TS155 - SUSSEX INLET ZONE SUBSTATION - STAGE 2 RENEWAL

TS155 – Business case

Prepared by Asset Strategy and Planning

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Endeavour Energy

REVIEW AND APPROVAL SCHEDULE

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1.0 EXECUTIVE SUMMARY

Sussex Inlet Zone Substation is a 33kV/11kV substation on The Springs Road, Sussex Inlet. It is fed from West Tomerong Transmission Substation (TS), supplies electricity to customers in the rural and coastal/holiday townships of Sussex Inlet, Swanhaven, Berrara, Wandandian and Bewong and was originally constructed in 1968.

The substation consists of two outdoor 33kV circuit breakers servicing two 15MVA power transformers and an outdoor 11kV busbar.

A Statement of Asset Need from Asset Standards & Design identified that the 11kV busbar and associated structures are suffering from corrosion damage and have reached the end of their life. Further, the busbar is equipped with a single bus-section isolator which cannot be maintained without a complete outage of the substation and has sub-standard clearances which presents hazards for operations and maintenance workers. Therefore the design and the condition of these assets is a safety issue it is recommended that this equipment is replaced.

Therefore, the purpose of this project is to consider options for the substation to provide for the renewal of assets which have reached the end of their effective service lives and or present safety hazards to reduce the risks currently presented by the substation assets to as low as reasonably practicable to ensure the ongoing safe and reliable operation of the substation.

Options were considered for the substation including:

- Do nothing;
- Non-network options including demand management strategies;
- Refurbishment of the existing 11kV busbar;
- Construction of a new outdoor 11kV busbar;
- Construction of a new control building with indoor 11kV switchgear; and
- Construction of a new control building with indoor 33kV and 11kV switchgear

This project will be subject to the RIT-D regulatory test for non-network solutions and the screening test considers both the option of retiring the substation completely and reducing its capacity. However, these approaches were found to not be feasible due to the low cost of the asset renewal solutions compared to the cost of provision for the demand currently provided by the substation by non-network means.

Further, the risk and benefit assessment of the available renewal options concluded that the approach with the lowest present cost value which most effectively addresses the risks presented by the assets at Sussex Inlet Zone Substation is to construct a new control building with new indoor 11kV switchgear which is therefore the preferred option.

The cost of this option is estimated to be $5.8 million in real FY18 terms and $6.0 million in nominal terms. The contingency allowance for the project is proposed to be $0.6 million, taking the total, including contingency, to $6.6 million.

The PIP8.5 includes a funding allocation of $10.5 million over the FY20 – FY22 years for this project. However, it is proposed that commencement of the works be brought forward to FY18 to address the safety issues presented by the substation in an appropriate timeframe and that funding be re-phased to the FY18 - FY20 years via the change control process accordingly.

Accordingly, it is recommended that:

- A capital expenditure of $6.0 million to replace the 11kV busbar at Sussex Inlet Zone Substation as detailed in this business case be approved;
- A contingency sum of $0.6 million, representing 10% of the project estimated costs to cover unforseen events be approved.

The total project estimate, including base costs and the contingency sum, totals $6.6 million.

2.0 INTRODUCTION

2.1 PURPOSE

The purpose of this document is to obtain approval for the expenditure for the works to renew the 11kV busbar at Sussex Inlet Zone Substation in 2017/18 – 2019/20 to reduce the risks currently presented by the substation asset to as low as reasonably practicable (ALARP) to contribute to the ongoing safe and reliable operation of the substation.

2.2 BACKGROUND

Sussex Inlet ZS is a rural 33kV/11kV zone substation fed from West Tomerong TS via Tomerong ZS. The substation is located in The Springs Road outside of the township of Sussex Inlet and supplies electricity to customers in the rural and coastal/holiday townships of Sussex Inlet, Swanhaven, Berrara, Wandandian and Bewong. The substation is located in an industrial/commercial area but there is now a residential development taking place in the area on the other side of The Springs Road to the substation.

The substation is equipped with two 33/11kV 15MVA power transformers which were manufactured by Tyree in 1971. These transformers where originally commissioned at Nowra ZS before replacing two 5MVA transformers at Sussex Inlet ZS in 2012 and 2013.

There are two Areva OX36 circuit breakers in the 33kV transformer bays which were manufactured in 2005 and replaced older AEI bulk oil breakers. The substation also includes an outdoor 11kV switchyard which contains four Nulec reclosers which were manufactured between 2001 and 2004 and replaced older Standard Waygood and Westinghouse bulk-oil circuit breakers.

The substation was established in 1968 and therefore, apart from the more recent assets, is 49 years in age.

The need to replace the original power transformers was first identified in a statement of asset need (SAN) prepared by Asset Standards and Design in May 2011. The SAN also recommended the replacement of the 11kV busbar and support structures at Sussex Inlet ZS due to corrosion damage. However, it was resolved at the time that the replacement of the transformers was an urgent and pressing need due to their condition whilst the 11kV busbars were less urgent and would require a longer period to develop an appropriate solution. Therefore the substation's renewal needs would be addressed in two stages with the transformers being replaced in the first stage and the 11kV busbar and associated works in the second stage.

An aerial view of the substation in shown in Figure 1 below.

FIGURE 1 – SUSSEX INLET ZS AERIAL VIEW

Since the time of the initial condition assessment, the condition of the 11kV busbar and equipment has deteriorated to the point where it is appropriate to now initiate the second stage of the project.

Subsequently, this document represents the second stage of the works and proposes the renewal of the remaining aged assets at the substation.

The Statement of Asset Need, the system diagram for the 33kV network supplied by West Tomerong Transmission Substation and the single-line diagram and the layout for Sussex Inlet ZS as it currently exists are shown in Appendix A, Appendix B, Appendix C and Appendix D respectively.

3.0 PROJECT NEED

3.1 SUBSTATION ASSETS

Table 1 below shows the age (in 2017) of the various assets at Sussex Inlet ZS, compared with their depreciation life and their effective service life as provided to the regulator in the Regulatory Information Request (RIN) each year.

As indicated in Table 1, the age of the substation equipment is varied, ranging from new to 49 years. Further, the written down value of the substation in July 2017 was $1.76 million.

TABLE 1 – ASSET AGE

Asset category	Asset details	Asset age at 2017 (years)	Depreciation life (years)	RIN effective service life (years)
33/11kV Power Transformers	2 x Wilson 15MVA	46	50	50
33kV Switchgear	Support structures	4-49	45	45
	2 x Alstom OX36 CBs[1]	11	45	45
11kV switchgear	Support structures	49	45	45
	1 x Nulec N12 reclosers	15	45	45
	3 x Nulec N12 reclosers	13	45	45
Protection relays	Numerical transformer protection	4	15	Not individually categorised
SCADA	LogicaCMG MD1000 RTU	11	15	10
Isolators, Busbars and switchyard structures	Aluminium, copper and galvanised steel	4	45	45
Control building	Sheet metal shed	30	45	45

3.1.1 33/11KV POWER TRANSFORMERS

The two power transformers are rated at 15MVA and were manufactured by Wilson in 1971. Hence they are currently 46 years in age. These transformers were installed at Sussex inlet in 2012 and 2013 respectively and were originally in service at Nowra ZS. These transformers were removed from Nowra ZS due to load growth issues and were refurbished before being installed at Sussex Inlet ZS

These transformers are in satisfactory condition and currently have no renewal requirements.

[1] Whilst the effective life of this equipment is currently 45 years, experience to date with Areva OX36 circuit breakers and other modern sub-transmission SF_6 and vacuum circuit breakers which contain electronic systems is that both the quality of construction and the issue of support for their electronic systems will reduce their effective life to considerably less 45 years. Effective lives of between 25 and 30 years are considered to be more realistic.

TRANSFORMER OIL CONTAINMENT AND FIRE PROTECTION

Each power transformer is surrounded by a concrete bund which is sealed and drained through its own pumped oil-water separator. The bunds are equipped with deflector screens to ensure any oil leaks from the transformer's tank, radiators or pipework is captured within the bund.

However, there is insufficient space between the power transformers to provide adequate protection to the other transformer in the event of a fire in one of the transformers. This shortcoming was identified during the replacement of the transformers in 2012 but its resolution was left to this second stage of the project due to the urgency of replacing the two original transformers due to their condition, at the time. Accordingly, it is proposed that a fire wall should be constructed between the two power transformers as part of this project.

Further, the control box in Transformer No. 1 is located below the existing bund level. It is therefore subject to flooding during storms. The control box should be raised above the bund level as part of any redevelopment works at the site.

TRANSFORMER NOISE

An environmental noise impact study was conducted by consultants Day Designs Pty Ltd to investigate the environmental noise impact of Sussex Inlet ZS in August 2013. It was found that the power transformers are currently within noise limits given the current industrial/commercial land use near the substation. However they would become non-compliant if residential properties were to be developed near to the substation. This may occur in the future as residential development is currently underway in the area. However, the timing of any impact of this development on the substation is not clear at this stage.

The report proposed that if a non-compliance was to eventuate due to future residential development it should be addressed by the installation of sound walls around two sides of both of the transformers. An alternative solution is the replacement of the transformers with low noise units. These solutions should be considered in the light of the demand forecasts for the substation if and when the residential development encroaches on the substation in the future.

3.1.2 33KV EQUIPMENT

CIRCUIT BREAKERS

The 33kV switchyard is equipped with two Alstom OX36 SF_6 circuit breakers which were manufactured in 2005 and installed in 2006. Whilst these breakers have not had any issues with SF_6 gas leaks to date, they are suffering from corrosion damage. There is a known issue with OX36 SF_6 circuit breakers at other locations involving deterioration of the current transformer covers and SF_6 leaks. Refer to the Asset Class Condition – 33kV, 66kV and 132kV Circuit Breakers report [1] for further detail.

Notwithstanding this, it is assumed that these units will continue to remain serviceable for the foreseeable future given appropriate maintenance.

33KV ISOLATORS AND SUPPORTS

The 33kV busbars are of outdoor design. The two isolators SX14 and SX24 were installed in 2013 on new support structures and are in good condition. There is also a 33kV busbar support in each of the transformer bunds. The support in Transformer No. 1 bund is a steel reinforced concrete structure while the support in Transformer No. 2 bund is a steel structure. Both are suffering from corrosion damage. The structure in Transformer No. 1 bund has concrete loss exposing the inner reinforcing steel. The steel in both structures is experiencing extensive rusting which is affecting structural integrity. Therefore these supports should be substantially refurbished or replaced in the short term

3.1.3 11KV SWITCHYARD

RECLOSERS

The 11kV switchgear consists of four 11kV Nulec reclosers which were manufactured between 2001 and 2004 and replaced older bulk-oil circuit breakers which were manufactured by Standard Waygood and Westinghouse. These units are 13 to 15 years in age and currently have no renewal needs.

11KV BUSBARS, ISOLATORS AND SUPPORTS

The switchyard was established circa 1968 when the substation was commissioned. The 11kV steel support structures have significant corrosion over a substantial area. Much of the corrosion is at welded spots and the structure footings. This corrosion has also caused metal loss of the footing and other locations.

Further, there is only a single 11kV bus-section isolator (SXA7) with inadequate safety clearances around it and therefore maintenance of the isolator requires an outage of the entire substation. Sussex Inlet ZS's distribution network is isolated with only two 11kV feeder ties to other zone substations and therefore the substation's 11kV load cannot be transferred away effectively. As a result, there is no recorded maintenance of this isolator. This isolator is normally open with the busbar being operated split with both power transformers in service. Generally maintenance on each bus section is carried out by transferring the bus-section's load to the other section through the 11kV distribution feeders and associated air-break switches. Whilst this procedure allows the feeder substation to be maintained it is sub-standard arrangement for a zone substation which presents additional risks for operations and maintenance workers. The risks include that of mechanical failure of the bus-section isolator if it is called on to be operated to make the busbar solid in an emergency or for other maintenance purposes.

In addition, there are isolators on the 11kV side of the power transformers but no circuit breakers. During normal maintenance switching the isolators are operated with the transformers disconnected from both the 33kV and 11kV sides but during emergency situations there may be a risk of arch flash incidents if an isolator needs to be used to disconnect a power transformer on the 11kV side.

Therefore, the 11kV switchyard presents a safety issue for operators that are required to use isolators, in particular the bus section isolator, in the arrangement for switching purposes.

As noted above, maintenance on the feeder isolators, transformer isolators and power transformers are conducted by transferring the substation load onto one bus-section through 11kV distribution switches and taking an outage of the other bus-section to conduct maintenance on all equipment in that section. This is currently achievable given the existing low demand on the substation. However if the load increases in the future this method will become unworkable.

Further, the congested layout of the 11kV busbar with minimal clearances and poor layout heightens the risk that an error could be made during maintenance or an emergency situation resulting in an arc-flash or electrical safety incident.

The risks and issues noted above are due to the design of the busbar arrangement and thus it is recommended that a new busbar with standard clearances and a double isolator arrangement or preferably a bus-section breaker be considered.

Refer to Appendix A for further detail of the condition of the 11kV busbar equipment.

3.1.4 AUXILIARY TRANSFORMERS

The primary auxiliary supply is provided by an 11kV/415V 25kVA transformer manufactured by Standard Waygood in 1968 which is located on the 11kV busbar. Backup supply is from a 33kV/415V 63kVA transformer manufactured by Tyree in 2006 which is located in the 33kV Transformer No. 2 bay. The 33kV/415V unit appears to be in reasonable condition however, the 11kV /415kV unit is suffering from significant corrosion damage. Therefore, this transformer should be replaced in the short-term.

Further, the two auxiliary transformers have different phase rotations which causes delays during changeover. This should be corrected if either or both of the auxiliary transformers are replaced.

3.1.5 METERING CUBICLE

The metering equipment is located in a cubicle in between the two power transformers. The cubicle exterior is rusted and is suffering from severe corrosion damage. One of the door latches is broken and cannot effectively keep the door closed.

Therefore, it is recommended that this cubicle is replaced in the short term and or the metering equipment be relocated.

3.1.6 STATION BATTERY

There is one main station battery bank that contains sealed lead acid cells and a battery charger. This equipment was commissioned in 2015, is in good condition and has no current renewal needs.

The dc supply equipment is located in the protection control room. Any major redevelopement works at the substation should include relocating the battery into a separate battery room or enclosure with suitable ventilation to current standards to improve its security and to improve safety in the control room. The works should also include installling a second battery bank at the substation to provide security of the dc supply and avoid reliability risks as per the substation design instruction SDI510 [2].

3.1.7 PROTECTION SYSTEMS

The power transformers are currently protected by transformer differential protection. This scheme was installed in 2013 and is in good condition. However, the scheme does not include circuit breaker fail protection as there is no 33kV busbar or associated bus-section or feeder breakers. If the 33kV transformer breakers fail to clear a transformer fault the upstream 33kV recloser 35174 in the sub-transmission network is required to clear the fault. However, this recloser will not detect high impedance transformer faults which will result in the fault remaining until it evolves into a more serious incident which could lead to a fire in the transformer.

This is not an unusual situation for small rural substations such as Sussex Inlet. Notwithstanding this, the inclusion of a 33kV fault thrower, a feeder circuit breaker and/or a 33kV busbar to allow for circuit breaker fail protection to be implemented should be considered as part of any major redevelopment of the substation.

Further, as noted above, there are no transformer 11kV circuit breakers. In the event of a transformer fault the 33kV circuit breaker operates with no effective isolation on the 11kV side which requires the 11kV busbar to be operated split so that there is no risk of the other transformer back-feeding the fault.

The 11kV feeders are protected by reclosers and without 11kV transformer circuit breakers there is no opportunity for high speed breaker fail protection. Backup 11kV protection is provided by 11kV current transformers on the secondary of the power transformers which are connected to the 33kV transformer overcurrent protection and the 33kV transformer breaker. As a result, the 33kV transformer breaker will clear distribution feeder faults if an 11kV recloser fails to operate. However, due to the need to grade with the 11kV protection, the back-up protection is slow resulting in an increased arc-flash and earth potential rise safety risks for workers and the public.

Given this risk, any new 11kV arrangement should include transformer and feeder circuit breakers and an 11kV breaker fail protection scheme to provide reliable high speed back-up protection for distribution feeder faults in line with existing program PS012 – *Distribution feeder safety improvement* [3] which is being implemented in zone substations throughout the network.

3.1.8 SCADA AND COMMUNICATIONS SYSTEMS

The SCADA system includes a Megadata MD1000 RTU with distributed DIU's. The equipment was installed in 2006 and is expected to reach the end of its effective life within five years due to aging of its components and unavailability of replacement parts. Therefore, any major renewal works to the control building should consider replacing the SCADA system.

3.1.9 CONTROL BUILDING

The control building was built in 1987 and houses the protection and control equipment. It is of a simple sheet metal construction on a concrete slab with penetrations for the control cables. The roof is suffering from corrosion and there is damage to the sealing. The building is also subjected to flooding during storms. Further, the building has poor sealing and ventilation and provides poor protection to the equipment inside.

Therefore, it is proposed that the building should be renewed in the short term.

3.1.10 OVERALL SUBSTATION CONDITION

In summary, the condition of the 33kV equipment and power transformers at Sussex Inlet Zone Substation is satisfactory apart from the 33kV busbar support structures. However, there are risks associated with the 11kV outdoor busbar and control building which indicate that they should be retired and/or replaced in the short-term.

3.2 SUBSTATION CAPACITY

The firm capacity of the two power transformers at Sussex Inlet ZS is 15MVA compared to a current summer peak demand of 7.5MVA and a winter peak of 5.9MVA.

These peak demands are forecast to increase modestly over the next 10 years reaching 7.9MVA in summer and 6.4MVA in winter (with a 50% probability of being exceeded (POE)) by the end of the forecast period. This is due to residential development to the east of the substation which is currently expanding.

Any significant increase in demand beyond that period is likely to come from development of a town centre to the north of the substation. This may trigger the need for an increase in transformer firm capacity towards 25MVA in the longer term. However, the existing transformers have adequate capacity for the 10 year forecast demand period. The load forecasts for Sussex ZS (for a 50% POE) for the summer and winter peak periods are shown in Table 2 and Table 3 below.

TABLE 2 - SUMMER PEAK DEMAND FORECAST SUMMARY

Forecast	Actual demand			Forecast diversified demand (50% POE and temperature corrected)									
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MVA	4.9	5.2	7.5	8.0	8.0	8.0	8.0	8.0	7.9	7.9	7.9	7.9	7.9

TABLE 3 - WINTER PEAK DEMAND FORECAST SUMMARY

Forecast	Actual demand			Forecast diversified demand (50% POE and temperature corrected)									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
MVA	5.2	6.1	5.9	6.0	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.4

3.3 33KV SUB-TRANSMISSION ARRANGEMENT

Sussex Inlet ZS is supplied at 33kV from West Tomerong TS via Tomerong ZS. It has a single feed from Feeder 7526 which has a summer rating of 14.1MVA and a winter rating of 23MVA. This provides adequate capacity for the 10 year forecast demand period. However, greater capacity from this feeder as well as a second feeder to provide firm capacity may be required beyond the forecast period when the future town centre is established.

3.4 11KV FEEDER REQUIREMENTS

Sussex Inlet ZS currently supplies four 11kV distribution feeders. This is adequate for the 10 year forecast period however, any redevelopment works involving the 11kV equipment should consider future development beyond this period as noted above.

To this end it is recommended that any redevelopment provide for 4 x 11kV feeders in the short term and allow for or provide for a further four feeders in the future. It is also recommended that the switchgear is adequately rated to facilitate an augmentation of the substation to a firm 25MVA transformer capacity in the future.

3.5 ENVIRONMENTAL REQUIREMENTS

Currently the adjacent properties to Sussex Inlet ZS are commercial and industrial developments. However, residential development is being undertaken on the other side of the road to the substation.

As discussed in section 3.1.1, an environmental noise impact study was conducted by consultants Day Design Pty Ltd to investigate the environmental noise impact of Sussex Inlet ZS in August 2013 [3]. It was found that the substation currently complies with acceptable noise limits at the adjacent properties as set by the NSW Industrial Noise policy. However, noise limits will be exceeded at the closest residential properties when the residential development across the road approaches the location of the substation.

Given the age of the transformers and the future expected increase of load (refer section 3.2) it is considered that noise mitigations options be considered as part of any redevelopment works but not necessarily be implemented until a later time when the impact on the substation of the residential development is clear and the capacity required from the power transformers is also clear. It may also be possible that the transformers are reaching the end of their life at that time which would favour the option of replacing them with low noise units to address the noise issue.

3.5.1 RISK ASSESSMENT

Table 4 below is based on the Company's risk assessment procedure, Board Policy 2.0.5 and assesses the principal risks presented by the assets in Sussex Inlet Zone Substation. This table summarises the most significant risks which will need to be addressed to reduce the risk presented by the substation assets to ALARP.

This risk assessment is qualitative, refer to section 3.5.2 below for a quantitative assessment of the risk costs associated with each of the risk elements.

TABLE 4 – RISK ASSESSMENT

Asset	Event	Likeli-hood	Impact	Risk rating	Consequence and comments	Proposed treatment	Expected risk after treatment
11kV busbar	Mechanical failure during switching	Possible (C)	Major (4)	**High (C4)**	Operator receives arc flash injuries while switching bus-section isolator, due to the failure of the isolator	Replace with new arrangement with double isolators or bus section breaker	Low (A2)
	Mechanical failure of 11kV busbar	Possible (C)	Moderate (3)	Medium (C3)	Bar failure due to hot joints and corrosion and lack of bus-section breaker will result in loss of supply to all of the connected customers.	Replace 11kV busbar	Low (A2)
11kV busbar	Safety incident at 11kV busbar	Possible (C)	Major (4)	**High (C4)**	Maintenance operator or operator accidently comes within clearance of live busbars due to error and the poor clearances and congested layout of the 11kV busbars. Arc-flash and or electrical injury result.	Replace busbar with an arrangement with appropriate clearances, safe layout and high speed protection	Low (A1)
11kV protection	Arc-flash or EPR safety incident in distribution network	Unlikely (D)	Major (4)	Medium (D4)	Worker or the public receive additional injury due to a fault, with failure of the primary 11kV protection and due to the slow back-up protection arrangement	Install 11kV feeder and TX CBs, duplicate relays (and dc system) and breaker fail protection scheme (as per program PS012)	Medium (E4)
Protection & control equipment	Failure to operate due to poor control building environment	Possible (C)	Major (4)	**High (C4)**	Failure to clear transformer fault resulting in fire in transformer and loss of both transformers. Other less likely consequences include, ignition of a bush fire and injury to personnel.	Improve control building sealing, ventilation and drainage to reduce the likelihood of the event occurring. Provide fire walls between the transformers to limit the consequences of the event.	Low (A2)
33kV CBs	Failure to operate on high impedance transformer fault	Rare (E)	Major (4)	Medium (E4)	Failure to clear transformer fault resulting in fire in transformer and loss of both transformers. Other less likely consequences include, ignition of a bush fire and injury to personnel.	Provide CB fail protection to reduce likelihood of the event occurring. Provide fire walls between the transformers to limit the consequences of the event.	Low (A2)
33kV support structures	Mechanical failure	Possible (C)	Minor (2)	Medium (C2)	33kV bar failure resulting in outage of one transformer and connected customers	Replace support structures	Low (A2)

This assessment confirms that the principal risks which need to be addressed at Sussex Inlet ZS are the safety issues surrounding the 11kV busbar with lower risks associated with the control building and the 33kV protection.

3.5.2 RISK COSTS

The estimated cost of each of the risks noted in Table 4 are quantified in Table 5 below. Costs are in real FY18 terms and are based on the likelihood of the event occurring and the estimated financial impact of all of the consequences relevant to that event (not just the most significant consequences). These costs are shown on an annual basis for the FY18 year and are generally expected to increase over time if not addressed, as noted in the table.

Terms used in the assessment and shown in the summary in Table 5 include:

- Likelihood of event (LoE) occurring in any one year;
- Consequence of event (CoE) – a description of the consequence and behind that is an estimated cost of that consequence such as the value of statistical life (VSL) or value of customer reliability (VCR) to enable an assessment of the value of the risks on a financial basis;
- Likelihood of the consequence occurring (LoC) when the event occurs (in any one year);
- Disproportionality factor (DF) – the additional amount that is considered appropriate to spend to address the risk. DF is high for safety risks and low for reliability and other purely monetary risks (such as equipment damage)
- Cost of the consequence (CoC) – an estimated equivalent cost of each consequence on an annual basis taking into account the initial consequence cost, likelihood of the occurrence and disproportionality factors.

Refer Appendix F for further detail of the risk cost assessment including the supporting spreadsheet calculations and key assumptions used.

TABLE 5 – RISK COST ASSESSMENT

Event	LoE (% pa)	Consequence	LoC (% pa)	DF	CoC ($)	Comments
Mechanical failure of 11kV busbar	9	Operator receives third degree burns	10	10	1,900,000	
Safety incident at 11kV busbar	2.14	Worker comes within clearances and receives third degree burns	100	10	4,600,000	
Arc-flash or EPR safety incident in distribution network	0.14	Worker exposed to serious arc-flash	100	10	66,000	PS012 calculation
		Bushfire initiated		1	101,000	PS012 calculation
Failure of TX protection to operate due to poor control building environment	0.2	Damage to plant	10	1	7,500	
		Loss of supply to the substation's customers for	10	1	38,100	
		Safety incident for workers in the substation	0.1	1	100	
Failure of 33kV CB to operate on high impedance TX fault	0.2	Damage to plant	10	1	1,500	
		Loss of supply to the substation's customers for	10	1	7,600	
		Safety incident for workers in the substation	0.1	1	20	
Mechanical failure of 33kV support structures	10	Loss of 1 section of 11kV busbar – loss of supply to customers	100	1	226,800	
Total ($) (rounded to nearest $10,00)					**6,990,000**	

3.5.3 CONCLUSION

The safety risks associated with the 11kV busbars and associated equipment due to their sub-standard clearances and congested arrangement and their poor condition represent the highest risk cost by a significant margin and therefore the project should focus on addressing these risks. As a result of the risk assessments it is recommended that action be taken to address the risks presented by:

- The outdoor 11kV switchyard;

Further, if major works are undertaken in the substation, consideration should be given to:

- Replacement of the control building;

- Replacement of the 33kV support structures in the transformer bunds;
- Replacement of the SCADA RTU;
- Installation of fire walls between the power transformers;
- The provision of 33kV CB failure protection; and
- The provision of an 11kV primary protection failure scheme.

4.0 RENEWAL OPTIONS

The options considered to address the asset and network needs identified at Sussex Inlet Zone substation include:

- Do nothing;
- Non-network options including demand management strategies;
- Refurbishment of the existing 11kV busbar;
- Construction of a new outdoor 11kV busbar;
- Construction of a new control building with indoor 11kV switchgear; and
- Construction of a new control building with indoor 33kV and 11kV switchgear.

4.1 DO NOTHING

This option will not satisfy the renewal needs of the 11kV busbar and control building and will give no assurance that the risks presented by Sussex Inlet ZS are ALARP. Therefore this option is rejected as being inadequate.

4.2 NON NETWORK OPTIONS

The equipment in consideration for renewal at Sussex Inlet ZS is the 11kV busbar and control building. This equipment is required at the substation as long as there is a need for the substation itself at the existing site. As discussed in section 3.2 the current peak demand on the substation is 9.7MVA and therefore a permanent reduction of 9.7MVA will be the required to be provided by non-network solutions to allow the substation to be decommissioned and so avoid the need for renewal works at the substation.

An assessment of the level of demand that may be reduced in the Sussex Inlet ZS supply area by implementing demand management strategies such as reducing swimming pool and air-conditioning loads during peak demand periods indicates that the maximum potential demand reduction available is 1.4MVA. Table 6 below summarises the assessed demand management opportunities in the Sussex Inlet ZS supply area.

TABLE 6 – POTENTIAL DEMAND REDUCTION

Area	Customers/loads	Take-up rate/Conversion rate	Potential demand reduction (kVA)
Residential - PeakSaver	3,253 customers	8% @ 1.7kVA	442
Residential - CoolSaver	3,253 customers	8% @ 1.3kVA	338
Residential - SolarSaver	3,253 customers	2.8% @ 2kVA	182
Industrial/Commercial	2.3 MVA	10% to 20%	up to 460
Total			**1,422**

Therefore, there is insufficient permanent demand reduction available in the Sussex Inlet ZS supply area to meet the level required and non-network options are considered not feasible for this site.

This project is the subject of a RIT-D assessment and a RIT-D non-network screening test that considers the option of retiring the substation completely and reducing its capacity as an alternative to undertaken renewal works in the substation is currently being prepared. However, it is expected that the non-network approaches will not be feasible due to the low cost of the asset renewal solutions compared to the cost of provision for the demand currently provided by the substation by non-network means.

4.3 NETWORK OPTIONS - RENEWAL STRATEGIES

The network options available for renewing the assets in question include:

- Refurbishment of the existing 11kV busbar;
- Construction of a new outdoor 11kV busbar;
- Construction of a new control building with indoor 11kV switchgear; and
- Construction of a new control building with indoor 33kV and 11kV switchgear.

4.3.1 REFURBISH 11KV BUSBAR

This option proposes to maintain the existing 11kV switchyard arrangement and to address the bus-isolator issues by installing a bus-section circuit breaker bay cabled to the ends of the two bus sections making the existing bus-section isolator redundant.

The 11kV transformer bays could also be modified to include circuit breakers. This will allow all equipment in the arrangement to be effectively maintained and provide operational flexibility to run the substation with a solid 11kV busbar as required.

The corrosion of the busbar support structures would be repaired by cutting out the corroded sections and welding in new sections and by paint treatment.

The 11kV/415V auxiliary transformer would also be replaced.

Whilst this option is technically feasible, it is a short-term patch-up approach which does not address the safety risks presented by the poor clearances and congested design of the existing 11kV busbar arrangement. Accordingly, it is not considered that this option reduces the risks posed by the substation to ALARP and therefore this option is not considered to be sufficiently adequate to warrant further assessment.

4.3.2 NEW OUTDOOR 11KV BUSBAR

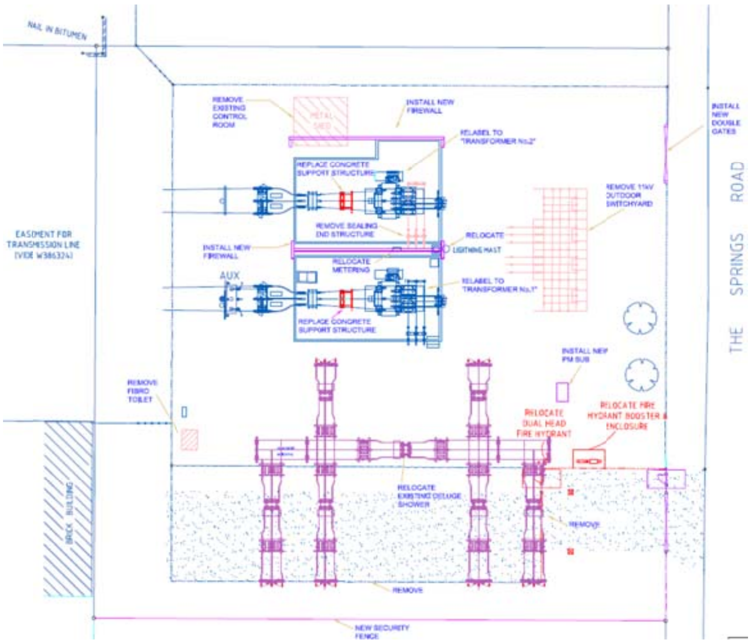
This option includes construction of a new 11kV busbar in the switchyard adjacent the existing 11kV busbar to replace the existing 11kV busbar.

The new design would include a bus-section circuit breaker, two transformer breakers and four feeder breakers. However, a new 11kV busbar with appropriate bay clearances to current standards will consume a large portion of the available space in the substation yard and will constrain any future augmentation of the substation that. This option does not provide for 33kV circuit breaker failure protection. A review of the options for providing this functionality concluded that it was not feasible to provide this functionality for this option due to space constraints in the substation switchyard.

Notwithstanding this, this option addresses the principal risks identified at the substation and is considered appropriate for further assessment.

A conceptual general arrangement of this option is shown in Figure 2 below.

FIGURE 2 – OUTDOOR 11KV BUSBAR



4.3.3 NEW 11KV CONTROL BUILDING

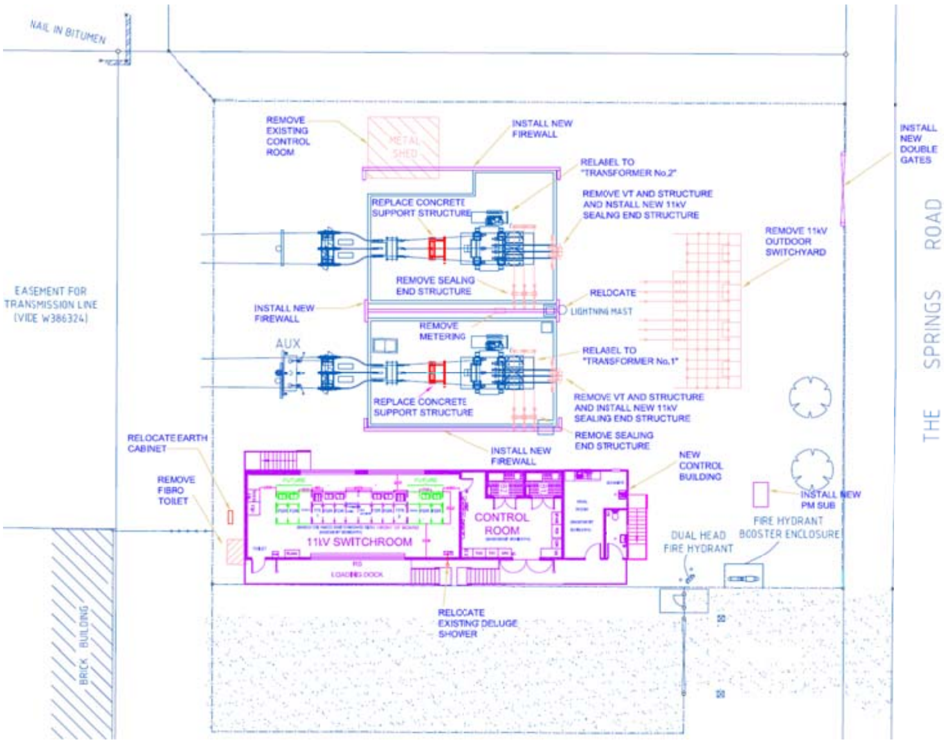
This option proposes to replace the existing outdoor 11kV arrangement with a new indoor switchboard in a new control building which will also include new protection and control and auxiliary equipment.

This option also does not provide 33kV circuit breaker fail protection due to space constraints in the substation switchyard.

Notwithstanding this, this option will address the 11kV busbar risks and the existing control building risks and is therefore considered appropriate for further assessment.

A conceptual general arrangement of this option is shown in Figure 3 below.

FIGURE 3 – 11KV CONTROL BUILDING



4.3.4 NEW INDOOR 33KV SUBSTATION

This option proposes to replace the existing outdoor 33kV and 11kV arrangements with new indoor 33kV and 11kV switchboards in a new control building which will also include new protection and control and auxiliary equipment.

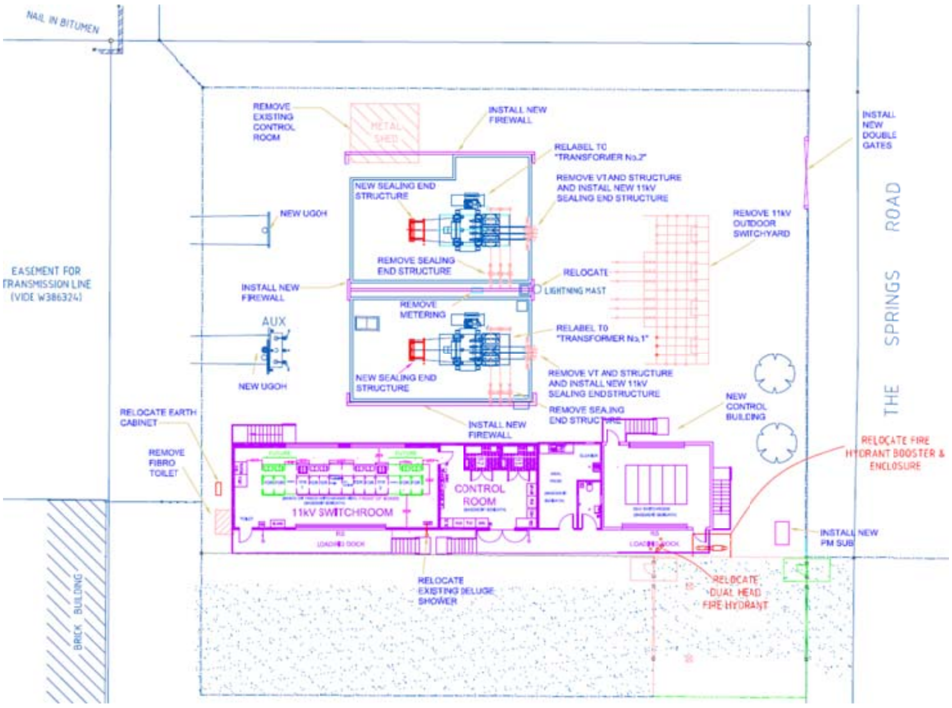
Further, it will also need to provide for the future needs of the substation which is likely to involve a second incoming 33kV feeder. This will require a 33kV busbar arrangement with two transformer breakers, one bus-section breaker, one feeder breaker and provision for a further 33kV feeder breaker.

The 33kV busbar will not be effectively utilised until the second feeder breaker is installed in the future. Until that time the substation will remain radially fed.

This option has the potential to address all of the risks identified at the substation and provides for 33kV circuit breaker failure protection but is likely to be significantly more costly than the new 11KV control building option. Notwithstanding this, this option provides additional benefits in converting the 33kV switchgear to an indoor arrangement and therefore will be further assessed against the other viable options.

A conceptual general arrangement of this option is shown in Figure 4 below.

FIGURE 4 – INDOOR SUBSTATION



4.4 RENEWAL OPTIONS UNDER CONSIDERATION

The scope initially proposed for the three network options which warrant further assessment as discussed above are summarised in Table 7 below.

TABLE 7 – REDEVELOPMENT OPTIONS

Option	Redevelopment works
Option 1 - New outdoor 11kV busbar	• Construct a new outdoor11kV busbar to the south of the existing busbar; • Install 2 x TX breakers, 1 x bus-section breaker and 4 x 11kV feeder breakers; • Install a new 11kV padmount auxiliary transformer; • Construct a small new control building; • Install new protection and control equipment, SCADA RTU and duplicated battery and dc system in the new control building; • Replace the two corroded 33kV support structures; • Install fire walls between and beside the two power transformers; • Demolish and remove the existing 11kV busbar and metering cubicle ; • Demolish and remove the existing control building including existing protection and control and auxiliary equipment.
Option 2 – New 11kV control building	• Construct a new control building on the southern side of the existing switchyard; • Install a new 11kV switchboard with 2 x TX breakers, 1 x bus-section breaker and 4 x 11kV feeder breakers (and space for a further 4) in the new building; • Install a new 11kV auxiliary padmount transformer; • Install new protection and control equipment, SCADA RTU and duplicated battery and dc system in the new control building; • Replace the two corroded 33kV support structures; • Install fire walls between and beside the two power transformers; • Demolish and remove the existing 11kV switchyard and metering cubicle; • Demolish and remove the existing control building including existing protection and control and auxiliary equipment.

Option	Redevelopment works
Option 3 – New indoor 33kV substation	• Construct a new control building to the south of the existing switchyard; • Install a new 33kV switchboard with 2xTX breakers, 1 x bus-section breaker and 1x 33kV feeder breakers (and space for an additional breaker); • Install a new 11kV switchboard with 2xTX breakers, 1 x bus-section breaker and 4 x 11kV feeder breakers (and space for a further 4) in the new building; • Install a new 11kV auxiliary padmount transformer; • Install new protection and control equipment, SCADA RTU and duplicated battery and dc system in the new control building; • Cable the 33kV feeder into the new switchboard; • Install fire walls between and beside the two power transformers; • Demolish and remove the existing 11kV switchyard, metering cubicle and 33kV structures; • Demolish and remove the existing control building including existing protection and control and auxiliary equipment.

4.5 OPTION COST ESTIMATES

Estimated costs for the above options are shown in Table 8 below.

TABLE 8 – OPTION COST ESTIMATES

Items	Option 1	Option 2	Option 3
Project definition, REF, project management	310,000	310,000	310,000
Outdoor 11kV bays			
Feeders	1,200,000	0	0
Bus-sections	100,000	0	0
Indoor 33kV bays			
Feeders	0	0	432,000
Bus-sections	0	0	240,000
Indoor 11kV bays			
Feeders	0	307,000	307,000
Bus-sections	0	94,000	94,000
Transformer bays			
Bays	0	460,000	776,000
Fire walls between and beside the power transformers	180,000	270,000	270,000
Building & switchyard			
Control building	1,760,000	3,130,000	3,630,000
Ancillary equipment			
11kV auxiliary switchboard, batteries & chargers, radio system, SCADA, UFCL	390,000	390,000	390,000
Additional costs			
Mains – transformer 11kV cables and auxiliary transformer cables	270,000	270,000	420,000
11kV distribution works – cables from the switchboard to the UGOHs	474,000	474,000	474,000
Storage of equipment	10,000	10,000	10,000
Demolition of 11kV busbar and control building	100,000	100,000	100,000
Relocation of lightning mast	10,000	10,000	10,000
Replacement of access gate	10,000	10,000	10,000
Installation of core balance CTs	12,000	12,000	12,000
Relocation of fire hydrant/ booster valve equipment	50,000	0	50,000
Replace 33kV busbar supports	20,000	20,000	0
Install 33kV overhead to underground structure	0	0	20,000
Total	**5,586,000**	**5,791,000**	**7,983,000**

Endeavour Energy

5.0 ASSESSMENT OF THE OPTIONS

In order to determine the preferred option, the identified options for addressing the renewal needs and risks of the substation have been assessed against a number of key risk indicators and for their present cost and value of benefits they provide versus the risk-costs they address.

5.1 TREATMENT OF RISK

The risk assessment categories include:

- Safety impact;
- Environmental impact;
- Construction risk;
- Operating and maintenance requirements;
- Reliability and supply security impact;
- Sustainability impact.

5.2 RISK RATINGS

Each of the viable options have been assessed against each other for each of the above risks as shown below. All risks are assessed based on the Company's risk assessment procedure, Board Policy 2.0.5 by assessing the likelihood and consequence of an event. Refer to Appendix F for further detail of the assessment.

5.2.1 SAFETY IMPACT

This indicator is applied to the final outcome of the project and also to the actual construction process itself. It is assumed that all equipment and procedures used by Endeavour Energy for all options will provide a safe work environment for staff and workers and will comply with the relevant safety standards. However, some options are inherently safe by design whereas others require more effort through the application of procedures and work methods to ensure safety. An option which is inherently safe will therefore achieve a lower risk score than an option which requires more effort to ensure it is safe.

All options remove the hazards presented by the poor condition of the 11kV busbar and control building. However, *Option 1* retains an outdoor arrangement with open air-insulated busbars and equipment. Also in this option construction of the 11kV circuit breaker bays will be close to the existing live 11kV switchyard which presents risks for workers which will need to be managed carefully. Therefore this option scores a poor rating for the safety impact indicator.

Options 2 and 3 however, provide a new indoor 11kV solution with fully enclosed and arc-fault contained switchgear with only the UGOH connections to the power transformers and the 33kV switchgear as the exposed live parts. These options will also provide improved design of access ways and avoidance of trip hazards which will provide a safer work environment than is possible with *Option 1*. *Option 3* also has the advantage of the 33kV switchgear being converted to an indoor arrangement. However, there is minimal 33kV switchgear in the existing 33kV arrangement which is retained in *Option 2* and will therefore show only a minor improvement in risk over *Option 2.*

5.2.2 ENVIRONMENTAL IMPACT

Environmental impacts apply to the finished substation as well as to the construction process. Environmental impacts may include:

- Noise impact;
- Visual impact and overshadowing;
- Effective control of oil leaks and spills and drainage off the site;
- Construction impact on neighbouring residents;
- Impact on the natural environment;
- Impact on public open spaces; and

- Traffic impacts.

Option 1 which retains the outdoor 11kV switchyard scores poorly due to its unappealing visual impact compared to the new indoor arrangements provided by *Options 2 and 3*.

Common to all options is the possible need in the future to reduce the noise emissions from the power transformers if and when current residential development encroaches on the substation.

5.2.3 CONSTRUCTION FEASIBILITY

Construction feasibility considers the risks to the cost and delivery schedule of the project due to issues surrounding the complexity of the construction procedures required. This will be affected by:

- Complexity of construction (number of temporary works required);
- Staging requirements for construction (number of basic construction stages);
- The extent of work in a live switchyard;
- The availability of space for construction works.

In *Option 1* the 11kV feeder and bus-section breakers will be built clear of the live equipment. However the transformer breakers will be built near the existing transformers and 11kV yard requiring restrictive work methods to ensure safety. Further, there will be space constraints in this option due to the clearance requirements for the new 11kV bays and the limited availability of space on the site. Further, the existing fire hydrant must be relocated. This will lead to accessibility issues with a subsequent risk of delays to the project.

In *Options 2 and 3* there are also no connections to the existing live equipment except during the final change-over works. There is also sufficient space to construct the new control building clear of the existing live equipment as it will require less space than an outdoor busbar allowing the works to be carried out in an efficient manner in a single stage. Therefore, these options present a very low construction risk and a lesser risk than *Option 1*.

5.2.4 OPERATING AND MAINTENANCE REQUIREMENTS

This indicator assesses the ongoing operating and maintenance requirements in terms of cost and resource demand and is influenced by issues including:

- The maintenance requirements of the equipment;
- The use of established and well understood equipment and procedures to reduce O&M risks;
- The flexibility of the substation arrangement for carrying out switching and maintenance tasks;
- The ease of access to the equipment for switching and maintenance tasks; and
- The susceptibility of the equipment to damage due to environmental or human factors such as lightning strikes, birds, storm damage and vandalism.

Option 1 retains an outdoor 11kV switchyard which presents an ongoing maintenance cost (and supply reliability) risk. The existing corrosion issues will be addressed in the short term, however, the new equipment will experience greater corrosion damage due to the outdoor arrangement than the indoor equipment in *Option 2 and Option 3*.

Option 2 removes the outdoor switchyard and replaces it with new indoor equipment with minimal maintenance requirements. Therefore this option presents a very low risk with respect to operating and maintenance costs.

Option 3 will provide 33kV circuit breaker fail protection. This will reduce the risk of a fire in a power transformer due an uncleared high impedance fault. Option 3 also replaces the 33kV outdoor equipment including the existing 33kV circuit breakers which are at risk of developing SF_6 leak issues due to their type and therefore scores the most favourably for this indicator.

5.2.5 RELIABILITY AND SUPPLY SECURITY RISK

This indicator considers the risk posed to the reliability of the supply to customers and the security of the supply provided by the substation (at 11kV busbar level) during the development works and also by the completed asset.

When complete, *Option 1* retains an outdoor 11kV switchyard and therefore is exposed to the risk of unplanned outages in the event of storm damage, lightning strike, birds and possums on the busbars and vandalism. There is also the risk of an inadvertent trip of the 11kV busbar due to the work taking place in close proximity to the live busbars.

Options 2 and 3, involve construction of an indoor 11kV substation in an area clear of the existing substation which significantly reduces the risk of an inadvertent trip of the substation during the construction period. Further, indoor equipment will reduce the risk of loss of supply due to equipment failure when compared to the outdoor 11kV equipment in *Option 1*. *Option 3* minimises this risk further by including indoor 33kV switchgear.

5.2.6 SUSTAINABILITY IMPACT

This indicator considers the energy and resource use during construction and also for the life-cycle of the asset. It also considers how well the option supports the business objective of strategically managing the network (ie to avoid future bottle necks in resource demand). This indicator includes consideration of:

- Provision for the future needs and/or further development of the substation as may be required in the future;
- Minimisation of returns to the site for additional work;
- Utilisation of assets;
- Provision for reuse of redundant equipment;
- Minimisation of usage of materials (as compact as practicable);
- Minimisation of wastage of materials and resources (temporary works); and
- Minimisation of the ongoing use of energy.

Option 2 and *Option 3* renew the aged assets in the substation and provide sufficient space for future switchgear extensions and transformer replacements if required. Accordingly, these options present a low risk in terms of the sustainability indicator.

However, in *Option 1* there will only be sufficient space around the new 11kV switchyard for two extra feeder circuit breakers. Any more circuit breakers will have to be installed in the vicinity of the existing 11kV switchyard. These bays will need to be cabled from the switchyard. This will compromise space required to replace the transformers and 33kV equipment if and when required in the future. Therefore this option presents risks for future works at the site and scores poorly for the sustainability indicator.

5.2.7 SUMMARY OF RISKS

Based on the above analysis Table 9 below gives a visual representation of the risks presented by each of the options. It shows that *Option 2* and *Option 3* provide improvements to safety, environmental impact, construction feasibility and customer reliability and a significant improvement in sustainability compared to *Option 1*. The operating and maintenance risk is higher in *Option 1* than *Option 2,* however, they are both considered moderate risks while *Option 3* scores a low risk for this indicator.

TABLE 9 – SUSSEX INLET ZS QUALITATIVE RISK ASSESSMENT

Option	Option detail	Safety	Environment	Construction	Operating & maintenance	Reliability	Sustainability
1	New 11kV busbar						
2	New 11kV control building						
3	New indoor 33kV substation						
Code	Extreme risk	High risk	Moderate risk	Low risk			

Accordingly, Option 3, which includes constriction of a new control building with a new 33kV and 11kV switchgear, is the preferred redevelopment approach from a risk perspective.

5.3 NET PRESENT COST OF OPTIONS

The present cost of each option has been assessed including the initial capital costs and the present value of future capital expenditure on development works. The assessment assumes the substation will require augmentation to a firm capacity of 25MVA with a second 33kV feeder and a 33kV busbar in 15 years. It further assumes that, due to the space constraints, the new 33kV busbar will be indoors effectively implementing Option 3 arrangement discussed above.

The assessment covers a common 45 year period including the residual value at the end of the period of capital investments made during the period and is summarised in below. Refer to Appendix F for further detail of the present cost analysis.

TABLE 10 – PRESENT COST OF OPTIONS

Proposed works	Initial cost ($M)	All costs ($M)	Estimated year of expenditure	Present cost ($M)
Option 1				
Initial redevelopment works	5.59	5.59	2018 - 2021	5.59
Future indoor 33kV redevelopment		6.61	2033	3.45
Safety risk of workers coming within clearances of the 11kV busbars and associated switchgear		0.21 per year	2018-2033	2.30
Total present cost				**11.34**
Option 2				
Initial redevelopment works	5.79	5.79	2018 - 2021	5.79
Future indoor 33kV redevelopment		5.81	2033	3.03
Safety risk of the outdoor 11kV is eliminated by installing indoor vacuum switchgear		-	-	-
Total present cost				**8.82**
Option 3				
Initial redevelopment works	7.93	7.93	2018 - 2021	7.93
Future indoor 33kV redevelopment		3.86	2033	2.01
Safety risk of the outdoor 11kV is eliminated by installing indoor vacuum switchgear		-	-	-
Total present cost				**9.95**

5.4 PREFERED OPTION

As shown in the discussion and tables, Option 2 provides a significant reduction in risk compared to Option 1 for a modest increase in initial capital cost. Furthermore, Option 2 provides the lowest present cost of the three options when the safety risk cost of the outdoor 11kV assets in the substation is taken into account.

Option 3 provides a similar reduction in risk as Option 2 but at a higher initial capital cost and a higher overall present cost.

Therefore, Option 2 is recommended as the preferred approach to address the risks and renewal needs at Sussex Inlet Zone Substation.

6.0 PREFERRED REDEVELOPMENT OPTION

6.1 PREFERED OPTION DETAILS

This project includes replacement of the 11kV busbars and other minor elements of the substation including:

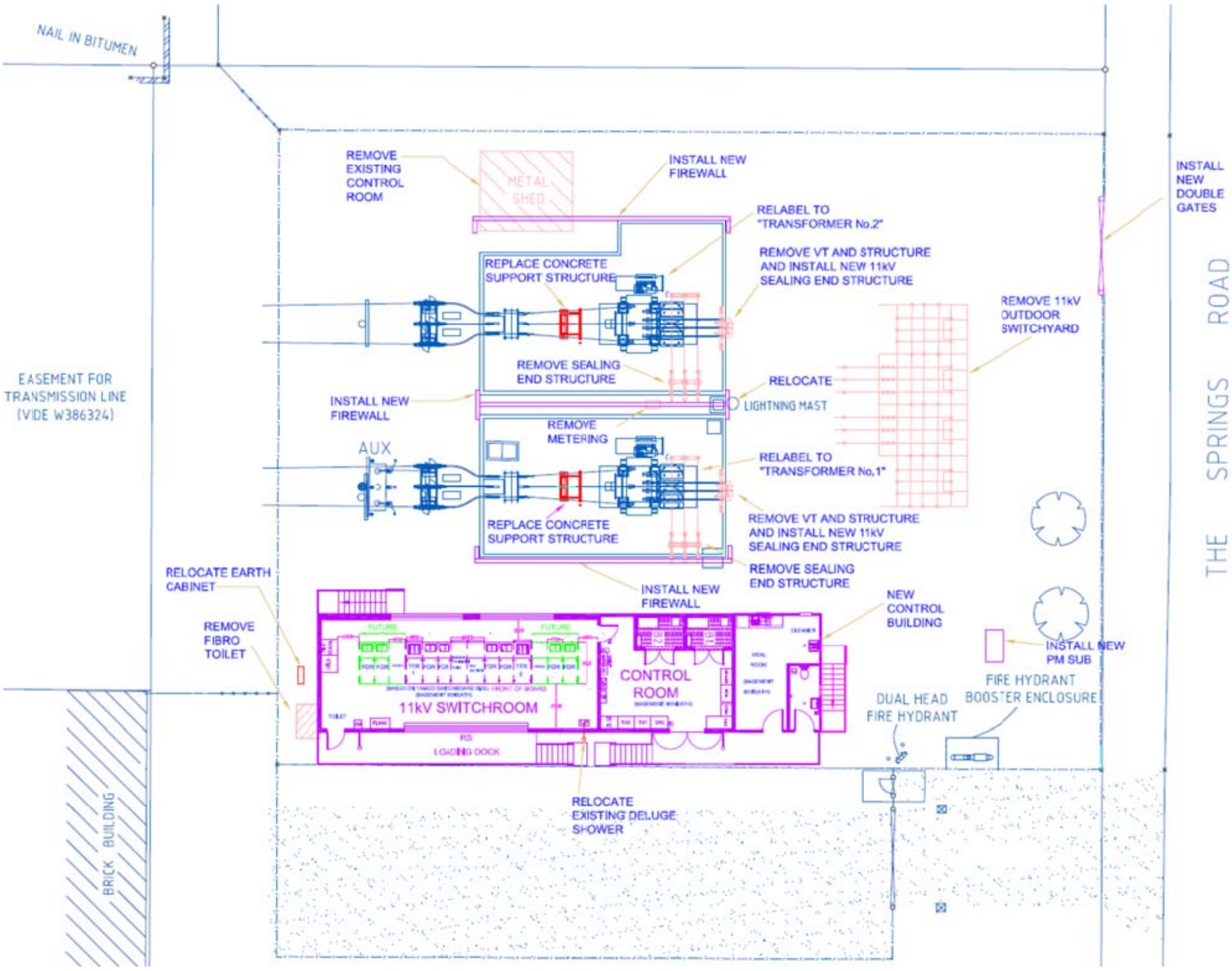
- Construction of a new control building with new indoor 11kV switchgear, auxiliaries and protection and control equipment;
- Installation of a new 11kV auxiliary padmount transformer;
- Replacement of the 33kV support structures in the transformer bunds;
- Installation of firewalls between and beside the two power transformers;
- Other minor refurbishment works in the substation (such as raising TX No. 1 control box, replacing corroded operator earth mats, 33kV low busbar barrier, faded safety signage);

- Demolition and removal of the existing 11kV busbar and associated switchgear; and
- Demolition and removal of the existing control building including existing protection and control and auxiliary equipment.

The Regional Transmission Manager should be consulted as to whether removed equipment should be disposed of or placed in stores for re-use.

A conceptual general arrangement of the proposed works is shown in Figure 5 below.

FIGURE 5 – PROPOSED GENERAL ARRANGEMENT



7.0 PROJECT COSTS AND FUNDING

The estimated costs of the preferred option (Option 2) are summarised in Table 11 below. Refer Appendix G for further detail of the cost estimate. The costs are in real FY18 terms.

TABLE 11 - ESTIMATED PROJECT COST ($ REAL FY18)

Item	Base cost ($)
Project management	
Project definition, REF, project management	310,000
Indoor 11kV bays	
Feeders (4 of)	307,000
Bus sections (1 of)	94,000
Transformer bays	
Bays (2 of)	460,000
Fire walls (3 of - between and either side of the power transformers)	270,000
Building & switchyard	
Control building	3,130,000

Item	Base cost ($)
Ancillary equipment	
11kV auxiliary transformer, switchboard, batteries & chargers, radio system and SCADA, UFCL	390,000
Additional works	
Mains – transformer 11kV cables and auxiliary transformer cables	194,000
11kV distribution – cables from the switchboard to the UGOHs	474,000
Major equipment storage	10,000
Demolition of 11kV busbars and control building	100,000
Relocation of lightning mast	10,000
Replacement access gate	10,000
Installation of core balance CTs	12,000
Replacement of the 33kV busbar supports	20,000
Total	**5,790,000**

7.1 CONTINGENCY

The principal risks are reflected in Table 12 against the various functional activities or work packets required to implement the project. The principle contingency sum for the works includes unforseen site constraints leading to design modifications due to soil contamination including asbestos.

TABLE 12 - CONTINGENCY PROVISIONS ($ REAL FY18)

Item	Contingency provisions	
	Amount ($M)	Detail
Civil & building works	0.40	Soil contamination including asbestos and excessive rock
Distribution works	0.10	Soil contamination including asbestos and excessive rock.
Procurement/ Subcontract	0.10	Variations to equipment costs.
Total	**0.60**	

7.2 PROJECT FUNDING

Project TS155 - *Sussex Inlet ZS 11kV switchgear replacement* has a funding allocation of $10.5 million over the FY20 – FY22 years in portfolio investment plan PIP8.5. However, it is proposed to bring forward the commencement of the project to the 2017/18 year to address the safety risks posed by substation in a timely manner. Accordingly, it is proposed that the funding allocation in the PIP be re-phased via the change control process to provide funding from FY18.

TABLE 13: PIP 8.5 SUMMARY

PIP element	PIP rating
Project ID	TS155
Principal Driver	Renewal
Ranking	In top 96.88% of projects

The project is estimated to cost $5.8 million in real FY18 terms. The estimated delivery period is FY18 to FY20 with the expenditure spread shown in Table 14 along with the provision in the PIP8.5.

The total cost of the project in nominal terms is $6.0 million.

TABLE 14: PROJECT EXPENDITURE SPREAD

Expenditure spread ($M)	2017/18	2018/19	2019/20	2020/21	2021/22	Total
PIP 8.5 ($ nominal)			3.0	3.5	4.0	**10.5**
Project cost ($ real)	1.2	2.3	2.3			5.8
Project cost ($ nominal)	1.2	2.4	2.4			**6.0**
Contingency	0	0.3	0.3			**0.6**
Total costs ($ nominal)						**6.8**

8.0 RECOMMENDATIONS

It is recommended that:

- A capital expenditure of $6.0 million for the construction of a new control building with a new 11kV switchboard at Sussex Inlet Zone Substation over the FY18 – FY20 period as detailed in this business case be approved; and
- A contingency sum of $0.6 million to cover unforseen events be approved.

The complete project estimate, including the contingency sum totals $6.6 million.

9.0 APPENDICES

APPENDIX A – STATEMENT OF ASSET NEED

APPENDIX B – WEST TOMERONG SYSTEM DIAGRAM

APPENDIX C – EXISTING SUSSEX INLET ZONE SUBSTATION SINGLE LINE DIAGRAM

APPENDIX D – EXISTING GENERAL ARRANGEMENT

APPENDIX E – SUSSEX INLET ZONE SUBSTATION ENVIRONMENTAL NOISE ASSESSMENT

APPENDIX F – SUSSEX INLET ZONE SUBSTATION RISK ASSESSMENT

APPENDIX G – SUSSEX INLET ZONE SUBSTATION PROPOSED GENERAL ARRANGEMENT

APPENDIX H - TS155 COST ESIMATE

APPENDIX I – DISTRIBUTION WORKS

APPENDIX J - SUSSEX INLET ZONE SUBSTATION IMAGES

10.0 REFERENCES

[1] Asset Standards & Design, “Asset Class Condition - 33kV, 66kV and 132kV Circuit Breakers,” 2017.

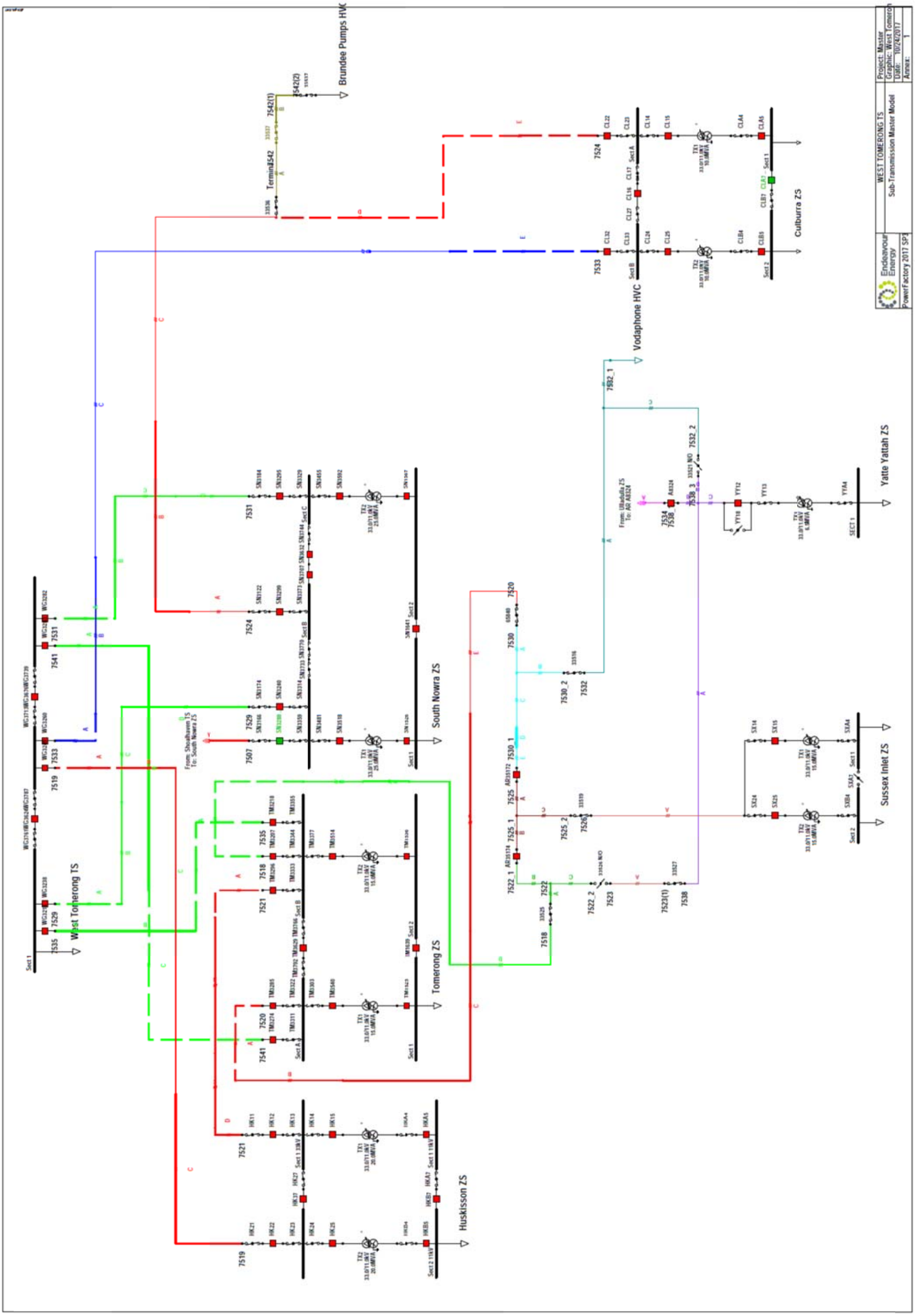
[2] Asset Standards & Design, “SDI 510 - Buildings,” 2016.

[3] Asset Strategy and Planning, “PS012 - Distribution Feeder Safety Improvement,” July 2017.

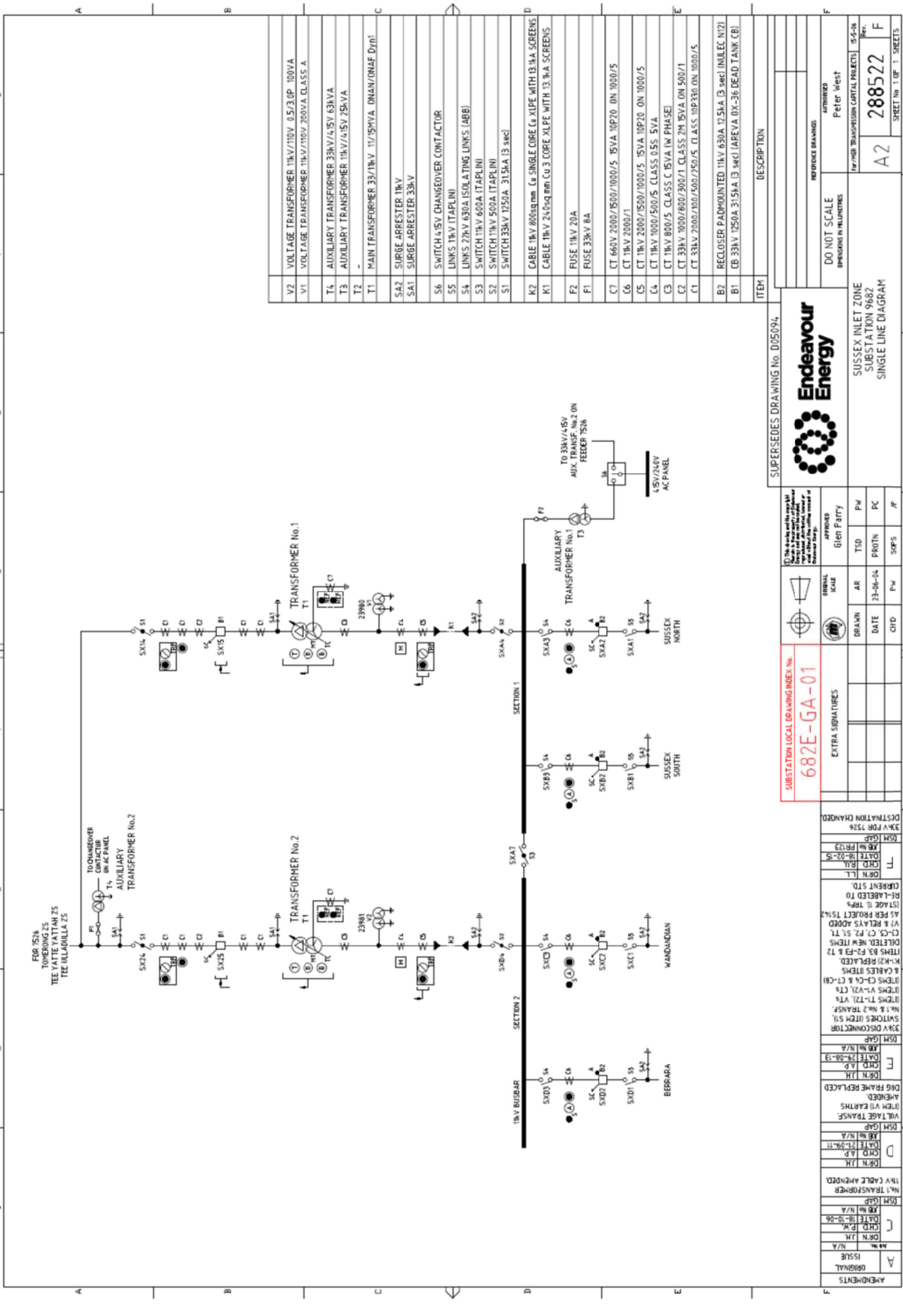
[4] Asset Standards & Design, “SDI 503 - Transmision and Zone Substation Fire Detection, and Suppression Systems,” 2014.

APPENDIX A – STATEMENT OF ASSET NEED

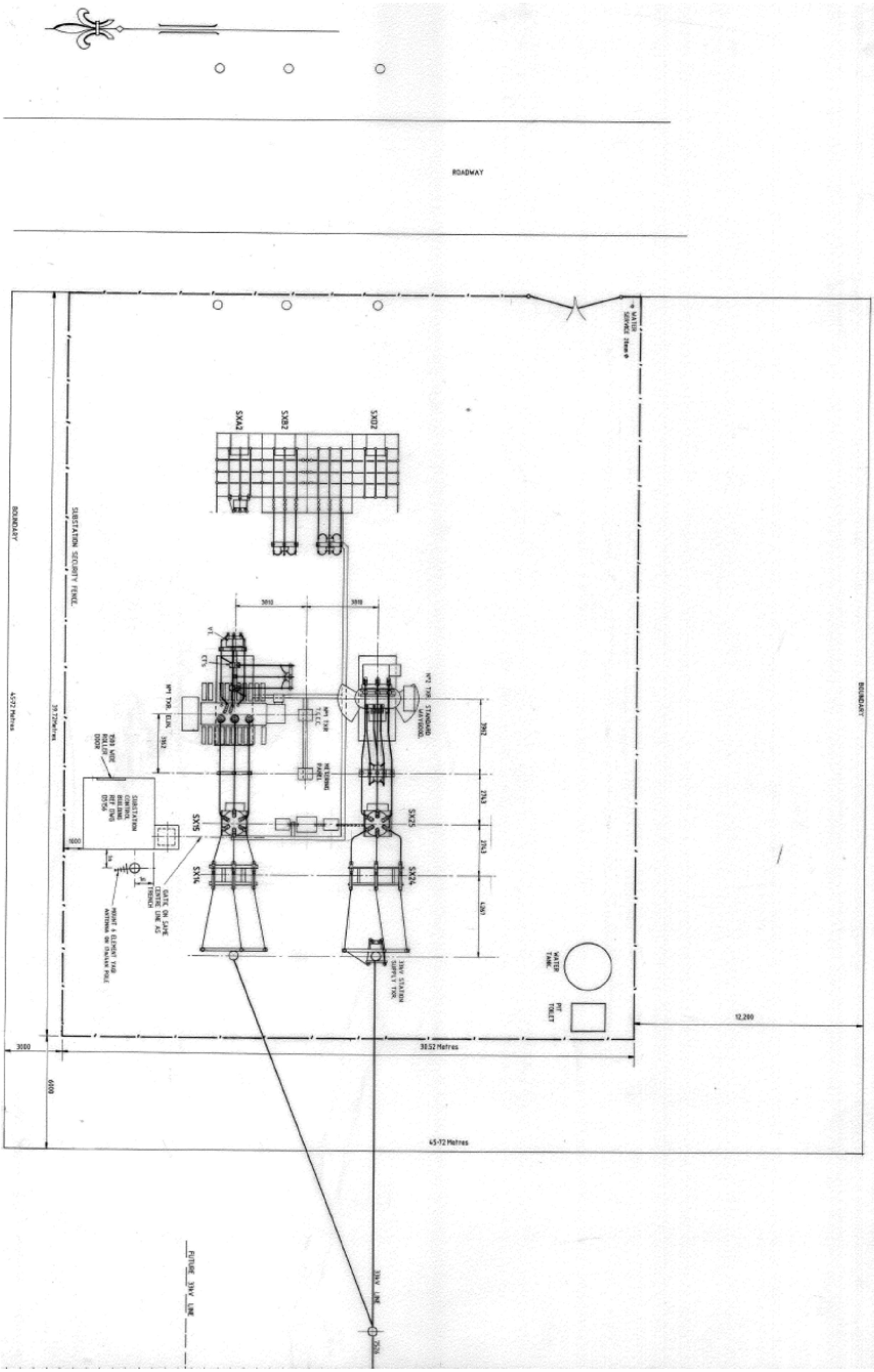
Sussex Inlet Zone Substation Statement of Asset Need, October 2017.


West Tomerong TS
South Nowra ZS
Tomerong ZS
Huskisson ZS
Sussex Inlet ZS
Yatte Yattah ZS
Culburra ZS
Vodaphone HVC
Brundee Pumps HVC

APPENDIX C – EXISTING SUSSEX INLET ZONE SUBSTATION SINGLE LINE DIAGRAM



Endeavour Energy


ROADWAY
12,200
3000
30.52 Metres
45·72 Metres

APPENDIX E – SUSSEX INLET ZONE SUBSTATION ENVIRONMENTAL NOISE ASSESSMENT

Environmental Noise Impact, Sussex Inlet Zone Substation at Sussex Inlet, NSW, Report No 4665-2, 9 August 2013

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ENVIRONMENTAL NOISE IMPACT
SUSSEX INLET ZONE SUBSTATION
AT SUSSEX INLET, NSW

REPORT NUMBER: **4665-2**

PREPARED FOR: Endeavour Energy Pty Ltd
PO Box 6366
Blacktown NSW 2148

Attention: Mr Stephen Douglas
Telephone: 4252 2838

DATE ISSUED: 9 August 2013

Report Status	**Prepared by:** William Wang	**Approved by:** Stephen Gauld
Final		

Document R\4665-r2, 12 pages plus attachments

TABLE OF CONTENTS

1.0 CONSULTING BRIEF

Day Design Pty Ltd was engaged by Endeavour Energy Pty Ltd to investigate the environmental noise impact of their Sussex Inlet Zone Substation at Sussex Inlet. This commission involves the following:

Scope of Work:

- Inspect the site and environs.
- Measure the background noise levels at critical locations and times.
- Establish the acceptable noise level criteria.
- Quantify noise emissions from the Zone Substation.
- Calculate the level of noise emission, taking into account distance attenuation and natural topography.
- Prepare a site plan identifying the development and nearby noise sensitive locations.
- Provide reasonable and feasible recommendations for noise control (if necessary).
- Prepare an Environmental Noise Impact Report.

2.0 PROJECT DESCRIPTION & SUMMARY OF FINDINGS

Endeavour Energy supplies electricity to the greater part of Sydney's west, the Blue Mountains, the Illawarra, the Shoalhaven and Southern Highlands regions. To sustain this service they have a number of Substations to convert high voltage electricity to standard 240 volt supply. The transformers used for the conversion typically generate a low frequency ‘hum’ at 100 Hz.

Sussex Inlet Zone Substation is located on The Springs Road, Sussex Inlet and has two 33 / 11 kV, 15 MVA transformers recently relocated from Nowra Zone Substation.

The Zone Substation is located in a commercial and light industrial area with commercial premises adjoining the site to the north, south and west. The nearest existing residence to the site is on the northern side of Sussex Inlet Road, approximately 300 metres to the north. Opposite the site to the east is vacant land, which is to be developed as a residential development in the future. Details of the proposed development are not known at this stage, however the closest potential lots are at a distance of approximately 40 metres from the existing transformers. The nearest commercial and residential premises and vacant residential land are shown on the attached site plan in Figure 1.

Ambient background noise measurements were carried out near to the vacant residential land and the results are detailed in Section 4 of this report.

Noise control measures have been recommended in Section 7 of this report to reduce the noise emission from the Sussex Inlet Zone Substation to comply with the NSW Environment Protection Authority’s Industrial Noise Policy guidelines at all future residences.

3.0 NOISE SURVEY INSTRUMENTATION

Noise level measurements and analysis were made with sound instrumentation as follows:

Table 3.1 Noise Instrumentation

Description	Model No.	Serial No.
Infobyte Noise Logger	iM4	105
Condenser Microphone 0.5” diameter	MK 250	3357

An environmental noise logger is used to continuously monitor ambient noise levels and provide information on the statistical distribution of noise during an extended period of time. The Infobyte Noise Monitor iM4 is a Type 1 precision environmental noise monitor meeting all the applicable requirements of AS1259 for an integrating-averaging sound level meter.

All instrument systems had been laboratory calibrated using instrumentation traceable to Australian National Standards and certified within the last two years thus conforming to Australian Standards. The measurement system was also field calibrated prior to and after noise surveys. Calibration drift was found to be less within 1 dB for long-term measurements. No adjustments for instrument drift during the measurement period were warranted.

4.0 MEASURED AMBIENT NOISE LEVELS

In order to assess the severity of a possible environmental noise problem in a residential area it is necessary to measure the ambient background noise level at the times and locations of worst possible annoyance. The lower the background noise level, the more perceptible the intrusive noise becomes and the more potentially annoying.

The ambient L_{90} background noise level is a statistical measure of the sound pressure level that is exceeded for 90% of the measuring period (typically 15 minutes).

The Rating Background Level (RBL) is defined by the NSW Environment Protection Authority as the median value of the (lower) tenth percentile of L_{90} ambient background noise levels for day, evening or night periods, measured over 7 days during the proposed days and times of operation (EPA, 2000).

The places of worst possible annoyance are future residences to be located on vacant land to the east of the Zone Substation. The times of worst possible annoyance will be during night time hours when ambient noise levels are typically at their lowest. Consideration is also given to the nearest existing residence and neighbouring commercial premises to the Zone Substation.

Ambient L_{90} background noise levels were measured at Location ‘A’ shown on the Site Plan over seven (7) days from Tuesday 19 July 2011 to Wednesday 27 July 2011. These levels are presented in the attached Figure 2 and also in Table 4.1 below.

Table 4.1 Rating Background Level

Noise Measurement Location	Time Period	Rating Background Level
Location ‘A’ –	Day (7am to 6 pm)	**34 dBA**
Ocean & Earth Factory,	Evening (6 pm to 10 pm)	**34 dBA**
The Springs Road, Sussex Inlet	Night (10 pm to 7 am)	**32 dBA**

Meteorological conditions during the testing consisted of heavy rain and strong winds for the majority of the week. Consequently weather affected data has been excluded from the results. Meteorological conditions during the final days of monitoring consisted of clear skies with negligible wind and this data has been used to determine rating background noise levels in the vicinity of the Zone Substation.

The rating background noise levels shown in Table 4.1 are consistent with a quiet, semi-rural location as is the case at The Springs Road, Sussex Inlet and are therefore considered reliable for the receptor area.

5.0 ACCEPTABLE NOISE LEVELS

5.1 NSW Industrial Noise Policy

The NSW Environment Protection Authority (EPA) published their Industrial Noise Policy in January 2000. The Industrial Noise Policy is specifically aimed at assessing noise from industrial noise sources scheduled under the Protection of the Environment Operations Act 1997 (POEO, 1997).

Sussex Inlet Zone Substation is not a 'scheduled premises' under the Protection of the Environment Operations Act 1997 as Endeavour Energy Pty Ltd is not required to hold a licence under that Act for operations at the site.

The appropriate regulatory authority may, by notice in writing given to such a person, prohibit the person from causing, permitting or allowing:

(a) any specified activity to be carried on at the premises, or
(b) any specified article to be used or operated at the premises,

or both, in such a manner as to cause the emission from the premises, at all times or on specified days, or between specified times on all days or on specified days, of noise that, when measured at any specified point (whether within or outside the premises,) is in excess of a specified level.

It is an offence to contravene a noise control notice. Prior to being issued with a noise control notice, no offence has been committed.

The Industrial Noise Policy provides a useful framework to assess noise emission from non-scheduled premises, whether that premises produces offensive or non-offensive noise.

The Protection of the Environment Operations Act 1997 defines "Offensive Noise" as noise:

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

    (i) is harmful to (or is likely to be harmful to) a person who is outside the premises from which it is emitted, or

    (ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulation.

The limits set out in the NSW Industrial Noise Policy were used as a guide for determining whether predicted levels of noise were considered offensive or not.

5.2 Residential Receptor Noise Intrusiveness Criteria

The EPA states in Section 2.1 of the Industrial Noise Policy that the L_{eq} level of noise intrusion from broad-band industrial noise sources may be up to 5 dB above the L_{90} background noise level at the receptor without being considered offensive.

The Rating Background Level at The Springs Road, Sussex Inlet was 32 dBA at night and 34 dBA in the evening and daytime. Therefore the acceptable L_{eq} noise intrusiveness criteria for **broadband noise** in this area are:

- (34 + 5 =) 39 dBA during the day and evening, and
- (32 + 5 =) 37 dBA at night.

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level. Correction factors may be applied to the noise intrusiveness criteria to determine the project specific criteria.

Each of the Nowra Transformers displays tonal characteristics and modifying factors are applicable and are presented in the attached Datasheet AC 500-9.

Therefore the acceptable L_{eq} noise intrusiveness criteria for **tonal and/or low frequency noise** in this area are:

- (34 + 5 – 5 =) 34 dBA during the day and evening, and
- (32 + 5 – 5 =) 32 dBA at night.

5.3 Residential Noise Amenity Criterion

Depending on the type of area in which the noise is being made, there is a certain reasonable expectancy for noise amenity. Table 2.1 of the NSW Industrial Noise Policy provides a schedule of recommended L_{eq} industrial noise levels that under normal circumstances should not be exceeded. If successive developments occur near a residential area, each one allowing a criterion of background noise level plus 5 dB, the ambient noise level will gradually creep higher.

Compliance with the Noise Amenity levels in Table 2.1 will limit ambient noise creep. For example in a rural residential area, the L_{eq} noise emission level may not exceed 50 to 55 dBA in the daytime (7 am to 6 pm), 45 to 50 dBA in the evening (6 pm to 10 pm) and 40 to 45 dBA during the night (10 pm to 7 am).

Wherever the existing L_{eq} noise level from industrial noise sources approaches or exceeds the Amenity criterion at a critical receptor location, the intrusive L_{eq} noise from the noise source in question must be reduced to a level that may be as much as 10 dB below the existing L_{eq} industrial noise level.

5.4 Commercial Receptor Noise Amenity Criterion

The L_{eq} intrusive noise level criterion at nearby commercial premises is 65 dBA.

5.5 Project Specific Noise Criteria

When all the above factors are considered, we find that the most stringent noise criterion is:

- **39 dBA** for **broadband noise** sources**,** and **34 dBA** for **tonal noise** sources during the day and evening; and
- **37 dBA** for **broadband noise** sources**,** and **32 dBA for tonal noise** sources at night.

These criteria apply at the most-affected point on or within the residential property boundary – or, if that is more than 30 metres from the residence, at the most-affected point within 30 metres of the residence. For upper floors, the noise is assessed outside the nearest window.

In addition, the following criteria also apply at the boundary of non-residential areas:

- **65 dBA** at nearby **commercial premises**

6.0 SUSSEX INLET ZONE SUBSTATION NOISE EMISSION

The main sources of noise from the Sussex Inlet Zone Substation are the transformers that operate continually throughout the day and night. The transformer noise level does not change appreciably from the day to the night and therefore the predicted noise level at night will be the worst-case scenario. Two transformers from Nowra Zone Substation have been relocated to the Sussex Inlet Zone Substation.

6.1 Measured Sound Power Levels

Day Design has measured the sound power level of each of the transformers located at the Sussex Inlet Zone Substation.

A schedule of the sound power levels is given in Table 6.1 below with the tonal components shown in bold, typically at 100 Hz and a harmonic at 200 Hz.

Table 6.1 Sussex Inlet ZS Transformer L_{eq} Sound Power Levels

Description	dBA	Sound Power Levels (dB) at Third Octave Band Centre Frequencies (Hz)						
		50	100	200	400	800	1k6	3k15
		63	125	250	500	1k	2k	4k
		80	160	315	630	1k25	2k5	5k
No 1 Transformer		67	**90**	**90**	74	73	64	55
33/11 kV, 15 MVA	**84**	68	72	73	75	67	61	50
(16% load)		72	70	**82**	77	66	61	48
No 2 Transformer		68	**91**	**90**	72	72	56	49
33/11 kV, 15 MVA	**82**	70	73	73	65	67	55	46
(5% load)		72	70	**82**	71	60	53	47

Knowing the sound power level of a noise source (see above Table 6.1), the sound pressure level (as measured with a sound level meter) can be calculated at a remote location using suitable formulae to account for distance losses, ground absorption, sound barriers, atmospheric effects, etc.

6.2 Predicted Sound Pressure Levels

Table 6.2 shows the predicted Sound Pressure Levels at nearby receptors.

Table 6.2 Predicted L_{eq} Sound Pressure Levels at Receptor Locations

Receptor Location	Acceptable Noise Level	Calculated Noise Level	Tonal	Compliance
Nearest Existing Residence 1023 Sussex Inlet Road	32 dBA	28 dBA	Yes	Yes
Vacant Residential Land Potential Nearest Residential Boundary	32 dBA	46 dBA	Yes	**No**
Northern Commercial Boundary Boundary of Zone Substation	65 dBA	56 dBA	Yes	Yes
South / West Commercial Boundary Boundary of Zone Substation	65 dBA	52 dBA	Yes	Yes

The predicted level of noise from the Sussex Inlet Zone Substation is below the acceptable noise limits at each of the nearest existing receiver locations. However, the noise emission from the transformers will exceed the acceptable noise limit of 32 dBA at the nearest future residences in the proposed residential development to the east of the site.

7.0 NOISE CONTROL RECOMMENDATIONS

The Sussex Inlet Zone Substation will meet the noise criteria at all existing residences and no noise controls are required.

However, for the future proposed residences of the adjacent subdivision, the extent of noise controls required will depend on the location of future dwellings, their height, any residential boundary screening, etc. Section 7.1 below provides recommendations for an assumed worst-case scenario of the proposed residences being two-storey buildings at a distance of 40 metres from either transformer.

7.1 Masonry Barriers

- Construct masonry barriers around each of the transformers to a minimum height of 1.5 metres above the main transformer tanks (approximately 6 metres from the ground);
- Masonry barriers should be constructed on the southern, northern and eastern side of each transformer without holes or gaps. (see Figure 3)
- Sound absorptive insulation on the inside faces of the masonry barrier (facing the transformer). The sound absorptive insulation should consist of 100 mm thick polyester insulation (density 32 kg/m^3) such as Tontine Acoustisorb fitted between 100 mm deep battens or purlins and faced with perforated galvanised steel (minimum open area 20%).

7.2 Predicted Noise Levels Following Noise Controls

Table 7.1 below shows the predicted noise level at each receiver location following the noise controls recommended in Section 7.1.

Table 7.1 Predicted L_{eq} Sound Pressure Levels at Receptor Locations – Following Noise Controls

Receptor Location	Calculated L_{eq} Noise Level	Tonal	Acceptable L_{eq} Noise Level	Compliance
Proposed Residential Subdivision Potential Nearest Lot Boundary	32 dBA	Yes	32 dBA	Yes

8.0 NOISE IMPACT STATEMENT

Provided recommendations made in Section 7 of this report are implemented, measurements and calculations show that the level of noise emitted by the Sussex Inlet Zone Substation will meet the Environmental Protection Authority's acceptable noise levels as outlined in the NSW Environmental Noise Policy.

We are of the opinion that sound emitted from this development will not cause "offensive noise" as defined by the Protection of the Environment Operations Act 1997.

William Wang, BE (Mechatronics), MIEAust., MAAS

Consulting Acoustical Engineer

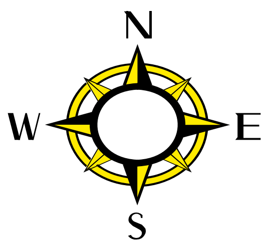
for and on behalf of Day Design Pty Ltd.

A.A.A.C. MEMBERSHIP
Day Design Pty Ltd is a member company of the Association of Australian Acoustical Consultants, and the work herein reported has been performed in accordance with the terms of membership.

Attachments:

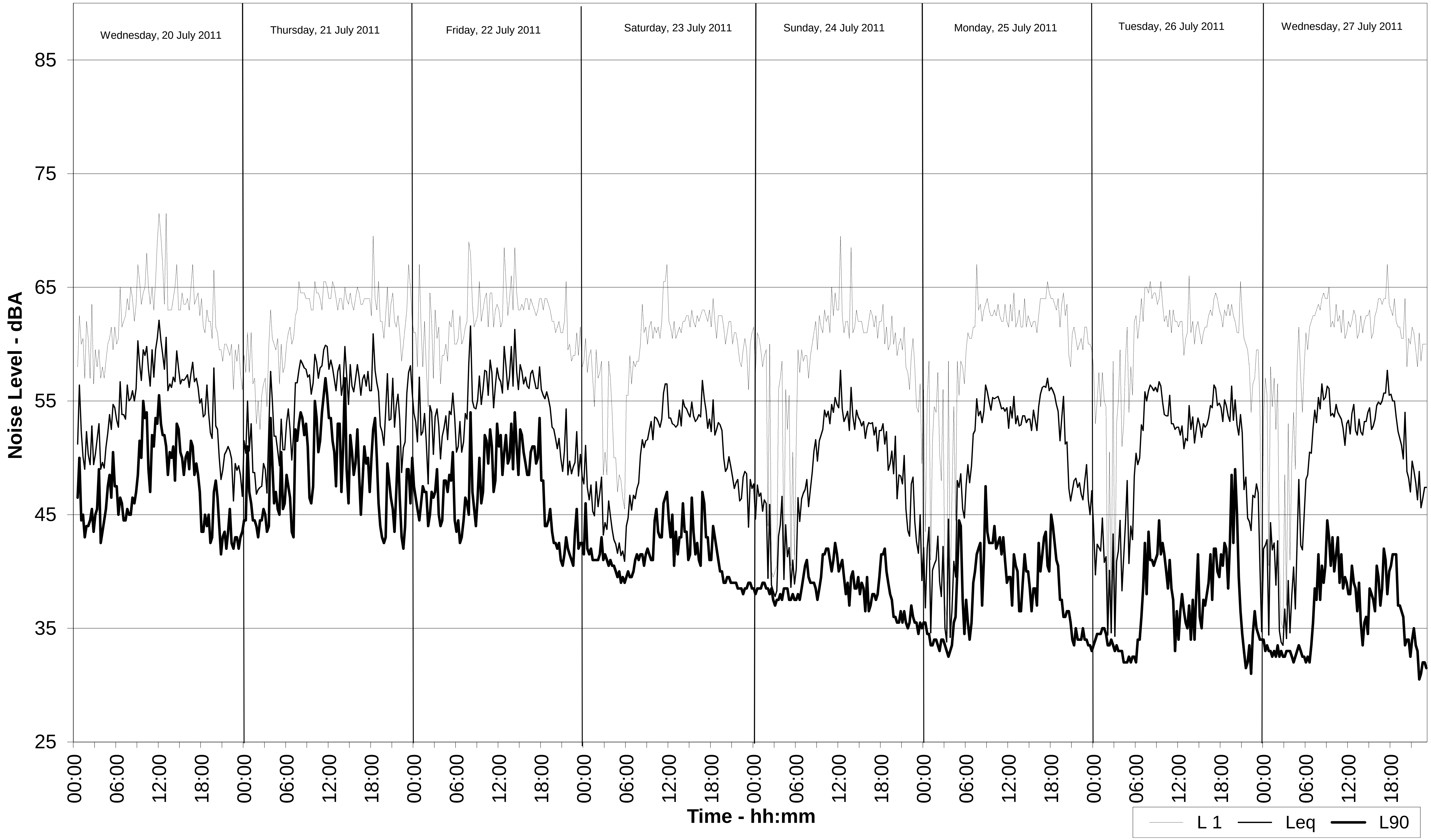
- Figure 1 – Site Plan
- Figure 2 – Ambient Noise Survey
- Figure 3 – Noise Control Recommendation
- AC 108-1 to 4 – Glossary of Acoustic Terms
- AC 500-9 – Modifying Factor Correction

DAY DESIGN	**Site Plan** **Sussex Inlet Zone Substation –** **Sussex Inlet, NSW**	**4665** **FIGURE 1**



Ambient Noise Survey

Located at Ocean and Earth Sussex Inlet Drive, Sussex Inlet, NSW



DAY DESIGN	Sussex Inlet Zone Substation Noise Control Options	4665-2 Figure 3

ACOUSTICAL – Pertaining to the science of sound, including the generation, propagation, effects and control of both noise and vibration.

AMBIENT NOISE – The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including road traffic, factories, wind in the trees, birds, insects, animals, etc.

AUDIBLE – means that a sound can be heard. However, there are a wide range of audibility grades, varying from "barely audible" to "just audible", "clearly audible" and "prominent". Chapter 83 of the NSW Environment Protection Authority – Environmental Noise Control Manual (1985) states:

"noise from a particular source might be offensive if it is clearly audible, distinct from the prevailing background noise and of a volume or character that a reasonable person would be conscious of the intrusion and find it annoying or disruptive".

It follows that the word "audible" in an environmental noise context means "clearly audible".

BACKGROUND NOISE LEVEL – Silence does not exist in the natural or the built-environment, only varying degrees of noise. The Background Noise Level is the average minimum dBA level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by cicadas, lawnmowers, etc. It is quantified by the L_{A90} or the dBA noise level that is exceeded for 90 % of the measurement period (usually 15 minutes).

- **Assessment Background Level (ABL)** is the single figure background level representing each assessment period – day, evening and night (i.e. three assessment background levels are determined for each 24hr period of the monitoring period). Determination of the assessment background level is by calculating the tenth percentile (the lowest tenth percent value) of the background levels (L_{A90}) for each period (Refer: NSW Industrial Noise Policy, 2000).
- **Rating Background Level (RBL)** as specified by the Environment Protection Authority is the overall single figure (L_{A90}) background noise level representing an assessment period (day, evening or night) over a monitoring period of (normally) three to seven days.

  The RBL for an assessment period is the median of the daily lowest tenth percentile of L_{90} background noise levels.

  If the measured background noise level is less than 30 dBA, then the Rating Background Level (RBL) is considered to be 30 dBA.

DECIBEL – The human ear has a vast sound-sensitivity range of over a thousand billion to one. The decibel is a logarithmic unit that allows this same range to be compressed into a somewhat more comprehensible range of 0 to 120 dB. The decibel is ten times the logarithm of the ratio of a sound level to a reference sound level. See also Sound Pressure Level and Sound Power Level.

Decibel noise levels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dBA, and another similar machine is placed beside it, the level will increase to 53 dBA, not 100 dBA. Ten similar machines placed side by side increase the sound level by 10 dBA, and one hundred machines increase the sound level by 20 dBA.

dBC – The dBC scale of a sound level meter is similar to the dBA scale defined above, except that at high sound intensity levels, the human ear frequency response is more linear. The dBC scale approximates the 100 phon equal loudness contour.

dBA – The human ear is less sensitive to low frequency sound than high frequency sound. We are most sensitive to high frequency sounds, such as a child's scream. Sound level meters have an inbuilt weighting network, termed the dBA scale, that approximates the human loudness response at quiet sound levels (roughly approximates the 40 phon equal loudness contour).

However, the dBA sound level provides a poor indication of loudness for sounds that are dominated by low frequency components (below 250 Hz). If the difference between the "C" weighted and the "A" weighted sound level is 15 dB or more, then the NSW Industrial Noise Policy recommends a 5 dBA penalty be applied to the measured dBA level.

EQUIVALENT CONTINUOUS NOISE LEVEL, L_{Aeq} – Many noises, such as road traffic or construction noise, vary continually in level over a period of time. More sophisticated sound level meters have an integrating electronic device inbuilt, which average the A weighted sound pressure levels over a period of time and then display the energy average or L_{Aeq} sound level. Because the decibel scale is a logarithmic ratio the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closely to the L_{Aeq} noise level.

FREE FIELD – This is a sound field not subject to significant reflection of acoustical energy. A free field over a reflecting plane is usually outdoors with the noise source resting on hard flat ground, and not closer than 6 metres to any large flat object such as a fence or wall; or inside an anechoic chamber.

FREQUENCY – The number of oscillations or cycles of a wave motion per unit time, the SI unit being the Hertz, or one cycle per second.

IMPACT ISOLATION CLASS (IIC) – The American Society for Testing and Materials (ASTM) has specified that the IIC of a floor/ceiling system shall be determined by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The IIC is a number found by fitting a reference curve to the measured octave band levels and then deducting the sound pressure level at 500 Hz from 110 decibels. Thus the higher the IIC, the better the impact sound isolation.

IMPACT SOUND INSULATION ($L_{nT,w}$) – Australian Standard AS ISO 717.2 – 2004 has specified that the Impact Sound Insulation of a floor/ceiling system be quantified by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The Weighted Standardised Impact Sound Pressure Level ($L_{nT,w}$) is the sound pressure level at 500 Hz for a reference curve fitted to the measured octave band levels. Thus the lower $L_{nT,w}$ the better the impact sound insulation.

IMPULSE NOISE – An impulse noise is typified by a sudden rise time and a rapid sound decay, such as a hammer blow, rifle shot or balloon burst.

INTRUSIVE NOISE LEVEL, L_{Aeq} – The level of noise from a factory, place of entertainment, etc. in NSW is assessed on the basis of the average maximum noise level, or the $L_{Aeq\ (15\ min)}$. This is the energy average A weighted noise level measured over any 15 minute period.

LOUDNESS – The degree to which a sound is audible to a listener is termed the loudness. The human ear perceives a 10 dBA noise level increase as a doubling of loudness and a 20 dBA noise increase as a quadrupling of the loudness.

MAXIMUM NOISE LEVEL, L_{Amax} – The rms maximum sound pressure level measured on the "A" scale of a sound level meter during a noise survey is the L_{Amax} noise level. It may be measured using either the Fast or Slow response time of the meter. This should be stated.

NOISE RATING NUMBERS – A set of empirically developed equal loudness curves has been adopted as Australian Standard AS1469-1983. These curves allow the loudness of a noise to be described with a single NR number. The Noise Rating number is that curve which touches the highest level on the measured spectrum of the subject noise. For broadband noise such as fans and engines, the NR number often equals the dBA level minus five.

NOISE – Noise is unwanted sound. Sound is wave motion within matter, be it gaseous, liquid or solid. "Noise includes sound and vibration".

NOISE REDUCTION COEFFICIENT – See: "Sound Absorption Coefficient"

OFFENSIVE NOISE

(Reference: Dictionary of the Protection of the Environment Operations Act 1997).

"Offensive Noise means noise:

(a) *that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:*

- (i) *is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or*
- (ii) *interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or*

(b) *that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."*

PINK NOISE – Pink noise is a broadband noise with an equal amount of energy in each octave or third octave band width. Because of this, Pink Noise has more energy at the lower frequencies than White Noise and is used widely for Sound Transmission Loss testing.

REVERBERATION TIME, T_{60} – The time in seconds, after a sound signal has ceased, for the sound level inside a room to decay by 60 dB. The first 5 dB decay is often ignored, because of fluctuations that occur while reverberant sound conditions are being established in the room. The decay time for the next 30 dB is measured and the result doubled to determine the T_{60}. The Early Decay Time (EDT) is the slope of the decay curve in the first 10 dB normalised to 60 dB.

SOUND ABSORPTION COEFFICIENT – αSound is absorbed in porous materials by the viscous conversion of sound energy to heat energy as the sound waves pass through it. Sound is similarly absorbed by the flexural bending of internally damped panels. The fraction of incident energy that is absorbed is termed the Sound Absorption Coefficient, α. An absorption coefficient of 0.9 indicates that 90 % of the incident sound energy is absorbed. The average α from 250 to 2000 Hz is termed the Noise Reduction Coefficient (NRC).

SOUND ATTENUATION – If an enclosure is placed around a machine, or a silencer is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 30 dBA, reduces the sound energy by one thousand times.

SOUND EXPOSURE LEVEL (SEL) – The total sound energy of a single noise event condensed into a one second duration or in other words it is an L_{eq} (1 sec).

SOUND PRESSURE LEVEL, L_p – The level of sound measured on a sound level meter and expressed in decibels, dB, dBA, dBC, etc.. $L_p = 20 \times \log (P/P_o)$ ... dB

where P is the rms sound pressure in Pascal and P_o is a reference sound pressure of 20 µPa. L_p varies with distance from a noise source.

SOUND POWER LEVEL, L_w – The Sound Power Level of a noise source is an absolute that does not vary with distance or with a different acoustic environment.

$L_w = L_p + 10 \log A$ ... dB, re: 1pW,

where A is the measurement noise-emission area in square metres in a free field.

SOUND TRANSMISSION CLASS (STC) – An internationally standardised method of rating the sound transmission loss of partition walls to indicate the decibels of noise reduction of a human voice from one side to the other. (Refer: Australian Standard AS1276 – 1979)

SOUND TRANSMISSION LOSS – The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS1191 - 2002.

STATISTICAL EXCEEDENCE SOUND LEVELS, L_{A90}, L_{A10}, L_{A1}, etc. – Noise which varies in level over a specific period of time (usually 15 minutes) may be quantified in terms of various statistical descriptors:

The L_{A90} is the dBA level exceeded for 90 % of the time. In NSW the L_{A90} is measured over periods of 15 minutes, and is used to describe the average minimum or background noise level.

The L_{A10} is the dBA level that is exceeded for 10 % of the time. In NSW the L_{A10} measured over a period of 10 to 15 minutes. It was until recently used to describe the average maximum noise level, but has largely been replaced by the L_{Aeq} for describing level-varying noise.

The L_{A1} is the dBA level that is exceeded for 1 % of the time. In NSW the L_{A1} may be used for describing short-term noise levels such as could cause sleep arousal during the night.

STEADY NOISE – Noise, which varies in level by 6 dBA or less, over the period of interest with the time-weighting set to “Fast”, is considered to be “steady”. (Refer AS 1055.1 1997)

WEIGHTED SOUND REDUCTION INDEX, R_w – This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 to 3,150 Hertz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999).

Internal partition wall R_w + C ratings are frequency weighted to simulate insulation from human voice noise. The R_w + C is always similar in value to the STC rating value. External walls, doors and windows may be $R_w + C_{tr}$ rated to simulate insulation from road traffic noise. This is normally a lower number than the STC rating value.

WHITE NOISE – White noise is broadband random noise whose spectral density is constant across its entire frequency range. The sound power is the same for equal bandwidths from low to high frequencies. Because the higher frequency octave bands cover a wider spectrum, white noise has more energy at the higher frequencies and sounds like a hiss.

Table 4.1 Modifying factor corrections

(See definitions in Section 4.2)

Factor	Assessment/ Measurement	When to apply	Correction[1]	Comments
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: **- 5 dB** or more if the centre frequency of the band containing the tone is above 400 Hz **- 8 dB** or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive **- 15 dB** or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise
Impulsive noise	A-weighted fast response and impulse response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5s
Intermittent noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	One event in any 24-hour period	0 to –20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise. *(See Table 4.2)*
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10 dB(A)[2] (excluding duration correction)	

Notes:
1. *Corrections to be added to the measured or predicted levels.*
2. *Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range.*

APPENDIX F – SUSSEX INLET ZONE SUBSTATION RISK ASSESSMENT

TS155 Sussex Inlet ZS cost and risk assessment, r2

Sssex Inlet ZS

CPI escalation =	2.5%							4.76%		
	Option		Option		Option 1		Option 2		Option 3	
Items	**Do nothing**		**Refurbish 11kV busbar**		**New Outdoor Switchyard**		**New indoor 11kV substation**		**New indoor substation**	
	Year 0	**Year 15**	**Year 0**	**Year 15**	**Year 0**	**Year 15**	**Year 0**	**Year 15**	**Year 0**	**Year 15**
Project Management										
Project Management & Project Definitions		310,000	100,000	310,000	310,000	200,000	310,000	200,000	310,000	100,000
Outdoor 11kV Bays										
Feeders		0	0		1,660,000		0		0	
Bus Sections		0	100,000		360,000		0		0	
Indoor 33kV Bays										
Feeders		400,000	0	400,000	0	400,000	0	400,000	432,000	200,000
Bus sections		250,000	0	250,000	0	250,000	0	250,000	240,000	
Indoor 11kV Bays										
Feeders		307,000	0	307,000	0	1,000,000	307,000	400,000	307,000	400,000
Bus sections		94,000	0	94,000	0		94,000		94,000	
Transformer Bays										
Bays		860,000	600,000	860,000	0	400,000	460,000	400,000	776,000	
Transformer Costs		2,892,000	0	2,892,000	0	2,892,000	0	2,892,000	0	2,892,000
Bunds / Sound Walls / Blast Walls / Fire Suppression		270,000	270,000	270,000	180,000	270,000	270,000	270,000	270,000	270,000
Building & Switchyard										
Building/Transformer Runway/Fencing/Landscaping/Building Fire Suppression		3,630,000	800,000	3,630,000	1,760,000	1,000,000	3,130,000	1,000,000	3,630,000	
Ancillary Equipment										
11kV Aux Switchboard/Aux. Transf./Batteries & chargers/Radio System/ New SCADA		375,000	375,000	375,000	375,000		375,000		375,000	
Underfrequency Load Shedding		0	0		15,000		15,000		15,000	
Additional Costs										
Mains		270,000	270,000	270,000	220,000		194,000		831,000	
Distribution		474,000	0	474,000	474,000		474,000		474,000	
Major Equipment Storage		10,000	10,000	10,000	30,000		10,000		27,000	
On Site Security		0	0	0	0		0		0	
Demolition works		100,000	100,000	100,000	100,000		100,000		100,000	
relocation of lightning mast		10,000	10,000	10,000	10,000		10,000		10,000	
New access gate		10,000	10,000	10,000	10,000		10,000		10,000	
Core Balance CTs					12,000		12,000		12,000	
Relocate fire Hydrant		100,000	0	100,000	50,000		0		50,000	
Replace 33kV bus supports			20,000		20,000		20,000			
33kV Seeling end structure									20,000	
Purchase new land						200,000				
Total	0		2,665,000		5,586,000		5,791,000		7,983,000	

	Do nothing	Refurbish 11kV busbar	New Outdoor Switchyard	New indoor 11kV substation	New indoor substation
Future works	10,362,000	10,362,000	6,412,000	5,812,000	3,862,000
Cost of land	0	0	200,000	0	0
Year	15	15	15	15	15
Period (years)	45	45	45	45	45
Indexing factor	4.76%	4.76%	4.76%	4.76%	4.76%
Present Cost of Future costs	5,158,000	5,158,000	3,292,000	2,893,000	1,923,000
Resildual Value	$3,454,000	$3,454,000	$2,337,000	$1,937,000	$1,287,000
PV of residual value	426,000	426,000	288,000	239,000	159,000
Total project including futre works	**4,732,000**	**7,397,000**	**8,590,000**	**8,445,000**	**9,747,000**

Prefered Option	**2**			
Option Cost	**5791000**			
		1	2	
Fixed Value				
%	**20.00%**	**40.00%**	**40.00%**	

	2017/18	2018/19	2019/20	Total (nearest $10,000)
Project cost ($Real)	$1,158,200	$2,316,400	$2,316,400	$5,791,000
Project cost ($Real)	$1,200,000	$2,300,000	$2,300,000	$5,800,000
Project cost ($Nominal)	$1,200,000	$2,400,000	$2,400,000	$6,000,000
Overheads	$360,000	$730,000	$730,000	$1,820,000
Contingency	$0	$300,000	$300,000	$600,000
Total including overheads	$1,560,000	$3,430,000	$3,430,000	$8,420,000

Contingency	Allowance	Year
Civil & building works - Soil contamination including asbestos and excessive rock	400000	2018/19-19/20
Distribution works - Soil contamination including asbestos and excessive rock	100000	2018/19-19/20
Procurement/ Subcontract - variations to equipment costs	100000	2018/19-19/20
Total contingency	600,000	

Discount rate	4.76%		
VSL (2015)	4200000		Risks
VSL (2017) escalated	4412625		
VCR (2015)	39,069	$/MWh	AEMO (July 2015)
VCR (2017) escalated	41,047	$/MWh	

Assumptions		
Isolator maintaince cycle (years)	12	SMI100
Transformer maintenance cycle	7	SMI100
33kV CB maintenance cycle	4.5	SMI100
Number of times isolator is operated (per year)	0.90	
Current likelihood of 11kV BS isolator failure during operation	10.00%	
Liklihood of mechanicak failure event	8.97%	
Liklihood of refurbished isolator failure during operation	0.10%	
Liklihood of Operator injured during isolator failure	10%	
Iscolator failure injury rating (injury factor)	0.441	
Disproportionate factor	10	
Likelihood of worker coming in clearance durng isolator maintenance (existing)	0.50%	
Liklihood of operators and inspectors coming withing clearance during visit (existing)	0.20%	
Safety incident on 11kV busbar	2.14%	
Likelihood of worker coming in clearance durng isolator maintenance (Standard)	0.25%	
Liklihood of operators and inspectors coming withing clearance during visit (standard	0.10%	
Number distribution of outages per year	10.3	Average number of OMS outages per year
Likelihood of 33kV structure failure	5.00%	
Likelihood of TX fault per year	2.00%	
Liklihood that TX faults is high impedance	10.00%	
Likelihood of prot system failure due to storm anfd flooding of building	5.0000%	
Likelihood of failure of TX protection to operate	0.20000000%	
Likelihood of prot system failure (good condition)	0.000013%	(primary and backup protection failure, Low risk is 0.5% relay failure per anum) sussex has 3 modes of TX protecrtion
Likelihood of failure on total fire ban day	2%	
Likelihood of 33kV CB fail	1%	
Likelihood of 33kV CB fail 33kV with busbar	0.01%	
Liklihood of worker adjacent TX	1.00%	
Estimated cost of a bushfire at Sussex Inlet	$3,000,000	
Cost of TX replacement	$1,700,000	
Average load at Sussex Inlet ZS (MVA)	2.5	Load duration curves
Estimated outage duration if both TXs lost (hours)	168	1 week
Estimated outage duration if 1 TX lost including fire (hours)	8	
Estimated time for emergency switching (hours)	4	

Do Nothing

Capex Expenditure

Do Nothing	$0.00
Future indoor redevelopment	$5,403,892.88

Risks

Safety Incident	Isolator failure during operation	$1,928,839.56	
	Worker 11kV contact	$4,609,755.85	
		$0.00	
TX fire caused by protection failure		$0.00	
	Damage to plant	$7,515.57	
	VCR	$38,107.75	
	Worker near TX	$99.48	
33kV CB fail on LL TX fault		$0.00	
	Damage to plant	$1,508.72	
	VCR	$7,624.26	
	Worker near TX	$18.63	
Failure of 33kV structure		$226,831.84	
Protection risks	Arcflach	$66,000.00	see PS012 assessment
	Bushfire	$101,000.00	see PS012 assessment
Present cost of risks		**$6,987,301.65**	
NPV		**$12,391,194.53**	

Refurbish busbar

Capex Expenditure

Refurbish busbar and replace control building	$2,665,000.00
Future indoor redevelopment	$5,403,892.88

Risks

Safety Incident	Isolator failure during operation	$0.00	
	Worker 11kV contact	$4,609,755.85	
		$0.00	
TX fire caused by protection failure		$0.00	
	Damage to plant	$0.16	
	VCR	$0.08	
33kV CB fail on LL TX fault		$0.00	
	Damage to plant	$757.16	
	VCR	$365.64	
Protection risks	Arcflach	$66,000.00	see PS012 assessment
	Bushfire	$101,000.00	see PS012 assessment
NPV		**$12,846,771.77**	

Option 1

Capex Expenditure

New outdoor 11kV switchyard	$5,586,000.00
Future 33kV redevelopment	$3,448,228.11

Risks

Safety Incident	Isolator failure during operation	$0.00
	Worker 11kV contact	$2,304,877.93
		$0.00
TX fire caused by protection failure		$0.00
	Damage to plant	$0.16
	VCR	$0.08
33kV CB fail on LL TX fault		$0.00
	Damage to plant	$757.16
	VCR	$365.64
NPV		**$11,340,229.08**

Option 2

Capex Expenditure

New indoor 11kV building	$5,791,000.00
Future 33kV redevelopment	$3,031,019.63

Risks

Safety Incident	Isolator failure during operation	$0.00
	Worker 11kV contact	$0.00
		$0.00
TX fire caused by protection failure		$0.00
	Damage to plant	$0.16
	VCR	$0.08
33kV CB fail on LL TX fault		$0.00
	Damage to plant	$757.16
	VCR	$365.64
NPV		**$8,823,142.67**

Option 3

Capex Expenditure

New indoor substation	$7,983,000.00
Future indoor redevelopment	$2,014,073.95

Risks

Safety Incident	Isolator failure during operation	$0.00
	Worker 11kV contact	$0.00
	Incorrect switching	$0.00
TX fire caused by protection failure		$0.00
	Damage to plant	$0.16
	VCR	$0.08
33kV CB fail on LL TX fault		$0.00
	Damage to plant	$13.12
	VCR	$6.34
NPV		**$9,997,093.65**

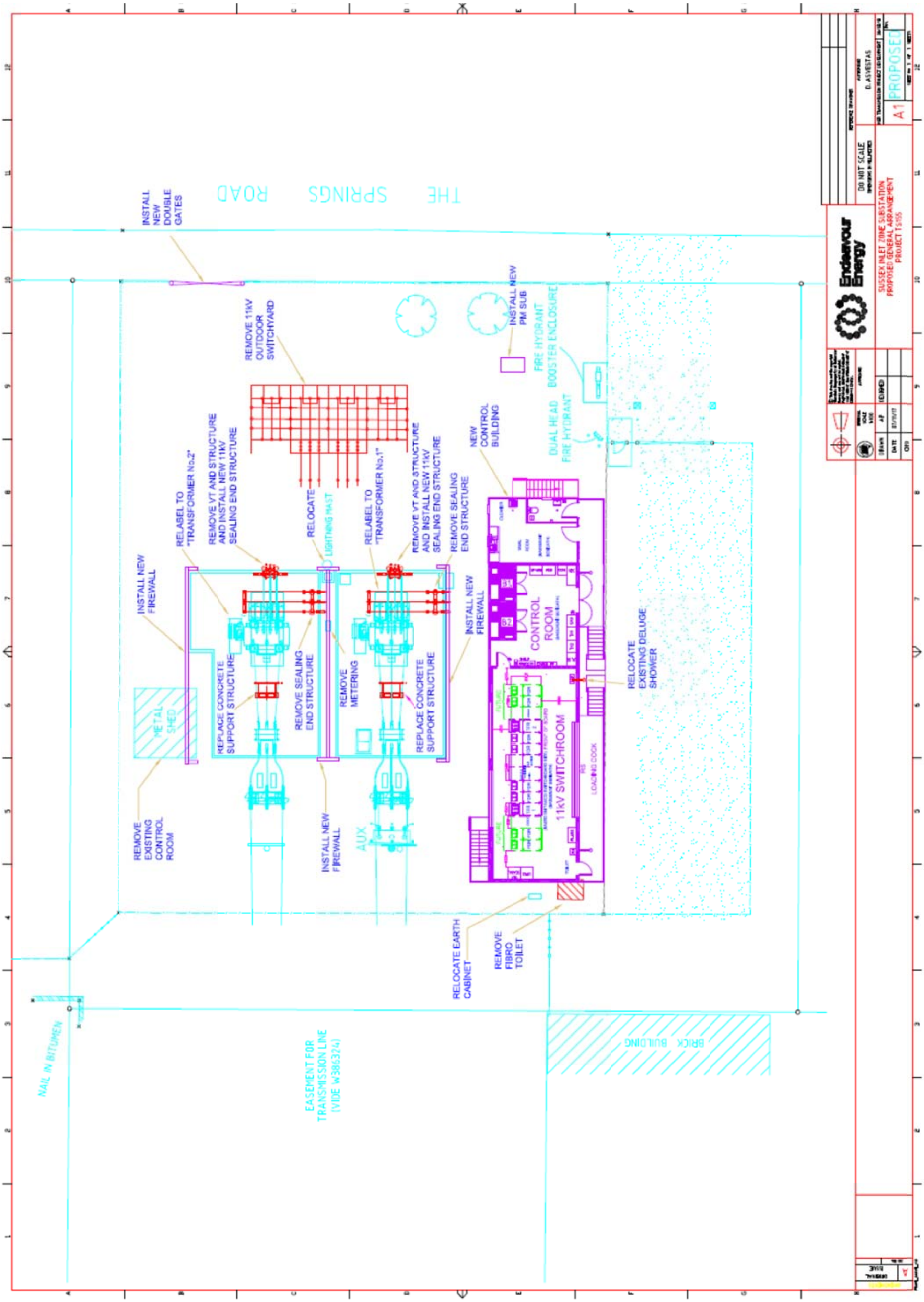
Marayong ZS - Qualitative Option Risk Assessment

Option No	Option Detail	Safety: Detail	Likelihood of event	Consequence	Item Score	Total Score	Environment and Community: Detail	Likelihood of event	Consequence	Item Score	Total Score	Construction: Detail	Likelihood of event	Consequence	Item Score	Total Score
1	**New 11kV switchyard**	Construction works near live switchyard	B	4	20		Outdoor switchyard	C	2	20		Construction works near switchyard (Delays and risk of damage)	D	2	100	
		Retains outdoor switchyard	B	4	20							Space constriants leading to delays	D	2	100	
2	**New 11kV control building**	Outdoor 33kV switchgear	A	3	4		Attractive, compact indoor design					Construction of a control building on a greenfield site				
		Indoor 11kV switchgear														
3	**New indoor Substation**	Indoor 11kV switchgear					Attractive, compact indoor design					Construction of a control building on a greenfield site				

Option No	Operating & Maintenance: Detail	Likelihood of event	Consequence	Item Score	Total Score	Reliability: Detail	Likelihood of event	Consequence	Item Score	Total Score	Sustainability: Detail	Likelihood of event	Consequence	Item Score	Total Score	All Risks: Total Risk
1	11kV Switchyard maintenance	D	2	100		Outdoor switchyard (greater number of outages)	C	2	20		No room for 33kV and transformer equipment	D	3	500		930
	Switching difficulty of outdoor switchgear	E	1	10												
	Retains alstom OX36 CBs	C	2	20												
	Lacks 33kV breaker fail protection	B	4	20												
2	Retains alstom OX36 CBs	C	2	20		Outdoor 33kV switchgear	A	2	0.8							44.8
	Lacks 33kV breaker fail protection	B	4	20		Indoor 11kV switchboard will reduce number of outages										
	All new low maintenance 11kV equipment															
3	All new low maintenance equipment					Indoor 33 & 11kV switchboard will reduce number of outages										0
	Provides 33kV breaker fail protection															

CODE				
CODE	Extreme risk	High risk	Moderate Risk	Low risk

APPENDIX G – SUSSEX INLET ZONE SUBSTATION PROPOSED GENERAL ARRANGEMENT



ITEM	QTY	Labour Cost ($)	Store Costs ($)	Plant Costs ($)	Direct Charge ($)	Total Cost ($)
Outdoor Feeder Bays						
132kV	0	$0	$0	$0	$0	$0
66kV	0	$0	$0	$0	$0	$0
33kV	0	$0	$0	$0	$0	$0
Indoor Feeder Bays						
132kV	0	$0	$0	$0	$0	$0
66kV	0	$0	$0	$0	$0	$0
33kV	0	$0	$0	$0	$0	$0
11kV	4	$136,100	$8,559	$11,701	$150,696	$307,057
Outdoor Bus Sections						
132kV	0	$0	$0	$0	$0	$0
66kV	0	$0	$0	$0	$0	$0
33kV	0	$0	$0	$0	$0	$0
Indoor Bus Sections						
132kV	0	$0	$0	$0	$0	$0
66kV	0	$0	$0	$0	$0	$0
33kV	0	$0	$0	$0	$0	$0
11kV	1	$42,775	$38	$1,740	$49,545	$94,098
Joggle Chamber/Bus Ducting	0	$0	$0	$0	$0	$0
Transformer Bays						
Bays	2	$224,106	$38,986	$27,595	$169,808	$460,495
Transformer Costs	0	$0	$0	$0	$0	$0
Bunds / Sound Walls / Blast Walls / Fire Suppression		$0	$0	$0	$270,000	$270,000
AFIC Equipment						
SFU & Injection Cells		$0	$0	$0	$0	$0
Building & Switchyard						
Building/Transformer Runway/Fencing/ Landscaping/Building Fire Suppression		$0	$0	$0	$3,130,000	$3,130,000
Ancillary Equipment						
11kV Aux Switchboard/Aux. Transf./ Batteries & chargers/Radio System/ New SCADA		$14,779	$0	$276	$360,248	$375,303
Underfrequency Load Shedding	2	$1,568	$0	$148	$13,380	$15,096
Capacitor Banks	0	$0	$0	$0	$0	$0
General Arrangment Update		$0	$0	$0	$0	$0
Project Management & Project Definitions						$310,213
Control Panels	0	$0	$0	$0	$0	$0
Mains		$84,374	$4,148	$7,718	$98,071	$194,311
Distribution		$0	$0	$0	$474,000	$474,000
Additional Costs						
Major Equipment Storage					$10,230	$10,230
On Site Security					$0	$0
Changeover/Preliminaries					$ -	$0
Outages		$ -	$ -	$ -	$ -	$0
Demolition of 11kV and building		$ -	$ -	$ -	$ 100,000	$100,000
Relocation of Lighning Mast		$ -	$ -	$ -	$ 10,000	$10,000
New Access Gate		$ -	$ -	$ -	$ 10,000	$10,000
Core Balance CT's (4 Fdrs)		$ -	$ -	$ -	$ 12,000	$12,000
Replace 33kV bus supports		$ -	$ -	$ -	$ 20,000	$20,000
0		$ -	$ -	$ -	$ -	$0
0		$ -	$ -	$ -	$ -	$0
SUB TOTAL:						**$ 5,792,803**
CPI:						**$ -**
TOTAL (to the nearest $100k):						**$ 5,800,000**
Contingency (to the nearest $100k):						**$ 600,000**

TS155 Sussex Inlet ZS 11kV switchboard replacement

Zone:	**Sussex Inlet, 9682**	Item No:	**MHS04380**	Amd No:	**0**
Feeder:	**SXA2 – Sussex North**	LG Area:	**SHOCC**		
Location:	**The Springs Rd, Sussex Inlet**	Prepared:	**Andrew Hardy**		

Reason for Works

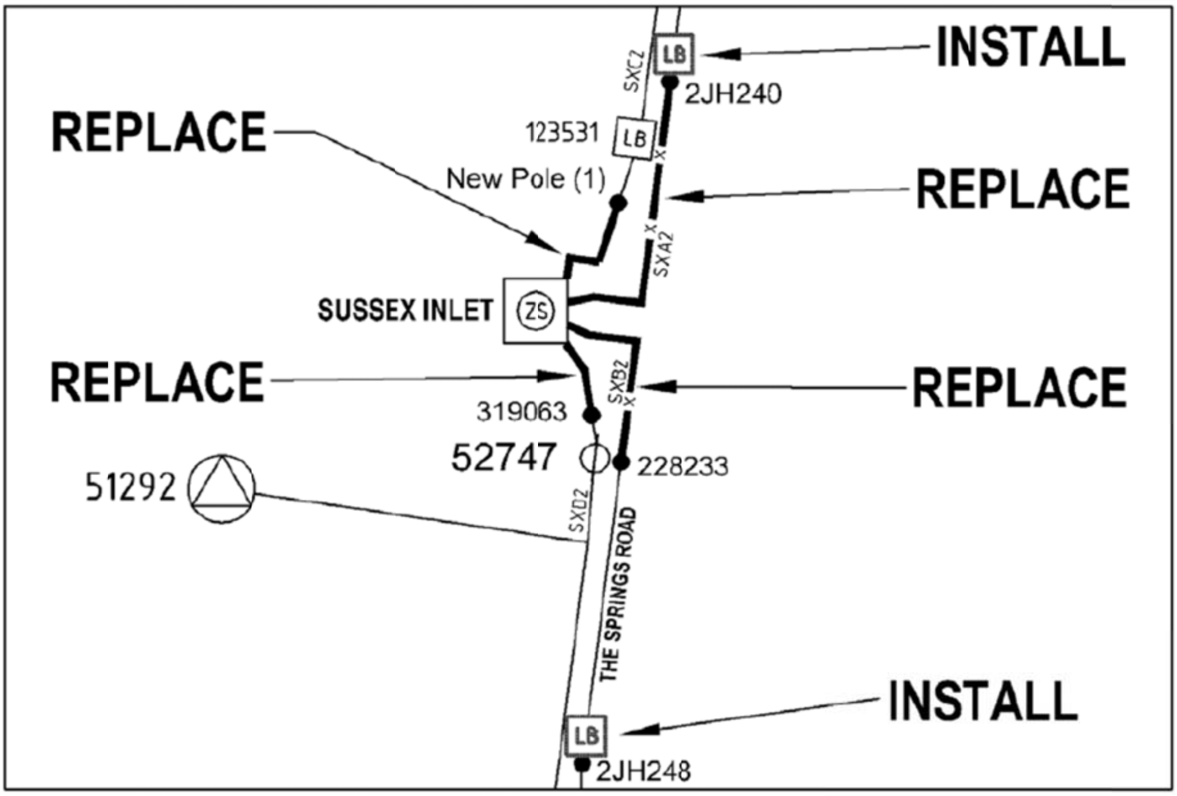
The replacement 11kV switchboard is an indoor unit for the existing outdoor arrangement.

The work removes the existing O/H feeder and distribution poles within the switch yard to the road reserve beyond the ZS site for SXA2, SXB2, SXC2 and SXD2.

Description Of Works	Length (km)
Replace existing 7/4.50 AAAC O/H conductor with 240mm² Cu XLPE cable from CB 'SXA2 - Sussex North' to new UGOH pole 2JH240 on The Springs Rd.	0.15
Install a LBS (Type 1) in a suitable location along The Springs Rd as indicated. Suggest pole 2JH240.	
Replace existing 7/4.50 AAAC O/H conductor with 240mm² Cu XLPE cable from CB 'SXB2 - Sussex South' to new UGOH pole 228233 on The Springs Rd.	0.11
Install a LBS (Type 1) in a suitable location along The Springs Rd as indicated. Suggest pole 2JH248.	
Replace existing 150mm2 Al 3C XLPE cable & 7/4.50 AAAC O/H conductor with 240mm² Cu XLPE cable from CB 'SXC2 - Wandandian' to new UGOH pole (1) on The Springs Rd.	0.1
Replace existing 7/4.50 AAC O/H conductor with 240mm² Cu XLPE cable from CB 'SXD2 - Berrara' to new UGOH pole 319063 on The Springs Rd.	0.08
Estimated Total Project Cost:	**$474,000**

Remarks

The works will be funded through TS155 - 11kV Switchboard Renewal Project.



Asset Strategy & Planning

Sussex Inlet ZS showing the 11kv busbar structure and the four feeder reclosers

11kV auxiliary transformer

11kV bus-section isolator

Control building with damaged roof and cable pit subject to flooding

33kV support structures