Capital Expenditure:
Expenditure Justification
Cover Sheet

Project name	Gold Creek 11kV Switchboard Extension
Expenditure type	Capital Expenditure – Augmentation
Business Group	Asset Strategy & Planning
Regulatory Period	1 July 2014 to 30 June 2019
Five year total spend	$0.77 Million
CAPEX category & Primary Drivers	Minor Augmentation CAPEX • Feeder capacity requirement at zone substation • Risk of stranding customers due to lead time • Economy of scale in constructing multiple feeder bays

Version control

Date	Version	Description	Reviewed	Author
01/07/14	1.0	First issue	F Gotla	Jacobs
17/11/14	1.1	Update to improve substantiation clarity	G Pallesen	Jacobs
05/12/14	1.3	Finalisation and inclusion of references	D Stanley	G Pallesen
09/01/15	1.4	Inclusion of additional block load information	D Stanley S Devlin	G Pallesen
15/01/15	1.6	Minor update from GM review	D Stanley	G Pallesen

Referenced documents

Document	Version
National Electricity Law Chapter 7A “Revenue and Pricing Principals”	19.12.2013
National Electricity Rules Chapter 6.5.7 Forecast capital expenditure	V66
Utilities Act (ACT)	2000
Utilities (Management of Electricity Network Assets Code) Determination	2013

Approval

Manager Primary Systems Strategy	Signature	Date
Branch Manager Asset Strategy and Planning	Signature	Date

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Executive Summary

This Project Justification Report investigates and recommends the consolidation (paralleling) of feeders and the extension of the 11kV switchboard at Gold Creek Zone Substation to provide for the forecast demand in the Gungahlin and Mitchell Districts.

The Gungahlin and Mitchell Districts have been experiencing higher than average demand growth at around 3.3% per annum over the past 10 years and this steady growth is forecast to continue over the next 10 years. Gold Creek Zone Substation is a primary source of electricity supply for the Gungahlin and Mitchell Districts.

Connection applications have been received for two major commercial block loads planned to be commissioned by 2015/16 and 2016/17 respectively. The nature of both these loads requires a secure and high level of reliability. It is anticipated the developer will be contributing to the HV infrastructure cost to ensure the security and reliability of electricity supply. Two new feeders are planned with a potential third feeder required for security of supply to one of these commercial block loads. A third block load is associated with the ACT Government's planned Light Rail project. The operational timing for this project is planned toward the end of this regulatory period. The Gold Creek Zone Substation has two (2) 11kV switchboards with ten (10) feeder bays each. All twenty (20) feeders are currently utilized to feed existing loads. There are no spare feeder bays at the Gold Creek Zone Substation.

A minimum of seven (7) additional feeder bays are forecast to be required to meet the 10 (ten) year load growth. This comprises three (3) feeders identified for known block loads, including a feeder for additional security required for one of the commercial blocks loads. There are two (2) feeders required to meet the forecast residential and commercial load growth from 2015 - 2020 and a further two (2) feeders required for the forecast demand growth between 2020 - 2025

ActewAGL Distribution (AAD) is required to meet regulatory obligations to provide reliable, secure supply in the long term customer interests. Without the proposed extension of the 11kV feeder bays, AAD is not able to meet these regulatory obligations.

The preferred solution of extending the 11 kV switchboards in conjunction with the consolidation of feeders achieves the objective of providing sufficient capability to meet the current and future feeder requirements of the network in a prudent and cost efficient manner. The efficiency of the preferred solution is achieved by combing a low cost solution where practical to the relatively more expensive but inevitable solution of expanding the existing switchboard. There are two stages of implementation for the preferred option (option three).

1. **Stage 1**: Feeder Consolidation; estimated at $14,000
2. **Stage 2**: Switchboard Extension; estimated at $756,000

Economic analysis on the preferred solution demonstrates that, due to the economy of scale, it is prudent to consider the long term (10 year) forecast requirements of the network and establish four (4) additional feeder bays rather than stage the extension.

The capital expenditure forecast for the preferred solution **(option three)** is estimated at **$770,000** and is expected to be completed over a two (2) year period with an expenditure forecast of $270,000 in 2015/16 and $500,000 in 2016/17. It is recommended that the preferred solution of feeder consolidation followed by extension of the 11 kV switchboards at Gold Creek Zone Substation for the provision of seven (7) feeder bays be undertaken.

A summary of the feeder requirements and the recommended supply solutions is given in Table 1.

Table 1 Summary of the feeder Requirements and recommended supply solutions

Load Type	Comment	11kV Feeders Required	Recommended Supply Solution
Customer Initiated Loads	Commercial block load	2 (2nd feeder for N-1 security of supply)	Consolidation of Feeders
Customer Initiated Loads	Commercial block load	1	Consolidation of Feeders
New Developments and Dwellings	Period 2015-2020	2	Extension of 11kV Switchboard
New Developments and Dwellings	Beyond 2020	2	Extension of 11kV Switchboard
Total		**7**	

The methodology and estimated costs for this feeder bay extension program are developed through the application of historical information, industry knowledge and Good Engineering Operating Practices. This approach complies with paragraphs 6 & 7 of National Electricity Law (NEL):

NATIONAL ELECTRICITY (NSW) LAW - SECT 7A

Revenue and pricing principles
When providing an estimate for a project, state that the estimate is commensurate with the economic costs and risks of the potential for under and over investment by a regulated network service in reference to Section 7A of the National Electricity Law, paragraph 6 & 7.

This program of works is required to enable AAD to meet the requirements of the National Electricity Rules (NER), chapter 6.

6.5.7 Forecast capital expenditure
(a) A *building block proposal* must include the total forecast capital expenditure for the relevant *regulatory control period* which the *Distribution Network Service Provider* considers is required in order to achieve each of the following (the *capital expenditure objectives*):
(1) meet or manage the expected demand for *standard control services* over that period;
(2**) comply with all applicable *regulatory obligations*** *or requirements* associated with the provision of *standard control services*;
(3) to the extent that there is no applicable *regulatory obligation or requirement* in relation to:
(i) the quality, reliability or security of supply of *standard control services*; or
(ii) the reliability or security of the *distribution system* through the supply of *standard control services*,
to the relevant extent:
(iii) **maintain the quality, reliability and security of supply** of *standard control services*; and
(iv) **maintain the reliability and security of the *distribution system*** through the supply of *standard control services*; and

(4) **maintain the safety** of the *distribution system* through the supply of *standard control services*.

AAD also has an obligation to comply with the Utilities Act 2000 (ACT) which imposes specific technical, safety and reliability obligations on AAD.

Utilities (Management of Electricity Network Assets Code) Determination 2013

The Management of Electricity Network Assets Code is a technical code under Part 5 of the *Utilities Act 2000* (the Act).

4 WHEN UTILITIES' OBLIGATIONS DO NOT APPLY

The obligations imposed on an electricity distributor under this Code do not apply when:
(1) the events or conditions are outside the control of the electricity distributor and prevent the electricity distributor from complying with this Code; and
(2) the consequences of the events or conditions are not created by the electricity distributor's actions or lack of actions.

5.3 Safe Design, Construction, Operation and Maintenance

(1) An electricity distributor must design, construct, operate and maintain its aerial lines, underground lines, substations, equipment and metering with reasonable care to avoid injury to any persons or damage to property or the environment and to provide a reliable and efficient power supply.

(4) The electricity distributor must ensure that the earthing and protection systems of its electricity network are designed, installed, operated and maintained with reasonable care to avoid injury to any persons or damage to property or the environment.

1. Strategic context & Expenditure need

1.1 Asset Overview

The Gold Creek Zone Substation is the primary source of power supply for the Gungahlin and Mitchell Districts. It was commissioned in 1993 and has been servicing the Gungahlin and Mitchell Districts for 21 years. The substation was designed as a two 132 kV/11 kV power transformer substation with two 11 kV switchboards comprising a total of twenty 11kV feeders. Currently all the 11 kV feeder bays are used to supply distribution feeders and no spare bays are available to accommodate current and future feeder requirements. The continuous rating of this substation is 57 MVA, with an emergency rating of 76 MVA in both summer and winter. The forecast 2015 peak winter load demand at Gold Creek Zone Substation is 60 MVA

There is sufficient space available at Gold Creek Zone Substation to accommodate the extension of the 11 kV switchboard, hence there are no physical constraints in extension of the switchboard, making it the preferred site. The high confidence commercial block loads and the fact that the zone substation is not capacity constrained leads to the conclusion that spare 11 kV circuit breakers should be available at the Gold Creek Zone Substation to facilitate customer connections that will enable the available zone substation capacity to be used.

1.2 Objectives

The objectives of the Gold Creek Zone Substation 11kV extension project are to:

- Provide sufficient 11kV feeder bays to meet the planned and forecast connection requirements in the Gold Creek Zone Substation over the ten (10) year forecast period.
- Ensure the reliability of supply to the existing and future customers in the Gungahlin District.
- Comply with the requirements of the NER, NEL and the Electricity Distribution (Supply Standards) Code. This includes identification and selection of prudent and cost efficient augmentation solution that:

- *Meets the required network planning criteria and performance standards*
- *Complies with all relevant legislation, regulations and administrative requirements*
- *Is able to be delivered within the time required*

1.3 Key Drivers

The key driver for this project is the requirement to cater for forecast customer connections and to meet security and reliability requirements for customer electricity supplied from the Gold Creek Zone Substation. The constraint in meeting the customer and demand growth requirements is the 11 kV switchboard at Gold Creek Zone Substation. The existing bays at the two (2) switchboards at the Gold Creek Zone Substation are fully utilised with twenty (20) feeders dedicated to various loads. Therefore, there are no spare feeder bays available to accommodate the forecast feeder requirements and hence cater for the planned and forecast connections.

2. Regulatory Compliance

Gold Creek Zone Substation has a 3% p.a. trend growth rate, 60 MVA of peak winter load, and twenty (20) existing 11 kV feeders with no spare 11 kV circuit breakers. Forecast demand modelling for Gold Creek shows a constant upward trend as well as the addition of block loads. The underlying steady growth rate plus the prospect of at least two (2) major block loads underpins the prudency of the preferred option selection. A third block load is associated with the ACT Government's planned Light Rail project. The operational timing for this project is planned toward the end of this regulatory period. It is common DNSP practice to have one (1) or, preferably (2) spare 11 kV circuit breakers on each 11 kV zone switchboard in urban areas to cater for trend growth, unexpected block loads, and for unplanned circuit breaker failure to ensure electricity supply security and reliability. The zone substation is not capacity constrained; therefore demand growth requiring supply from Gold Creek Zone Substation can be supported by the proposed new feeder bays.

It is a legal and regulatory obligation under the NEL, NER and Utility Act (ACT) for AAD to maintain security of supply and system reliability whilst proactively promoting the national electricity objective of making efficient investments in the longer term interests of the consumers.

2.1 Reliability and security of supply:

The Do Nothing Option places AAD in breach of its obligation to provide a reliable and secure supply to the Gungahlin District. The recommended option to consolidate existing feeders and install new feeder bays at the Gold Creek Zone Substation by 2016/17 is required to meet AADs NEL, NER and Utility Act (ACT) obligations.

National Electricity Law Chapter 7 —National electricity objective

The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for **the long term interests of consumers** of electricity with respect to

(a) price, quality, safety, reliability and security of supply of electricity; and

(b) the reliability, safety and security of the national electricity system. "

6.5.7 Forecast capital expenditure

(a) A *building block proposal* must include the total forecast capital expenditure for the relevant *regulatory control period* which the *Distribution Network Service Provider* considers is required in order to achieve each of the following (the *capital expenditure objectives*):
(1) meet or manage the expected demand for *standard control services* over that period;
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AAD has an obligation to comply with the Utilities Act 2000 (ACT) which imposes specific technical, safety and reliability obligations on AAD.

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5.3 Safe Design, Construction, Operation and Maintenance
(1) An electricity distributor must design, construct, operate and maintain its aerial lines, underground lines, substations, equipment and metering with reasonable care to avoid injury to any persons or damage to property or the environment and to provide a reliable and efficient power supply.

2.2 Cost compliance:

Cost compliance is achieved by proactively pursuing the philosophy of compliance with the national electricity objective by fully exploring and evaluating all alternatives technically and commercially so as to seek approval for a solution which provides an the grounds for an efficient investment while meeting the long term interests of the consumers.

The investment value has been determined using the FY 2012/13 market prices.

The methodology and estimated costs used for the Gold Creek Zone Substation feeder bay extension program are developed through the application of industry knowledge and Good Engineering Operating Practices based on historical similar projects. This approach complies with paragraphs 6 & 7 of National Electricity Law (NEL).

NATIONAL ELECTRICITY (NSW) LAW - SECT 7A

Revenue and pricing principles
When providing an estimate for a project, state that the estimate is commensurate with the economic costs and risks of the potential for under and over investment by a regulated network service in reference to Section 7A of the National Electricity Law, paragraph 6 & 7.

3. Network and Constraint Description

This section describes the existing loads in Gungahlin and Mitchell Districts being serviced by the Gold Creek Zone Substation and the anticipated load growth due to land releases and block loads anticipated to connect to the Gold Creek Zone Substation. The network constraint and the detailed utilisation of the existing feeders are also described.

3.1 Load Demographics

The significant loads of Gungahlin and Mitchell Districts are currently serviced by the Gold Creek Zone Substation.

The Gungahlin District is Canberra's northernmost town situated 10 km north of the Canberra town centre. It comprises eighteen suburbs of which thirteen are well established or in advanced stages of development, and a further five are either under construction or in a planning stage. The population of the district is currently around 47,000 and is expected to rise to approximately70,000 by the early 2020's, representing an expected 48% growth. The suburbs are predominantly housing developments with local shopping centres and schools, whilst the Gungahlin Town Centre is the commercial centre of the district and includes department stores, clothes retailers, car retailers, supermarkets, and special grocery outlets.

The Mitchell District is a light-industrial estate and does not contain any housing developments. New light industrial dwellings in the district over the next five (5) years are expected to increase at around 40% per annum. Of this, 60% of the growth is forecast in established suburbs and 40% in new developments in the suburbs of: Taylor, Moncrieff and Throsby. Significant (13 MVA) new loads in the Mitchell District include two commercial block loads. A third block load (3 MVA) is associated with the ACT Government's planned Light Rail project. The operational timing for this project is planned toward the end of this regulatory period.

Load growth for existing commercial customers, using existing feeders are planned for FY 2016/17 as shown in Table 2.

Table 2: Major Projects in Gungahlin Town Centre:

Development	Location	Zone Substation	Load (MVA)	Timing
Coles	Gungahlin	Gold Creek	3.00	1/02/2017
Bunnings	Gungahlin	Gold Creek	1.10	1/02/2017
Multi-Storey 1	Gungahlin	Gold Creek	2.10	1/02/2017
Woolworths	Gungahlin	Gold Creek	0.75	1/02/2017

3.2 Demand Growth

The Gold Creek Zone Substation peaks in the winter period consistent with a predominantly residential load. The winter and summer demand forecasts for the Gold Creek Zone Substation is provided in Figure 1 and Figure 2.

Figure 1: Summer demand for the Gold Creek Zone Substation

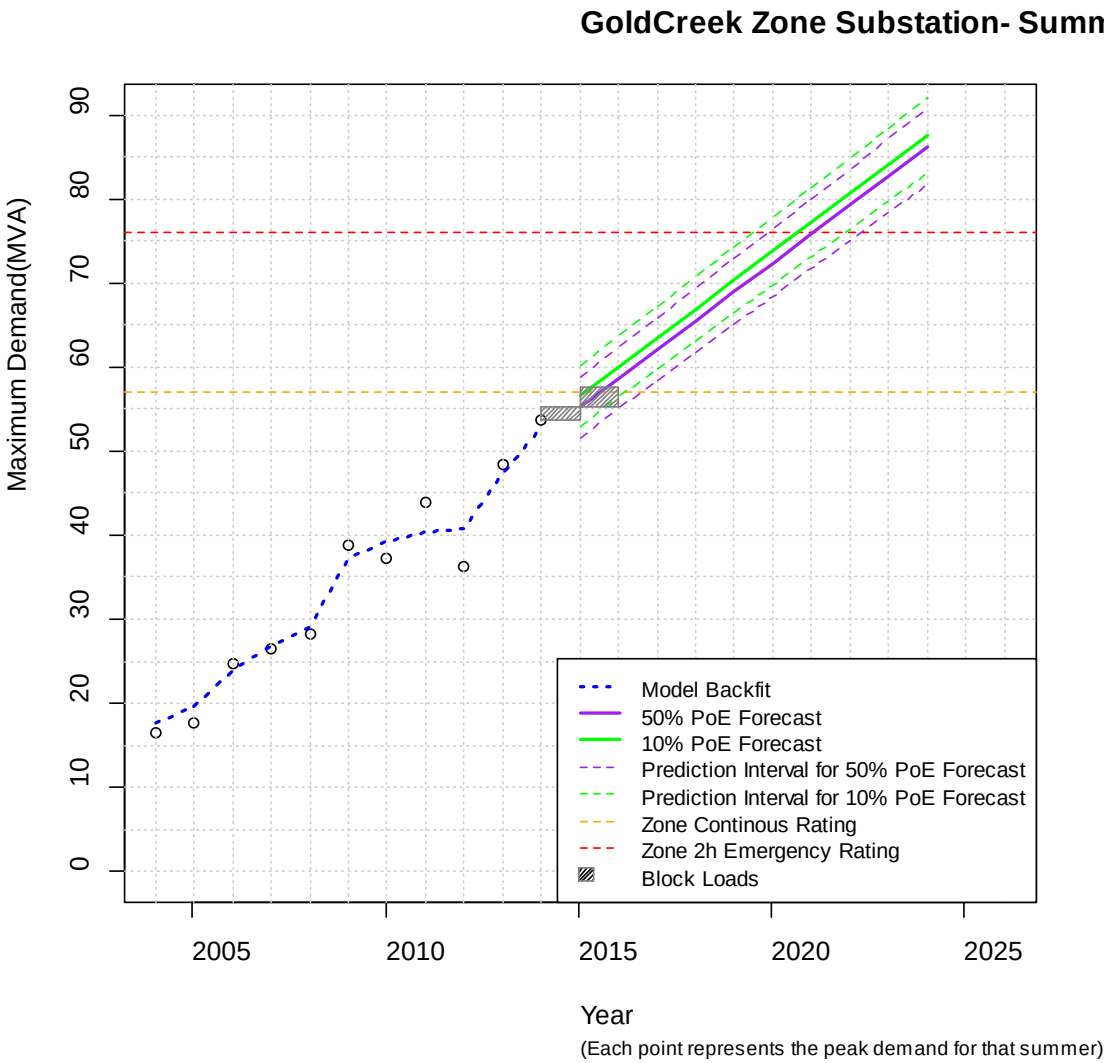
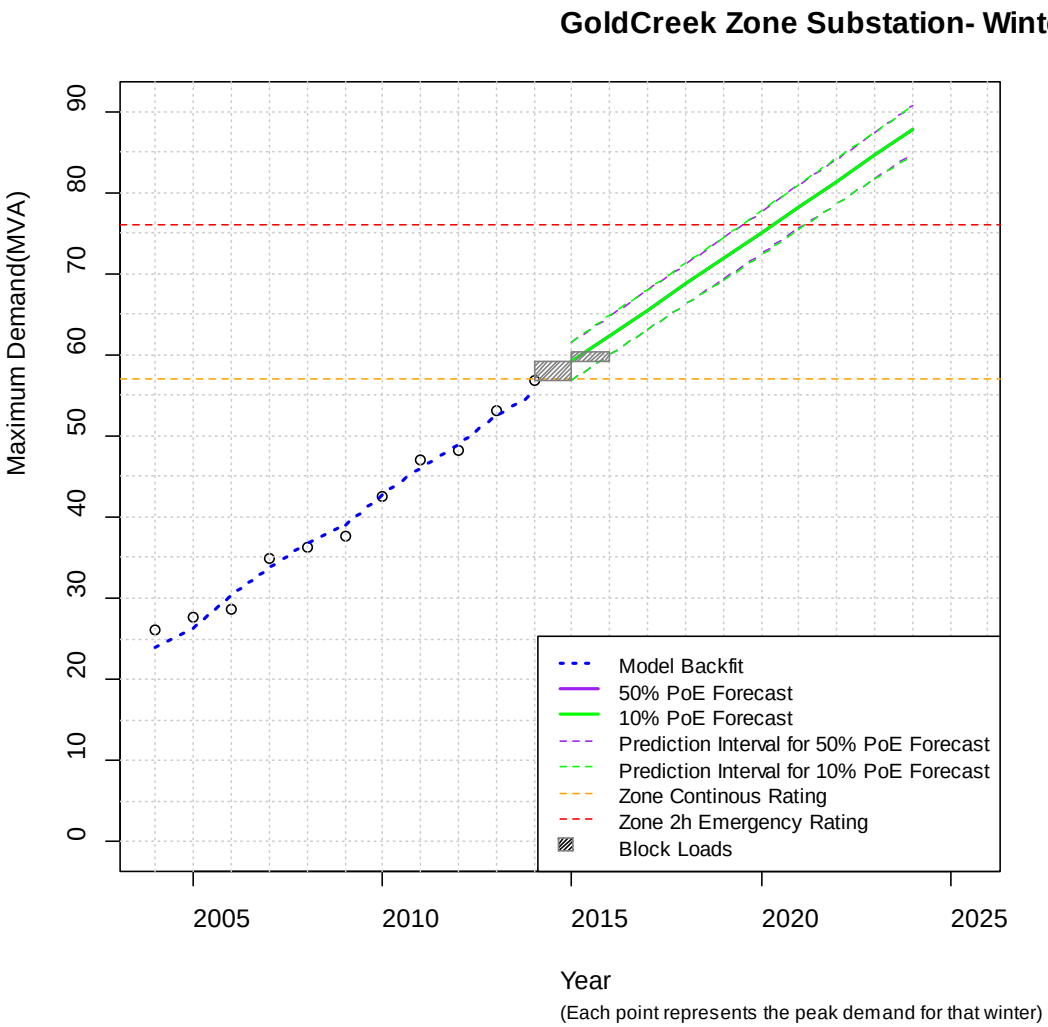


Figure 2: Winter demand for the Gold Creek Zone Substation



3.3 Residential Load

ACT Land Planning1 (ACT Government) has produced residential dwelling number growth forecasts with new dwellings expected in the Gungahlin and Mitchell areas through the government's land release program and the resultant expected construction and uptake of dwellings. AAD has considered the effect of growth in residential dwellings on overall load growth, and the resulting analysis indicates that residential load growth is covered by the underlying trend, so it was not added to the demand forecast to avoid double counting.

[1] Indicative Land Release Programs 2014-15 to 2017-18 June 2014, ACT Government Economic Development

3.4 Commercial Block Loads

Two planned block loads in the Gold Creek District area are forecast to require an additional 9.2 MVA by FY2016. A third block load of 3.0 MVA is associated with the ACT Government's planned Light Rail project. The operational timing for this project is planned toward the end of this regulatory period. The block loads are staged as shown in Table 3. Investigation of supply options for these customer initiated loads demonstrates that new 11kV feeders from Gold Creek Zone Substation need to be established to connect the commercial Block Loads.

It is assessed that two feeders are required to support these customer initiated block loads with a potential third feeder to provide security of supply to one of the block loads.

Table 3: Gold Creek Zone Substation block loads

Development	Scope of Work	Expected ADMD Increase (MVA)	Supply Required Date	Project probability
Commercial Block Load 1	Stage 1: Connection to existing Gungahlin fdrs (2.5 MVA) – complete. Stage 2: New Feeder from Gold Creek Sub. (6 MVA) Stage 3: Second fdr from Gold Creek for N-1 security of supply (Refer Network Augmentation Recommendation – 7519031 & 7521445)	6.0 MVA	Stage 1: complete Stage 2: FY2016 Stage 3: TBD	100%
Commercial Block Load 2	Stage 1: Connection to existing fdrs (3.0 MVA) Stage 2: New feeder from Gold Creek (5.4 MVA increasing to 7.4MVA) (Refer Network Augmentation Recommendation – 7521632 & 7522728)	7.4 MVA	Stage 1: FY2015 Stage 2: FY2016	100%
Block Load 3	A third block load is associated with the ACT Government's planned Light Rail project. The operational timing for this project is planned toward the end of this regulatory period.	3.0 MVA	FY 2019	30%

3.5 Feeder Requirements for Forecast Demand

Assuming an average feeder loading of around 200 A (which is based on the existing feeder demands at Gold Creek Zone Substation) to meet the demand forecast over the next ten (10) year period, it is assessed that there is a requirement for seven (7) feeders required to meet the forecast demand including additional security requested by one of the commercial block loads as shown in Table 4.

It is standard industry practice for DNSPs to have a couple of feeder bays spare for loads that require connection in a short timeframes and as a contingency measure in the event of an unplanned circuit breaker failure. There is at least a 12-18 month lead time for construction of an additional feeder bay so there is merit in considering the likely requirements over the next ten (10) year forecast period, especially given that the zone substation is not capacity constrained and given the growth of the demand forecast at the substation. Further, efficiencies gained through contracting for these additional feeder bays at the same time as the first three which are required to meet immediate customer connection requirements, improve the economics of the overall project and on a PV cost basis, this is a superior option.

Table 4: Summary of feeder requirements

Load Type	Comment	Demand	11kV Feeders
Customer Initiated Loads	Commercial Block Load 1	6 MVA	[2]2
Customer Initiated Loads	Commercial Block Load 2	7.4 MVA	1
New Developments and Dwellings	Period 2015-2020	8 MVA	2
System 'Spare' or Long term Developments	Period 2020 - 2025	5 MVA	2
Total Requirement – 10 year forecast	Period 2015 - 2025	26.4MVA	7

[2] This commercial block load has requested N-1 level of security for feeder supply and therefore two feeder bays are required.

3.6 Gold Creek Distribution 11kV Feeder Ties

The Gold Creek Zone Substation supplies the Gungahlin District via twenty 11 kV feeders. These feeders vary in length, capacity, loading and interconnectivity. The Distribution Network Reliability & Standard Supply Arrangements provides the criteria for feeder loading and capacity limits to maintain the reliability and security of supply of the distribution network. The criteria are provided in Table 5, subject to the following conditions.

1) Voltage drop and other design constraints
2) Availability of partial back up (ties with limited capacity to back feed)

Table 5: Distribution Feeder Loading Criteria

Feeder Arrangement	Feeder firm capacity	Feeder Loading Limit
Single radial feeder with inter-feeder ties from two other feeders	75% of thermal capacity	Load should not exceed firm capacity when network is in the normal configuration.
Single radial feeder with inter-feeder ties from one other feeder	50% of thermal capacity	Load can exceed feeder firm capacity for up to 200 hours pa(1)
Single radial feeder without back up ties or with partial back up e.g. rural feeder (2)	100% or less (3)	Load should not exceed feeder thermal capacity (1)

The 11 kV feeders comply with the network reliability and standard supply arrangement criteria and are loaded within the recommended capacity limits based on the level of interconnectivity. Table 6 provides a summary of the 11 kV feeders in terms of their capacity, loading and the number of available feeder ties.

Table 6: Gold Creek 11kV Feeders

Feeder	Primary Suburb	Firm summer Capacity (Amp)	Actual Loading[3] (2013)	Number of Feeder Ties
Anthony Rolfe 2	Harrison, Mitchell	345	298.2	4
Barrington 2	Amaroo, Ford	325	261.8	4
Birrigai Fdr 1	Ngunnawal	325	56.1	6
Boulevard North 2	Gungahlin TC	295	66.9	2
Bunburung Fdr 2	Ngunnawal	325	24.6	2
Ferguson Fdr 1	Palmerston	325	216.6	5
Gribble 2	Gungahlin TC	295	192.1	3
Gungahlin 1	Mitchell	295	307.0	8
Gurrang	Casey	325	128.8	8
Hughes 1	Nicholls	325	112.7	3
Lander Fdr 2	Amaroo, Bonner	325	284.1	4
Lexen 1	Nicholls	325	170.8	3
Ling 2	Amaroo	325	17.7	1
Magenta Fdr 2	Amaroo, Jacka	325	65.3	2
Nona 2	Franklin, Mitchell	325	223.4	5
Riley 2	Ngunnawal	325	158.1	3
Saunders Fdr 1	Casey	325	166.9	5
Wanganeen Fdr 1	Ngunnawal	215	48.3	1
Wellington Fdr 1	Ngunnawal	215	1.6	1
West 2	Gungahlin TC	325	250.1	4

The feeder loadings and configurations allows for the potential consolidation of feeders and the release of feeder bays for future use. This is considered as a core part of the recommended solution to cater for the initial customer connection requirements

Following a failure of an 11 kV circuit breaker, all customers on the feeder will experience an outage which must be restored or back fed within the hour in order to meet supply standard requirement. In addition, although explicit impact on reliability indices are not considered, the lightly loaded feeder also ensures that the number of customers lost for the failure, mal-operation or outage of the 11 kV circuit breaker or 11 kV feeder are minimal.

Taking the above factors into consideration, the feeders chosen as suitable for potential consolidation are given in Table 7. The feeders chosen are loaded below 22%.The consolidation involves transferring the load of 'Feeder B' to 'Feeder A'. Feeder B is then disconnected and made available along with the circuit breaker for a new feeder connection thus making a dedicated 11 kV feeder bay available. This is included in the recommended option.

Table 7: Feeder Consolidations

Feeder A	Feeder B	Combined Loading (A)	Meets Feeder Loading Criteria
Wellington Fdr	Gurrang Fdr	130	Yes
Bunberung Fdr	Wanganeen & Birrigai	151	Yes
Ling Fdr	Magenta	85	Yes

[3] *A number of lightly loaded feeders supply load to in the Northern direction, whereas the load growth especially the large loads are to the South of the substation. Boulevard North 2 feeder that supplies the Gungahlin town centre has not been consolidated as the load in the town centre is expected to increase.*

4. Options and Recommended Expenditure

AAD has investigated the options of consolidating lightly loaded feeders, establishment of new feeder bays and an option that combines consolidation of feeders and establishing new feeder bays to optimize cost and network reliability. These options are discussed below:

4.1 Option 1: 'Do Nothing' - Connect new loads to existing lightly loaded feeders

Description:

Under this option, any new customer loads will be connected to the existing 'lightly' loaded feeders where feasible. AAD will not spend any substantial capex on the Gold Creek Zone Substation.

While there are seven (7) 'lightly' loaded feeders, new customer loads cannot be connected to all these existing feeders as this arrangement also means that dedicated feeder bays for large loads cannot be provided. Without dedicated feeder bays for large customer loads, network switching becomes cumbersome thus increasing operational costs. Complex switching arrangements also increase safety risks to the network customers, staff and general public. With complex switching arrangements, there could also be an increase in response times to restore customer supplies after a network fault, storms or similar. A trip of a feeder circuit breaker will result in more customers losing supply for longer durations resulting in potential STIPIS penalties for AAD. These switching and return to service response times are particularly relevant when considering the known block loads documented in section 3.4 Commercial Block Loads, which includes two (2) known commercial blocks loads and the ACT's Light Rail Project.

This option would connect the new customer loads to 'lightly' loaded feeders where there are no physical constraints. The feeders that are lightly loaded feed loads northwards, whereas the new customer load growth is generally in the south. Perusal of this option can provide two (2) feeder bays that would only partly meet load growth in the south. Refer to section 3.6 Gold Creek Distribution 11kV Feeder Ties for specific details.

Residual Risk:

The option of doing nothing does not allow AAD to comply with its regulatory obligations on the basis of:

- not providing a HV connection solution to meet the forecast customer loads;
- due to physical constraints, there could be a delay in processing and connection of new customer load applications resulting in breach of the National Energy Customer Framework (NECF) timeframe regulations;
- inability to provide dedicated feeder bays would increase network switching complexity and costs;
- increased safety risks due to complex network switching arrangements;
- with increased switching requirements, it will take longer to restore customer supplies following a network fault or similar which would impact network reliability performance;
- inability to provide dedicated feeders to forecast block load customers requiring high level of security of supply as no spare feeders would be available.

AAD concluded that this option offers no cost efficient solution to overcome the anticipated physical connection constraints at the substation.

4.2 Option 2: Consolidation of existing feeders

Description:

Feeder consolidations releases three (3) feeder bays providing a solution for some of the initial 11 kV feeder bay requirements associated with customer initiated loads. However; it only provides a partial solution as insufficient feeder bays are released to meet the development growth and longer term network needs. Consolidation of feeders are advantageous in that, it frees up dedicated bays that can support the forecast demand growth so that there are minimal physical constraints in connecting new loads at the substation. This is a low cost solution that ensures feeder bay availability for immediate use (estimated time for consolidation is six (6) months). The consolidation of feeders involves transferring load from 'Feeder B' to 'Feeder A' as identified in Table 8, this integration/consolidation allows 'Feeder B' to be available to connect new loads.

The feeder consolidation provides a low-cost partial solution by providing three feeder bays and assists in delaying the establishment of four additional feeders for a short time. The consolidation of feeders have a relatively short execution timeframe, expected to be less than six (6) months, and are therefore considered a prudent and cost efficient option to provide a supply solution for the customer initiated capital projects. The cost will include preliminary planning, some field switching and asset recording. The cost of each consolidation is estimated to be approximately $4,600; therefore the cost of providing three additional feeder bays is estimated at $14,000

Table 8:: Potential Feeder Consolidations

Feeder A	Feeder B	Combined Loading (A)	Meets Feeder Loading Criteria
Wellington Fdr	Gurrang Fdr	130	Yes
Bunberung Fdr	Wanganeen & Birrigai	151	Yes
Ling Fdr	Magenta	85	Yes

Residual Risks

- Purchase and installation of 11 kV circuit breakers is the longest lead time item for establishing new feeders, and potentially longer lead time for the commissioning of new block loads; not providing a complete solution can result in the network being unable to meet growth for baseline demand and customer initiated demand, putting AAD in breach of its regulatory obligations
- Excessive consolidation impacts on the ability of utilizing the existing distribution network's infrastructure for future customer connections, as the existing feeders capacity will be reduced significantly by the proposed load consolidation. In the case of a zone substation such as Gold Creek with a demonstrated growth potential, it would be poor planning, resulting in unnecessary future reactive expenditure, to fully load up all the feeder bays and make no provision for inevitable growth over the coming few years.
- Excessive consolidation also impacts on the ability to separate industrial from residential customers and other customer classes. This facility is important as the strategy for planned outages is critically dependent on the customer class predominant on the feeder.
- Consolidation impacts on reliability of supply, as this arrangement increases the sum of the impacted distribution substations by a fault on that feeder. The protection schemes of the associated distribution substations may need to be reviewed to assess its grading capability with the zone substation's protection, which lead to a revision of the protection schema in a number of distribution substations.
- Although consolidation provides a short term saving of capital expenditure, without due consideration of mitigating the effects of the above points, it would be false economy leading to added operational costs in rectifying excessively complex feeder faults, and future capital expenditure in providing additional capacity that should have been foreseen and catered for.

Assessment:

Feeder consolidation only meets part of the needs and would not be able to meet demand over the forecast period. Feeder consolidation on its own is not a credible solution, however can form part of the total solution.

4.3 Option 3: Extension of the switchboard in conjunction with feeder consolidation

This option releases feeder capacity in stages to meet the required demand for the 5-10 year period:

1. **Stage 1**: Feeder Consolidation (provides 3 feeders).
2. **Stage 2**: Switchboard Extension to provide 2 (min) - 4 (max) feeders.

Stage 1 of this option is feeder consolidation (same as option 2); this stage consolidates seven (7) lightly loaded feeders, and releases three (3) feeder bays. Consolidation of feeders frees up dedicated bays that can support the identified load growth so that there are no physical constraints in connecting new loads at the substation. Consolidation of feeders has a relatively short execution timeframe, expected to be less than six (6) months suitable to meet immediate customer requirements. Each consolidation is estimated to be about $4,600; therefore the cost of providing three (3) additional feeder bays is estimated at $14,000

Stage 2 of this option is to extend the existing 11 kV switchboards following the consolidation of feeders. The existing switchboard is an obsolete model ABB switchgear, therefore in order to re-use these, either customised one-off panels have to be made to extend the existing switchboard or joggle chambers are required to interface between the old and new switchboard panels. It is cost efficient to use joggle chambers to interface and use standard panels.

It is proposed that four (4) 11 kV feeder bays and two joggle chambers, if required, be added to the existing switchboards; two feeder bays to accommodate the development growth over the next five years, and two additional spare feeder bays to accommodate growth from 2020 – 2025 also designed to be network spare for unplanned customer connections or spare in the event of the failure of one of the circuit breakers.

The extension of the 11 kV switchboards in conjunction with the consolidation of feeders achieves the objectives of providing sufficient capability to meet the current and future feeder requirements of the network in a prudent and cost efficient manner.

The scope of work associated with the extension includes the:

- Integration of the new switchboards with the existing 11 kV switchboard (same model switchgear or a joggle chamber)
- Extension of the 11 kV switchboard 1 (AG) and switchboard 3 (CG). (providing 2 x 11 kV CBs per group)
- Integration with existing control and protection schemes at Gold Creek Zone Substation

In implementing option three it was found to be prudent and efficient to construct the four (4) feeders including the two (2) required for long term requirements (beyond 2020) in a single stage (see section 3.3 sensitivity analysis).

The cost of the switchboard extension alone is estimated at $756,000. The total capital cost of the preferred solution (option three including feeder consolidation) is estimated at $770,000 and is expected to be completed over a two (2) year period with an expenditure forecast of $270,000 in 2015/16 and $500,000 in 2016/17.

Residual Risk:

There is a risk of underutilisation of the feeder bays. If customer projects are delayed significantly the feeder bays will not be utilised completely in the timeframe expected as a result of demand being lower than expected and significant block loads are delayed. This is mitigated by seeking a financial commitment from the customer prior to major project expenditure.

The option of extending the switchboard without any feeder consolidation can be considered a credible option, however this will be more expensive and would not add economically attractive option to this report and is hence omitted.

Assessment:

Feeder consolidation in conjunction with switchboard extension is a credible and complete solution which allows AAD to comply with it regulatory obligation of considering the long term interests of the customer. One of the commercial block loads has already established its initial load therefore there is a high probability of further load uptake – therefore this block load can be classified as having a high confidence level and the risk of underutilisation is low.

5. Sensitivity Analysis

This section includes the sensitivity analysis on key assumptions.

Scenario 1 - Defer investment for extension of the switchboard

Deferral of the four feeder bays by three years; commencing construction in 2018/19 from the preferred commencement date of 2015/16 in anticipation of delayed loads yields a net present cost reduction of approximately 7.3% of the capital investment. When the investment commences in 2015/16, the net present cost is $678,669 over 10 years at 8% discount rate, compared to minimal initial investment for feeder consolidation in year 2015/16, followed by a 3 year deferral of the switchboard extension at $629,014. The order of saving and the increased risk (due to deferral) of not having any spare feeder bays for an extended time is not sufficient to warrant deferral of capital. Feeder consolidation with minimal upfront works is assumed to be progressed in 2015/16 at an estimated cost of $14,000.

Load growth is unlikely to be deferred to such an extent that it is viable to defer the investment to the next regulatory period. One of the commercial block load has already established initial loads therefore there is a high probability of further load uptake. The second commercial block load is at advanced stages of commitment, therefore, the block load can be classified as a high confidence load and the risk of underutilisation is low.

The potential for one of the known commercial block loads to be delayed by up to four (4) years, causing the deferment of capital investment by three years, does not have a material impact on the net present cost of the project.

Scenario 2 - Staging the extension of the switchboard

The approach here is to construct the two (2) feeder bays required for the 2015-2020 period and defer the additional two (2) feeder bays proposed for the 2020-2025 period. Feeder consolidation with minimal upfront works is assumed to be progressed in 2015/16 at an estimated cost of $14,000. This scenario explores the cost efficiency of deferring part of the investment and any economy of scales applicable.

In absolute value, a two (2) feeder bay extension is 30% lower than the preferred of establishing four (4) additional feeder bays. However, if the additional bays are simply delayed rather than not being required at all in the near future, then the overall net present cost is increased by 6.4% over the preferred solution. This is because of the economy of scale in ordering and customising switchgear, remobilising labour and other overheads achieved through implementing all the proposed feeder bays at the same time by the same contractor.

The demand projection establishes that a minimum of two (2) feeder bays is required. Deferral of projected capacity augmentation gives the option to not construct the additional bays in the future. From undertaking customer consultant and from analysis of demand forecasts, it is considered that additional feeders will be required in the future and within the 2014-19 regulatory period. The sensitivity analysis demonstrates that deferring the spare feeders to the next period does not have an overall present cost benefit. Therefore it is both practical (in terms of efficiency of costs and ensuring supply standards) and prudent to expand the switchboard with sufficient connection capacity to accommodate long term growth.

Table 9: Cost components of the sensitivity studies

Cost Components of the sensitivity studies -	**Cost**
Stage 1 – Two 11kV Feeder Bay, joggle chambers, civil works and contract management	$ 529,200
Stage 2 – Two additional 11kV Feeder Bay, joggle chambers, civil works and contract management in 19/20	$ 300,000
Stage 1 & 2 - Four 11kV Feeder Bay, joggle chambers, civil works and contract management	$ 756,000

Table 10: Results of the sensitivity analysis

Discount Rate	**8%**								
Sensitivity Analysis	**Year 0**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Total**	**Present Cost**	**Change**
	14/15	**15/16**	**16/17**	**17/18**	**18/19**	**19/20**			
Preferred Solution (option 3)	0	$ 270,000	$ 500,000				$770,000	**$678,669**	0
Scenario 1 - Deferred Investment	0	$ 14,000			$ 255,600	$ 500,000	$769,600	**$629,015**	-7.30%
Scenario 2 - Staged Construction	0	$ 270,000	$ 273,200			$ 300,000	$843,200	**$722,375**	6.40%

6. Option Assessment

6.1 Options Comparison

Table 11: Summary of options

Options	Advantages and Disadvantages	Assessment
Option 1 **'Do Nothing'** Connect new loads to lightly loaded feeders	**Disadvantages** ▪ Provides partial solution does not meet projection for the 5 year period ▪ Inability to provide dedicated feeders for large loads such as data centres ▪ No spare feeders at Gold Creek Zone Substation ▪ Risk of not meeting need within timeframe to connect customers ▪ Outage of existing loads to cut over the new loads into existing feeder bays ▪ Volume of load lost and number of customers lost for a single failure event of the 11 kV circuit breaker is high ▪ Potential physical constraints **Advantages** ▪ Low cost and meets immediate requirements ▪ No additional CAPEX/OPEX investment	Non regulatory compliant Partial Solution; addresses immediate need – not a complete credible solution as it does not meet full capacity required
Option 2 **Feeder Consolidation**	**Disadvantages** ▪ Provides partial solution of releasing three (3) feeder bays; does not meet projection for the five (5) year period **Advantages** ▪ Allows deferral of extension of the switchboard or meets immediate client requirements and potentially allows for deferring CAPEX investment in switchboard extension ▪ Low cost solution of ensuring availability of capacity ~estimated at **$14,000**[4] for three feeder consolidations identified ▪ Release of suitable (without physical constraints) feeder bays ▪ Optimises utilisation of existing feeders	Non regulatory compliant Partial Solution; addresses immediate need – considered as cost effective in addressing immediate requirements.
Option 3 **Extension** of the switchboard in conjunction with feeder consolidation **(Recommended)**	**Disadvantages** ▪ Significantly more expensive than option 2 - Cost of CAPEX **$770,000** with $14,000 for stage 1 (feeder consolidation) and $756,000 for stage 2 (extension of switchboard) ▪ Potential of being underutilised if demand forecast is not met. **Advantages** ▪ Provides immediate solution via feeder consolidation ▪ Provides complete solution to accommodate demand forecast 5-10 years ▪ Provides system spare of feeders required for customer connection ▪ Economy of scale in constructing four (4) additional breaker bays, including two (2) for long term use or as 'spare'	**Regulatory compliant** **Preferred Solution**

[4] *All costs in this report are estimated 2012/13 direct costs and includes overheads.*

6.2 Preferred Solution

The preferred option (Option 3 – Consolidation of feeders and feeder bay extension) complies with AAD's regulatory obligations and offers the opportunity to stage the low cost feeder consolidation as stage 1 to meet requirements for the 2014-2019 regulatory period and stage 2 to extend the switchboard to accommodate four additional feeders to meet requirements for the 2019-2025 regulatory period.

The preferred option releases three (3) feeder bays, including an 11kV circuit breaker by consolidating seven (7) lightly loaded feeders into three bays. The sensitivity study establishes that it is economical to establish 4 feeder bays when extending the switchboard as the cost of the additional feeders is incremental.

A budgetary provision of $770,000 has been included in the 2014-19 regulatory period with an expenditure forecast of $270,000 in 2015/16 and $500,000 in 2016/17.

7. Recommendation

The Gold Creek Zone Substation demand forecast predicts a 3.3% trend growth rate which is much higher and more consistent than the trend diversified growth rate forecast for the rest of AAD's distribution network. The key drivers supporting the forecast growth rate include: continued baseline growth in existing residential areas; continued developments in suburbs such as Casey and Crace; new development areas in suburbs such as Moncrief, Taylo; and Throsby, and known customer initiated block loads in the Mitchell District.

The forecast demand growth indicates an increase in base residential demand for loads supplied by the Gold Creek Zone Substation in excess of 15 MVA over the next five (5) years, with a consequential requirement for at least two feeders within the 2014-19 regulatory period. Known customer initiated commercial block loads require two dedicated feeder bays. A further two feeder bays are forecast to be required for the period 2020 – 2025. In total it is identified that there are seven (7) feeder bays required to meet the forecast demand over the next ten (10) years.

The zone substation currently has approximately 55 MVA of load and utilises the twenty (20) existing 11 kV feeders. The high confidence commercial spot loads and the fact that the zone substation is not capacity constrained suggests that spare 11 kV circuit breakers should be available at the Gold Creek Zone Substation. It is common DNSP practice to have one (1) preferably (2) spare 11kV circuit breakers on each 11 kV zone switchboard in urban areas to cater for generic growth, unexpected block loads, and unplanned circuit breaker failures.

Further, customer initiated projects generally require an execution timeframe of less than twelve (12) months to accommodate project schedules. Purchase and installation of 11 kV circuit breakers and switchgear is the longest lead time item for establishing new feeders, and can be longer than the lead time given by some project developers for the commissioning of new spot loads. Extending the switchboard and ordering customised panel to interface with the existing switchboard at Gold Creek Zone Substation cannot be delivered to meet the demand forecast unless construction commences in 2015/16.

The preferred solution is a combination of the short term, low cost solution of consolidating feeders to release three (3) dedicated feeder bays and the long term solution of extending the switchboard to provide four (4) additional feeders. In addition to the consolidation of feeders being a cost effective solution it also has a short execution time (6 months), but provides only a partial solution as insufficient feeder bays are released to meet the long term demand forecast. This solution optimises the use of assets and provides a cost effective solution to meet long term requirements.

Stage 1: Feeder Consolidation; estimated at $14,000

Stage 2: Switchboard Extension; estimated at $756,000

Sensitivity analysis on the preferred solution demonstrates that due to the economy of scale, it is prudent to consider the long term (10 year) forecast requirements of the network and establish four (4) additional feeder bays rather than stage the extension. The efficiency of the solution is achieved by combing a cost-effective low cost solution where practical to the relatively more expensive but inevitable solution of expanding the existing switchboard.

It is recommended that the preferred solution of feeder consolidation followed by extension of the 11 kV switchboard at Gold Creek Zone Substation for the provision of seven (7) feeder bays be undertaken at an estimated cost of $770,000 in 2015/16 and 2016/17.