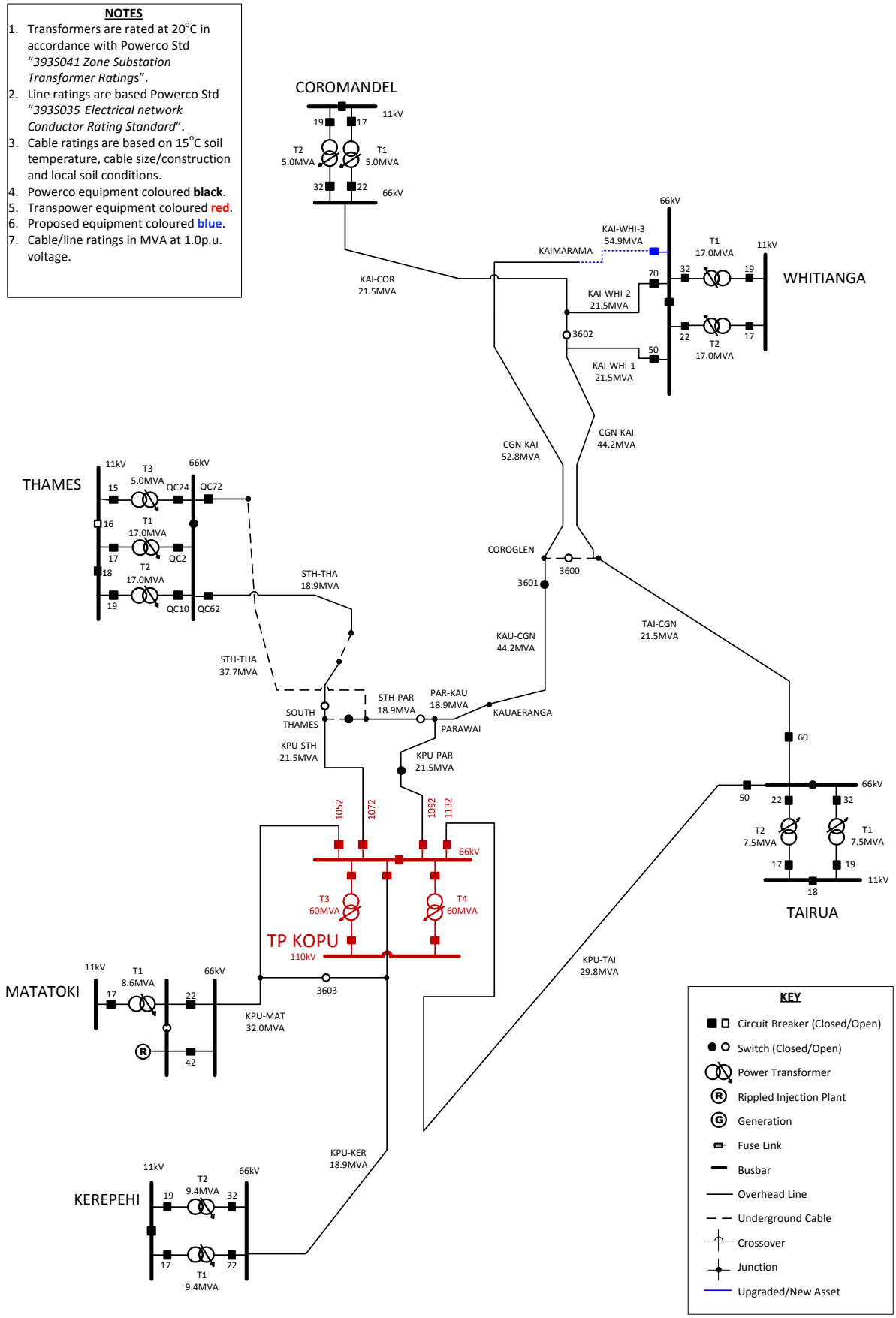


Figure 5: Option 6 and 7 - Kaimarama-Whitianga 110kV Line/Cable: One-Line Diagram

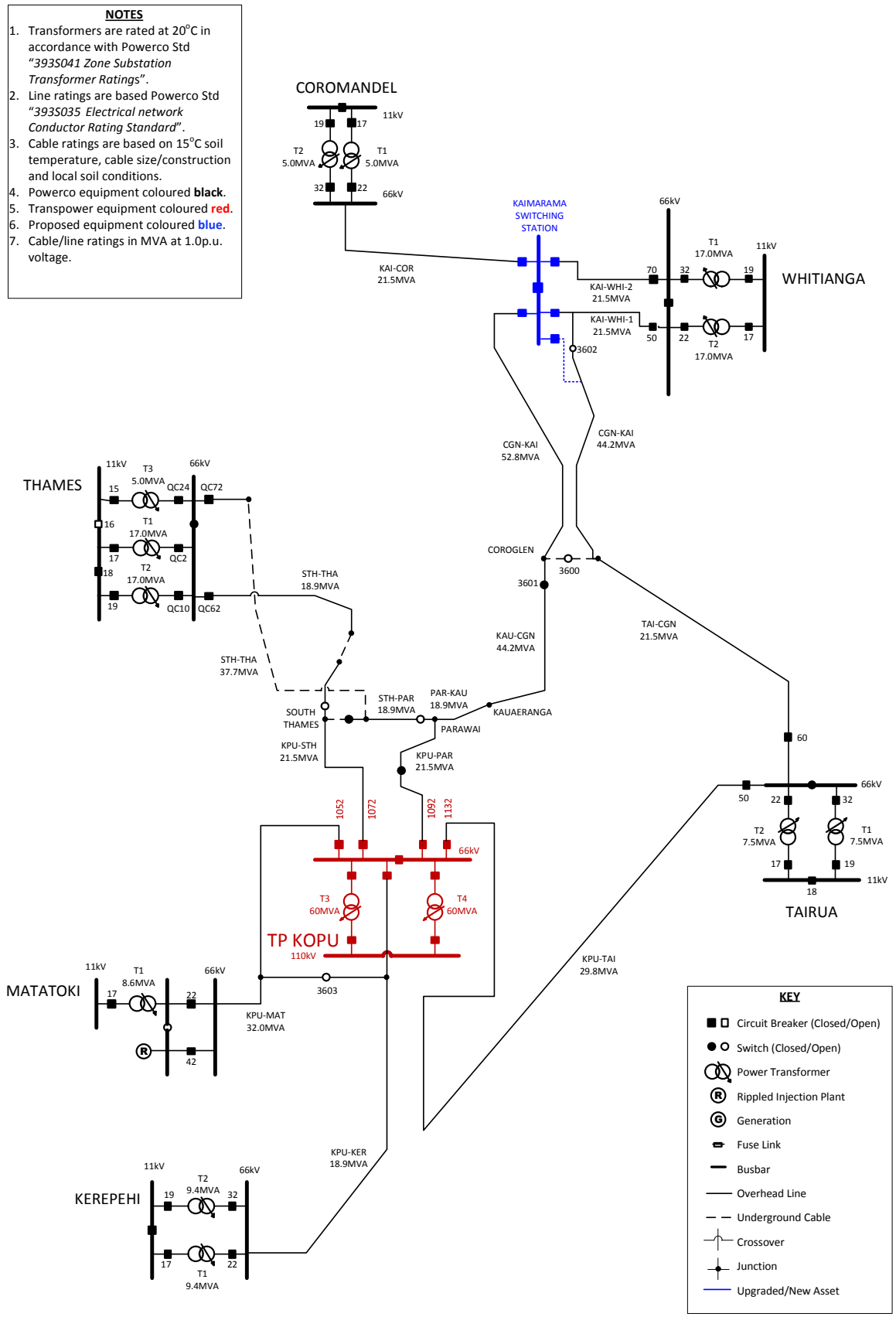


Figure 6: Option 11 - Kaimarama GIS Switching Station: One-Line Diagram

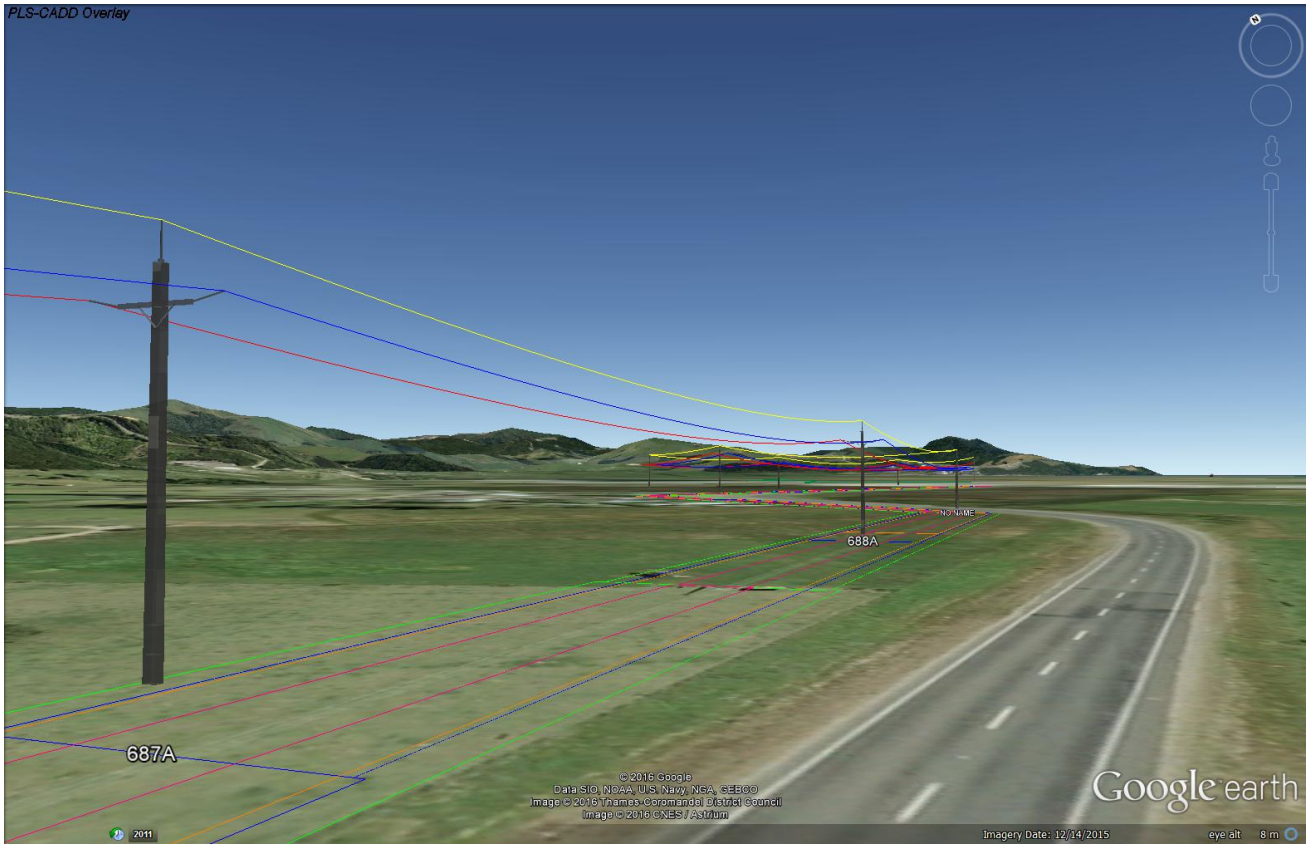


Figure 7: Sample of PLS-CADD Concept Design of 110kV Overhead Line (Option 6)

Figure 8: Concept photomontages of indoor GIS Switching Station (Option 11)