Draft Recommendation:

Emerging Transmission Network Limitations –

Brisbane South/Logan Region

(including part of the Greater Brisbane metropolitan area, the Port of Brisbane and TradeCoast industrial area)

Powerlink Queensland
8th March 2002

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While care was taken in preparation of the information in this paper, and it is provided in good faith, Powerlink accepts no responsibility or liability for any loss or damage that may be incurred by any person acting in reliance on this information or assumptions drawn from it. This draft recommendation has been prepared for the purpose of inviting information, comment and discussion from interested parties. All information and underlying assumptions should be independently verified to the extent possible before assessing any investment proposals.

1.0 Executive Summary

Powerlink Queensland has identified emerging limitations in the 275kV transmission network supplying the high growth Brisbane South/Logan region of south-east Queensland.

This region is primarily supplied by a double circuit 275kV line between Swanbank/Blackwall, near Ipswich, and a major supply substation at Belmont in Brisbane's southern suburbs. This line is reaching capacity limitations. Technical studies have identified that, from late 2003, an outage within the 275kV network supplying the Brisbane South/Logan area will cause loss of supply to customers. Action is required to overcome these limitations before late 2003 to allow Powerlink to meet its obligations under the Electricity Act and technical standards in the National Electricity Code.

Powerlink carried out consultation with interested parties to identify and determine feasible options to address the emerging network limitations. The feasible options identified were:

- **Option 1** involves construction of a double circuit 275kV line between Blackwall and Belmont, and includes the establishment of a new 275kV switching station at Greenbank.
- **Option 2** is the same as Option 1, except that the Greenbank switching station is excluded from the initial works.
- **Option 3** involves construction of a 275kV network augmentation between Swanbank and Belmont.

As part of the consultation carried out in 2001, Powerlink sought information on potential non-network alternatives (eg - involving demand side management initiatives or local generation) capable of addressing the identified network limitations. Whilst no such alternatives were identified, industry participants are invited to offer any new information in response to this draft recommendation.

Financial analysis was carried out to calculate and compare the Net Present Value (NPV) of the costs to market participants of the feasible options identified, in accordance with the ACCC Regulatory Test. The analysis included evaluation of the options under four scenarios associated with differing load growth outcomes and assumed Gold Coast augmentation requirements. Sensitivity to assumptions about capital cost, cost of network losses and discount rate was also assessed.

The ACCC Regulatory Test requires that for reliability requirements (as is the case for the Brisbane South/Logan area limitations), the recommended option be the option with the lowest net present value cost. The economic analysis in this paper identified that Option 2 is the least-cost solution over the fifteen-year period of analysis. Option 3 is similar in cost, but in the short-term results in a weaker network with inherently lower capability than Option 2.

Sensitivity analysis showed the results of the financial analysis to be consistent under variations of critical parameters in the analysis. Consequently, this report contains a draft recommendation to implement Option 2 to address the identified 275kV network limitations in the Brisbane South/Logan area:

- Powerlink to construct a double circuit 275kV line between Blackwall and Belmont at an estimated cost of $63.8M.

Powerlink invites submissions from Code Participants and interested parties on this draft recommendation. The closing date for submissions is Friday 5th April 2002.

2.0 INTRODUCTION

This report contains a draft recommendation to address emerging transmission network limitations in the Brisbane South/Logan region of south-east Queensland.

This draft recommendation is based on:

- The assessment that a reliable power supply will not be able to be maintained to the relevant area during credible single contingencies from late 2003 onwards.

- the consultation undertaken by Powerlink to identify potential solutions to address these emerging network limitations, and

- an analysis of feasible options in accordance with the Regulatory Test prescribed by the Australian Competition and Consumer Commission (ACCC).

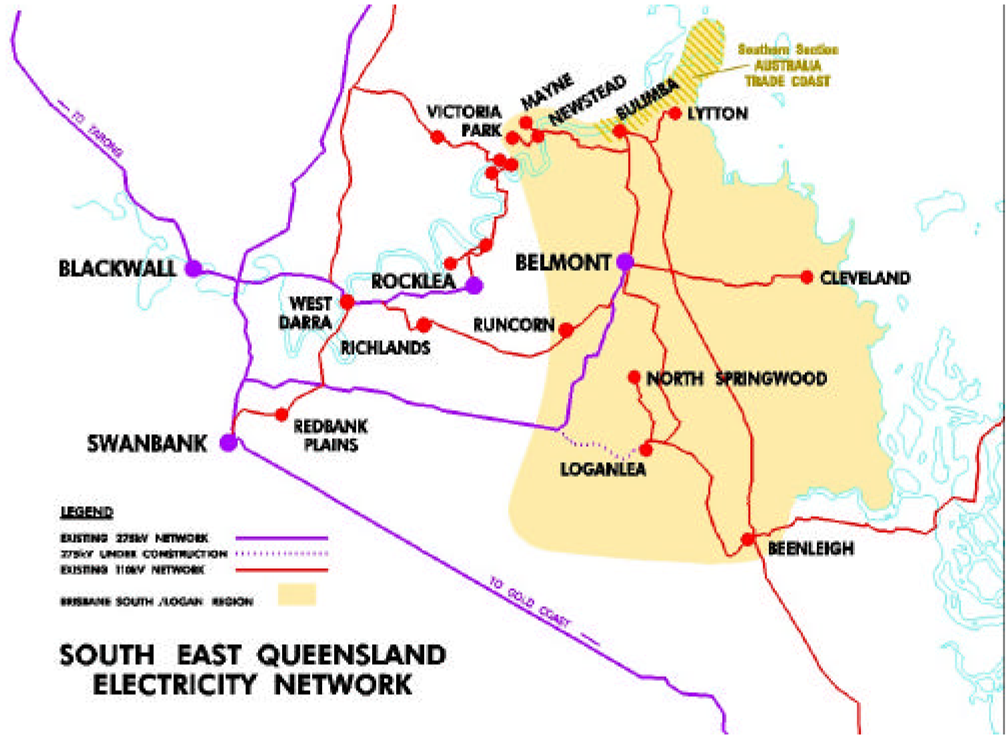
The recommended option maximises the net economic benefits to participants in the National Electricity Market. These economic benefits arise from maintaining a reliable power supply during single network contingencies at the least cost to the market and therefore to end-use customers.

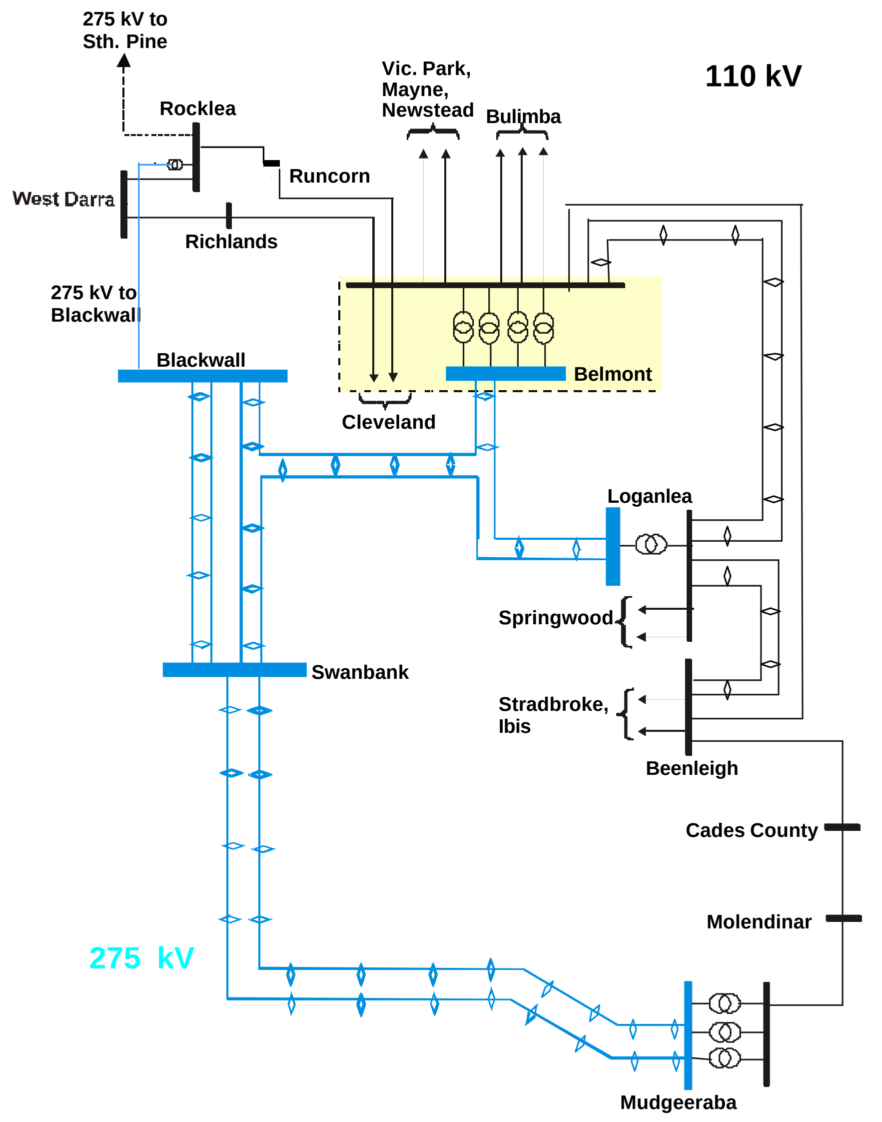
3.0 SITUATION OVERVIEW

Analysis by Powerlink has determined that, without corrective action, the capability of its grid supplying the Brisbane South/Logan area will be exceeded from the summer of 2003/04 onwards.

The Brisbane South/Logan Region is part of the Greater Brisbane metropolitan area, with relatively high population density. The relevant area represents about one-third of total electricity demand in the South East Queensland region, and incorporates most of Brisbane's southern suburbs, part of the Brisbane central business district, a large proportion of the TradeCoast industrial area near the Port of Brisbane, and the fast-growing area around Logan City.

Primary electricity supply to the area is via a double circuit 275kV transmission line between Swanbank/Blackwall (near Ipswich) and Powerlink's Belmont substation (in the south-east suburb of Mansfield) – refer map below. Power flows across these 275kV lines have been increasing over time, with peak loading occurring during the summer months from October to March.





System as at Winter 2002

Detailed load flow analysis has determined that, notwithstanding available subtransmission support, the capability of the existing network will be exceeded during a single fault or contingency by late 2003[1]. During a single contingency, the remaining Belmont circuit would be carrying approximately 880-900MVA, exceeding its summer emergency thermal limit (the safe maximum current carrying capacity of the equipment) of 861MVA[2]. Local 110kV lines in the area would also become overloaded in these circumstances.

If no action is taken to address this situation, customer loadshedding will be required during single contingencies to allow the electricity system to be operated safely (ie – to avoid unacceptable line overloads when any single 275kV network element is out of service)[3].

This does not allow Powerlink to meet 'N-1' reliability planning criterion (that is, the ability to supply all load with any single network element out of service) as defined in the National Electricity Code[4]. Therefore, capacity augmentation is required to maintain a reliable power supply to customers in the Brisbane South/Logan area.

[1] Assuming sufficient reactive reserves at Blackwall and the availability of both 50MVAr 110kV capacitor banks and at least one 120MVAr 275kV capacitor bank at Belmont. Also assumes medium load growth forecasts as published in Powerlink's 2001 Annual Planning Report….Powerlink anticipates that these forecasts will be revised in mid 2002. Very high power demands (well above demand forecasts) occurred during the summer period in 2001/02. These demands will be adjusted for temperature effects, and the long-term implications assessed over the next few months.

[2] Assumes establishment of Loganlea substation in early 2002. Load flows have been predicted based on an assessment of the worst single contingency, at peak demand and assuming a typical generating pattern.

[3] There would also be an increased risk of total collapse of the power system supplying Belmont.

[4] The Powerlink system has not been designed to withstand low probability, simultaneous double contingencies. However, solutions to address the emerging limitations during single contingencies may reduce or eliminate the severe loss of supply which occurs during a double circuit outage of the 275kV lines supplying the Brisbane South/Logan area.

4.0 OPTIONS CONSIDERED

4.1 Consultation Summary

In February 2000, Powerlink published a public notice[5] advising it was reviewing electricity demand forecasts and analysis related to the transmission of electricity into the south-east suburbs of Brisbane, Logan City and the Gold Coast beyond 2002. The review sought to identify developments that might impact load forecasts and/or the need to augment supply to these areas.

Powerlink also identified in its 2001 Annual Planning Report[6] an expectation that action would be required in the relatively short-term to address an anticipated major network limitation related to supply to the Belmont and Loganlea bulk supply points.

In June 2001, Powerlink issued a discussion paper providing more detailed information on the emerging network limitations in the Brisbane South/Logan area. This paper was the first step in meeting regulatory requirements related to potential network augmentations. It sought information from Code Participants and interested parties regarding potential solutions, including non-network solutions, to address the anticipated network limitations.

Powerlink received submissions from two (2) parties in response to the discussion paper:

- Brightstar Environmental, potential developers of renewable energy generation facilities in the Logan area
- CS Energy, owners of Swanbank Power Station.

Issues raised by these parties have been considered by electricity system planners at Powerlink (see section 4.2). Other information used in identifying potential solutions to address the network limitations included technical information about existing network capability, and independent load growth forecasts from the National Institute of Economic and Industrial Research (NIEIR).

Information gathered from these submissions, and in some cases from follow-up discussions, is outlined below. In addition to the more formal submission process, Powerlink is involved in a working group with major industrial energy users in the TradeCoast area near the Port of Brisbane, Energex and the Queensland Government Department of State Development. Major customers such as Incitec and Caltex have expressed their views to Powerlink regarding the importance and economic implications of a reliable power supply to the area.

4.2 Non-Transmission Options Identified

The primary purpose of the initial discussion paper was to identify feasible non-transmission solutions to be included in the analysis. In summary, the consultation identified the following information regarding solutions to address the emerging network limitations:

(a) *Demand side management (DSM)* – No information was put forward on possible demand side management during the consultation process. It is Powerlink's assessment that it would be difficult to achieve sufficient DSM to address the emerging network limitations. Existing demand side management programs in the Brisbane South/Logan area, and routine hot water switching activities, have been included in the demand forecasts used in the planning process. Load reductions to address the emerging network limitations would therefore be likely to require a large number of customers to voluntarily 'switch off' at peak periods. This is due

[5] Public notice advertisement in The Courier-Mail and Gold Coast Bulletin, 19th February 2000.
[6] Published in July 2001

primarily to the flat load duration curve characteristic of energy usage in the relevant area, which gives rise to extended periods throughout peak usage times that the existing grid will be unable to supply all energy requirements.

(b) *Grid support from existing generators* – During the consultation process, a submission was received from CS Energy, indicating its willingness to consider operation of generators at Swanbank to provide transmission support if this could assist in addressing the emerging network limitations. It was determined that grid support from generating units at Swanbank is not capable of addressing the emerging network limitations, as these generating units are 'upstream' of the network limitation. All other existing generators[7] cannot provide support either, as they do not alter the power flows on the critical transmission circuits between Swanbank/Blackwall and Belmont.

(c) *Smaller local generation* – An allowance for potential cogeneration and renewable energy developments in the relevant area is included in Powerlink's forecasts of energy and demand. Generation above these allowed levels would be required if local generation is to assist in addressing the identified network limitations. Any new generation plant would also need to be at least 30MW in size to have any significant impact on the emerging network limitations. 30MW is approximately equivalent to one year's load growth in the Brisbane South/Logan area.

No additional recently committed local generation projects in the relevant area were advised to Powerlink in the initial phase of the consultation.

Brightstar Ltd provided information that local governments in the relevant area were considering the establishment of waste-to-energy generation facilities, which could be developed up to 30MW in size by late 2003. However, no commitment to such generation has been made.

Uncommitted project proposals are not considered viable solutions to address the emerging network limitations. If new generation proposals are not developed by the summer of 2003, significant interruptions to customer power supply could result. This risk is not considered acceptable in an area of high density residential, industrial and tourism importance such as the Brisbane South/Logan area.

4.3 Transmission Options Identified

In addition to the consultation process to identify possible non-transmission solutions, Powerlink carried out studies to determine the most appropriate transmission network solution to address the emerging limitations.

4.3.1. Route Options

Powerlink has been carrying out community consultation on possible route options to reinforce the South East Queensland transmission network for several years. It is proposed that potential transmission solutions to address the Brisbane South/Logan network limitations follow a route from Blackwall (near Ipswich) south to Greenbank passing close to the Swanbank Power Station, and then north from Greenbank to Belmont via Loganlea. The majority of this land corridor was acquired in the late 1980s. Powerlink has been working with the community in the area during the past two years to finalise environmental work and easement acquisition to allow the network to be augmented when necessary. Utilising this existing easement is a feasible solution to the emerging network limitations in the Brisbane South/Logan area – see section 5.0.

[7] with available capacity and of sufficient size

As part of the route evaluation process, Powerlink also considered an option using an easement from Bundamba near Ipswich to Belmont[8]. This option had some significant technical deficiencies resulting in unacceptable overloads on the existing lines between Blackwall and Swanbank within two years. This route option is therefore not a viable solution as it requires further major augmentation almost immediately[10].

4.3.2. Transmission Development Options

Three feasible options utilising the easement via Greenbank were identified through the consultation process and internal technical studies:

- **Option 1** involves construction of a double circuit 275kV line between Blackwall and Belmont, and includes the establishment of a new 275kV switching station at Greenbank.
- **Option 2** is the same as Option 1, except that the Greenbank switching station is excluded from the initial works.
- **Option 3** involves construction of a 275kV network augmentation between Swanbank and Belmont.

Further details of these options are contained in the next section, and in the spreadsheets in Appendix 2. It should be noted that the spreadsheets include some related works to correctly compare the economic impacts of each option. For example, augmentation of supply to the Gold Coast is expected to be required in late 2007[11] independently of the need to address the emerging network limitations in the Brisbane South/Logan area. However, the timing of major augmentation to the Gold Coast may affect the economic comparison of options to address the Brisbane South/Logan area issues. This is explicitly taken into account in the financial analysis.

[8] This easement runs parallel to an existing line along the Logan Motorway for much of its length

[10] It is anticipated that future development of the electricity system may allow this route to be utilised in the longer term
[11] The sensitivity of this assumption to changes in load growth is tested by use of scenarios, as discussed in section 6.0.

5.0 Feasible Solutions

This section provides an overview of the feasible options identified, with full details of the financial analysis contained in the spreadsheets in Appendix 2. Other augmentations which are common to all options are excluded from the financial analysis.

Option 1 – Augmentation of Supply from Blackwall with early establishment of Greenbank substation		
Date Reqd Late 2003	Augmentation Construct double circuit 275kV line from Blackwall to Belmont Establish Greenbank switching station	Capital Cost $88.7M

In option 1, construction of a network augmentation would begin immediately for completion by late 2003. The works in option 1 include the construction of a double circuit 275kV line from Blackwall to Belmont, with the establishment of a 275kV switching station at Greenbank (see diagram in Appendix 1).

The new double circuit 275kV line will provide substantial additional transfer capacity to the area (Belmont would be supplied by four 275kV circuits instead of the existing two circuits), and this option therefore overcomes the identified emerging network limitations.

In the short to medium term, only one additional 275kV circuit is required to overcome overloads during single contingencies in the network supplying the Brisbane South/Logan area. However, it is important in terms of land use planning to utilise easements to cater as much as possible for future power needs, particularly in urban areas. Powerlink therefore considers it essential to construct a double circuit line on the easement between Blackwall and Belmont, rather than a single circuit line. This easement is a key land corridor between power sources feeding into Blackwall substation and the major population areas of south-east Queensland. Maximum use of the easement is necessary to reduce requirements for new infrastructure in the future.

As noted above, Option 1 also includes the establishment of Greenbank switching station by late 2003. This is an advancement of works which are assumed to be required in 2007 to augment supply to the Gold Coast. By 2007, the existing lines to the Gold Coast are expected to reach thermal limits (the maximum current carrying capacity of the lines)[12]. While significant network augmentation may be required, only works not common to all options to address the Brisbane South/Logan area issues have been included in this paper. The rationale for the advancement of the switching station at Greenbank is that it improves operational flexibility of the new lines to Belmont by creating a 'mid-point' switching station. In addition, it would allow placement of shunt capacitors at a strategic location to improve the voltage stability and capability of the network supplying the Brisbane South/Logan area. There are also some construction advantages associated with advancing the substation works at Greenbank.

[12] Augmentation may be necessary earlier, depending on solutions to the emerging voltage control issues associated with the transfer capability of the existing grid supplying the Gold Coast. A separate consultation process will be undertaken to identify and evaluate potential solutions.

Option 2 – Augmentation of Supply from Blackwall without Greenbank switching station		
Date Reqd	Augmentation	Capital Cost
Late 2003	Construct double circuit 275kV line from Blackwall to Belmont via Greenbank	$63.8M
Late 2007	Establish Greenbank switching station	$25.8M

Option 2 is the same as Option 1, except that Greenbank switching station is not established in late 2003. Instead, it is assumed to be established in late 2007, when it is expected to be required to address Gold Coast supply issues.

There will be some additional costs overall in this option in comparison with Option 1. It will be necessary to construct the new double circuit line to Belmont around Greenbank substation site, so that construction of the switching station can safely be carried out later.

Option 3 –Augmentation of Supply from Swanbank without Greenbank switching station		
Date Reqd	Augmentation	Capital Cost
Late 2003	Construct 275kV line from Swanbank to Belmont via Greenbank	$53.8M
Late 2007	Establish Greenbank switching station Construct double circuit 275kV line from Blackwall to Swanbank; reconfigure network at Swanbank to provide for double circuit supply Blackwall to Belmont	$25.0M $14.5M

Option 3 is similar to Option 2, except that construction of the section of 275kV line between Blackwall and Swanbank is deferred. Therefore, this option requires that a 275kV line initially be constructed from Swanbank Power Station to Belmont.

Option 3 provides additional transfer capacity to the Brisbane South/Logan area, and thus overcomes the identified emerging network limitations. However, the network capability is considerably lower than Options 1 & 2 in the early years. A double circuit 275kV line would be constructed between Swanbank and Belmont because of the need to maximise use of the easement. However, the two circuits would have to be operated in parallel as a single circuit due to physical limitations at Swanbank. Only one circuit can be connected to the power station switchyard[13].

Therefore, Option 3 initially results in only one new circuit supplying the Brisbane South/Logan area (making a total of three 275kV circuits). Three circuits will allow Powerlink to meet n-1 reliability planning criteria – that is, supply will be able to be maintained with one network element out of service. However, during a low probability double circuit outage (such as the incidents in early 2000 which caused major loss of supply to customers), Option 3 would have less capacity than Options 1 & 2. Options 1& 2 would be likely to be able to supply all load during such incidents in the short to medium term, whereas Option 3 would not.

Option 3 also requires additional works in late 2007 when supply to the Gold Coast is assumed to require augmentation. Powerlink's studies indicate that the reactive power capacity in south east Queensland will be exhausted at that time, resulting in likely instability of the power system during contingencies. Option 3 therefore will require augmentation of the network between Blackwall (a

[13] It is not feasible to construct more than one new bay at the existing Swanbank switchyard.

major power injection point in the Queensland electricity system) and Swanbank in late 2007 in addition to the establishment of Greenbank switchyard.

At this time, the system would be reconfigured to allow double circuit operation of the initial augmentation between Swanbank and Belmont.

6.0 MARKET DEVELOPMENT SCENARIOS

6.1 Context for Evaluation of Options

All feasible solutions to the identified network constraints must be viewed in the context of wider developments in the National Electricity Market:

- NEMMCO's Statement of Opportunities (SOO) issued in March 2001 contained information on existing and committed generation developments in Queensland. The SOO noted that approximately 2500MW of new generation capacity was committed for commissioning in Queensland by 2004.

- The new Commonwealth Government legislation to encourage increased generation from renewable energy sources came into effect on 1st April, 2001. Powerlink has incorporated independent forecasts of additional renewable energy generation into the forecasts of demand and energy used in assessing the expected incidence of future network constraints.

- The Queensland Government published the Queensland Energy Policy in May 2000. Recent steps have been taken towards implementation of policy initiatives, such as the requirement for Queensland energy retailers to source 13% of their energy from gas-fired generation from 1 January 2005.

6.2 Assumed Market Development Scenarios

The ACCC Regulatory Test requires that options to address a network limitation be assessed against a number of plausible market development scenarios. These scenarios need to take account of:

- the existing system
- future network developments.
- variations in load growth
- committed generation and demand side developments
- potential generation and demand side developments

The purpose of utilising this approach is to test the Net Present Value costs of the options being evaluated under a range of plausible scenarios.

<u>6.2.1. Existing Network and Future Transmission Developments:</u>

No market development scenarios have been developed related to new transmission works proposed by Powerlink outside the Brisbane South/Logan area. These are independent of the identified network limitations that are the subject of this report, and are considered to be common to all options analysed.

<u>6.2.2. Variations in Load Growth:</u>

Powerlink carries out the majority of its detailed planning using a medium economic growth, typical weather forecast for electricity usage. These forecasts include all known information about existing and planned demand side initiatives, and also include independent forecasts of local embedded generation developments.

Three market development scenarios (A, B, C) have been developed to simulate the impact of variations in customer load growth. A further scenario (Scenario D) has been included to demonstrate the impact on the economic analysis if the 275kV system supplying the Gold Coast requires major augmentation by 2005/06[14].

Scenario A	Medium load growth forecast (medium economic growth and typical weather conditions)
Scenario B	High load growth forecast (higher economic growth and typical weather conditions)
Scenario C	Low load growth forecasts (lower economic growth and typical weather conditions)
Scenario D	Early Gold Coast augmentation (advanced to 2005/06)

The main impact of these scenarios is on the assumed timing of augmentation to overcome thermal limitations in supply to the Gold Coast. Based on Scenario A (medium load growth forecasts), it is anticipated that this major network augmentation will be required in late 2007. This timing changes to 2006/07 for Scenario B (high load) and 2009/10 for Scenario C (low load).

Higher or lower load growth could occur due to actual conditions not matching assumptions about economic growth and electricity consumption patterns, or could reflect the impacts of demand side initiatives and/or output from embedded generators. However, no regard has been given to the cause or source of different electricity load forecasts. The purpose of the scenarios is to test the robustness of the option comparison, so the cause is not relevant to the outcome of the analysis.

6.2.3. Existing and Committed Generators:

Analysis of potential solutions in this paper is not considered sensitive to the generation pattern of existing and committed generators. Other than Swanbank Power Station, major existing and committed generators are located a considerable distance from the Brisbane South/Logan area. Variations in market bidding behaviour by these generators are expected to have minimal impact on the relevant network flows through the 275kV network supplying Belmont substation.

The generation pattern at Swanbank influences the relative amounts of power flowing on the existing Blackwall-Belmont circuit versus the existing Swanbank-Belmont circuit. However, this has no impact on the network limitations identified in this paper. From late 2003, loss of supply will occur during a contingency on either circuit regardless of generation at Swanbank, which is ‘upstream’ of the network limitation. For this reason, market development scenarios have not been developed to test assumptions about different operational patterns of existing and committed generators.

6.2.4. Potential Generation Developments:

Recent additional generation capacity commitments within Queensland mean that a healthy electricity supply-demand balance is anticipated over the medium term. New generation is only likely to be developed where organisations identify commercial opportunities, rather than being developed in response to load requirements. Large generation developments outside the immediate area (eg – such as proposals for major new generation in north Queensland or at Kogan Creek) will have minimal impact on the Brisbane South/Logan area limitations, and are therefore not significant factors in this study.

[14] The supply to the Gold Coast is presently limited by voltage stability issues. Consultation will occur on options to address this short-term issue. One option is to advance works which are assumed in this paper to be required to address thermal limitations that are expected to become a problem in later years.

Smaller generation developments may occur in the Brisbane South/Logan area in response to government initiatives to encourage the development of renewable energy generation and generation from gas-fired power sources. Powerlink is not aware of any well-advanced new generation proposals in the immediate area where the network limitations exist, and none have come forward in response to the previous call for options. However, it is plausible that such a generation development could occur. To avoid bias due to assuming a specific location for a hypothetical generator, Powerlink instead believes that Scenario C most appropriately reflects the impact of additional local generation. If an embedded generator approximately 30MW in size was developed and connected to the Energex distribution system at one of the relevant connection points in the Brisbane South/Logan area, it would reduce the forecast load needing to be supplied via the transmission and distribution network while it was operating. The impact on the existing network could therefore be considered equivalent to a lower load growth assumption such as that in Scenario C.

7.0 FORMAT AND INPUTS TO ANALYSIS

7.1 Regulatory Test Requirements

The requirements for the comparison of options to address an identified network limitation are contained in the Regulatory Test prescribed by the Australian Competition and Consumer Commission (ACCC)[15].

The Regulatory Test requires that the recommended option be the option that "maximises the net present value of the market benefit having regard to a number of alternative projects, timings and market development scenarios". To satisfy the Test, a proposed augmentation must achieve a greater market benefit in most, *but not necessarily all*, credible scenarios.

The Regulatory Test contains guidelines for the methodology to be used to calculate the net present value (NPV) of the market benefit. For example, where an augmentation is required to satisfy objectively measurable reliability standards, the methodology published by the ACCC defines "market benefit" as the total net cost to all those who produce, distribute and consume electricity in the National Electricity Market. That is, the option with the lowest net present value cost maximises the market benefit.

Information to be considered includes the 'efficient operating costs of competitively supplying energy to meet forecast demand' and the cost of complying with existing and anticipated laws. However, the Regulatory Test specifically excludes indirect costs, and costs that cannot be measured as a cost in terms of financial transactions in the electricity market.

7.2 Inputs to Analysis

A solution to address emerging network limitations in the Brisbane South/Logan area as outlined in this document is required to satisfy reliability requirements linked to Schedule 5.1 of the National Electricity Code and the requirements of the Queensland Electricity Act[16].

According to the ACCC Regulatory Test, this means that the costs of all options must be compared, and the least cost solution is considered to satisfy the Regulatory Test. The results of this evaluation, carried out using a cash flow model to determine the Net Present Value (NPV) of the various options, are shown in section 8.0.

Cost inputs to the NPV analysis are described below.

7.2.1. Cost of Transmission Augmentations:

The cost of the transmission augmentations outlined in the options in section 5.0 have been estimated by Powerlink. Sensitivity studies have been carried out using variations in the capital cost estimates of plus or minus 15% (see section 8.3).

[15] Powerlink is required to evaluate options for new transmission developments under the Regulatory Test in accordance with clause 5.6.2 (g) of the National Electricity Code.
[16] Powerlink's transmission authority includes a responsibility "… to ensure as far as technically and economically practicable, that the transmission grid is operated with enough capacity (and if necessary, augmented or extended to provide enough capacity) to provide network services to persons authorised to connect to the grid or take electricity from the grid." (Electricity Act 1994, S34.2). As noted in section 3.5, without action, Powerlink will be unable to maintain supply during single contingencies affecting the 275kV network supplying the Brisbane South/Logan area.
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The financial analysis considers all cost impacts of the proposed network augmentations to market participants as defined by regulatory processes. The estimated saving in the cost of network losses for each option has been included based on the assumption of typical load factor and an average cost of losses of $25/MWh[17]. Sensitivity studies have also been carried out on the assumed cost of losses (see section 8.3).

While a solution must be implemented by late 2003 to overcome the identified network limitations, the NPV analysis contains subsequent augmentation required to address Gold Coast supply issues. The sensitivity of the timing of these subsequent works (and therefore the incidence of the capital expenditure) has been taken into account through the use of four scenarios.

[17] Network losses are a function of the length and capacity of individual network elements, and the power being transferred through them. Additional network elements reduce the amount of power that must be forced through the existing network, and therefore reduce total losses.

8.0 FINANCIAL ANALYSIS

8.1 Description of Financial Analysis Approach

The economic analysis undertaken considered the net present value (NPV) of net market benefits of alternative options over the fifteen year period from 2002 to 2016. Full details of this analysis are contained in Appendix 2.

8.2 Net Present Value Analysis

Financial analysis was carried out to calculate and compare the Net Present Value (NPV) of the costs to market participants of each option under the range of assumed market development scenarios.

A discount rate of 10% was selected as a relevant commercial discount rate, and sensitivity analysis was conducted to test this assumption.

Capital and operating costs for items which are common to all options were not included in the analysis. These common costs include the capital and operating costs of other transmission works that Powerlink is proposing in the relevant area, where these costs are independent of the identified network limitations[18]. Where the timing of common works is affected by the proposed options, the cost of the other works proposed has been included in the NPV analysis.

The Regulatory Test requires the recommended option to have the lowest net present value cost under most but not necessarily all plausible scenarios. Because of this, a ranking system needs to be used to evaluate options within each scenario, based on the NPV results.

The following table is a summary of the economic analysis contained in Appendix 2. It shows the net present value of each alternative, and identifies the best ranked option, for the range of scenarios considered.

Discount rate 10%	**Scenario A** *Medium load growth*		**Scenario B** *High load growth*		**Scenario C** *Low load growth*		**Scenario D** *Early Gold Coast*	
	NPV ($M)	**Rank**	**NPV ($M)**	**Rank**	**NPV ($M)**	**Rank**	**NPV ($M)**	**Rank**
Option 1 Augmentation from Blackwall with Greenbank	$53.15	3	$53.30	3	$52.96	3	$53.45	3
Option 2 Augmentation from Blackwall without Greenbank	$47.02	1	$48.71	1	$44.27	2	$50.38	1
Option 3 Augmentation from Swanbank without Greenbank	$47.04	2	$49.31	2	$43.06	1	$51.79	2

8.3 Sensitivity Analysis:

In addition to examining the impact of varying load growth scenarios, the sensitivity of the option ranking to other critical parameters was also examined.

The effect of varying these parameters over their credible range was investigated using standard Monte Carlo techniques.[19] The following table shows the parameters that were investigated in the sensitivity analysis, the distribution that was assumed for each parameter and the range of values.

[18] As such, they have no impact on the relative ranking of options resulting from the analysis.
[19] Using the @Risk add-in for Microsoft Excel.

Parameter	Distribution
Capital Cost of Transmission Option	The capital cost of all options was tested for sensitivity to variations of plus or minus 15% from the expected value. The variation in each cost was modelled as a triangular distribution with the assumption that the costs are statistically independent. This means that the cost of each network component is allowed to vary within plus and minus 15% independently of the over or underspend of the other components.
Cost of losses	The sensitivity to the average cost of losses was tested by allowing this parameter to vary randomly between $20/MWh and $30/MWh using a triangular distribution with a mode of $25/MWh.

The Monte Carlo analysis assigns a value to each of the above parameters according to its distribution and then ranks the options. This simulation is done many times (in this case, 1,000 times) to cover a large number of combinations of parameters. The analysis identifies which option is the best ranked option (the option that has the lowest cost on an NPV basis for the largest number of samples) and gives the frequency for which this option 'wins'.

In addition to the above sensitivities, the sensitivity of the ranking of options to the discount rate assumption was also investigated by repeating the above analysis with a discount rate of 8%, 10% and 12%.   The following table shows the 'winning option' and the frequency for which it 'wins' for each scenario and discount rate across the range of parameters assessed.

	Discount Rate		
Scenario	8%	10%	12%
A – Medium Load Growth	2 (49%)	2 (49%)	2 (49%)
B – High Load Growth	2 (52%)	2 (54%)	2 (55%)
C – Low Load Growth	3 (64%)	3 (65%)	3 (66%)
D – Early Gold Coast	2 (55%)	2 (57%)	2 (58%)

As can be seen in this table, Option 2 is the highest ranked option under the majority of scenarios. Under some scenarios, it has only a marginally lower NPV cost than Option 3. Under low load growth scenarios, Option 3 has a slight NPV advantage. These sensitivity analysis results are consistent with the base case economic analysis, where Options 2 and 3 were found to be very similar in NPV costs. However, as noted earlier, while the costs are similar, the network capability is not. Option 2 results in a significantly stronger network configuration than Option 3.

In addition, evidence is emerging from the observed load patterns of the present summer that load growth is tracking on the high side of the medium growth forecast rather than the low side.

9.0 DISCUSSION OF RESULTS

The following conclusions have been drawn from the analysis presented in this report:

- There is no acceptable 'do nothing' option. If the emerging network limitations are not addressed by late 2003, power supply will be unable to be maintained during single 275kV contingencies on the lines supplying the Brisbane South/Logan area. This does not allow Powerlink to meet 'N-1' reliability planning criterion (that is, the ability to supply all load with any single network element out of service) as defined in the National Electricity Code.

- Powerlink carried out a consultation process in mid 2001, and was not advised of any demand side management initiatives or local generation options capable of addressing the identified network limitations. Industry participants are invited to offer further information in response to this draft recommendation, should they have any information about such alternatives.

- Economic analysis has identified that Option 2 in this paper is the least-cost solution over a fifteen year period of analysis. On this basis, an augmentation comprising a double circuit 275kV line from Blackwall to Belmont at a cost of $63.8M would satisfy the regulatory test.

- The Net Present Value cost of Option 3 is only marginally higher than Option 2. However, Powerlink considers that Option 2 is a much better solution. It provides a significantly higher network capability as it results in four 275kV circuits supplying the Brisbane South/Logan area, compared with only three circuits in Option 3. Option 2 therefore has significantly more capability during low probability double circuit outages. It is Powerlink's view that, given that options 2 and 3 are similar in NPV, the option with the better reliability and security characteristics should be implemented.

- Sensitivity analysis showed Options 2 & 3 to be ranked almost equally under variations in critical parameters used in the analysis. Option 2 has a marginal advantage in the majority of scenarios. As noted above, Option 2 is recommended because it results in a significantly stronger network configuration.

- In addition to maximisation of benefit, the Regulatory Test requires that a transmission network service provider optimise the timing of any proposed network augmentation that is justified under the Regulatory Test. It is evident from the analysis that action is required prior to October 2003 in order to maintain a reliable power supply to customers. Any deferral of timing beyond late 2003 will result in unacceptable system reliability.

10.0 DRAFT RECOMMENDATION

Based on the conclusions drawn from the analysis, the following course of action is recommended to address the emerging transmission network limitations in the Brisbane South/Logan region of south-east Queensland:

Draft Recommendation:

- Powerlink to construct a double circuit 275kV line between Blackwall and Belmont by October 2003 at an estimated cost of $63.8M.

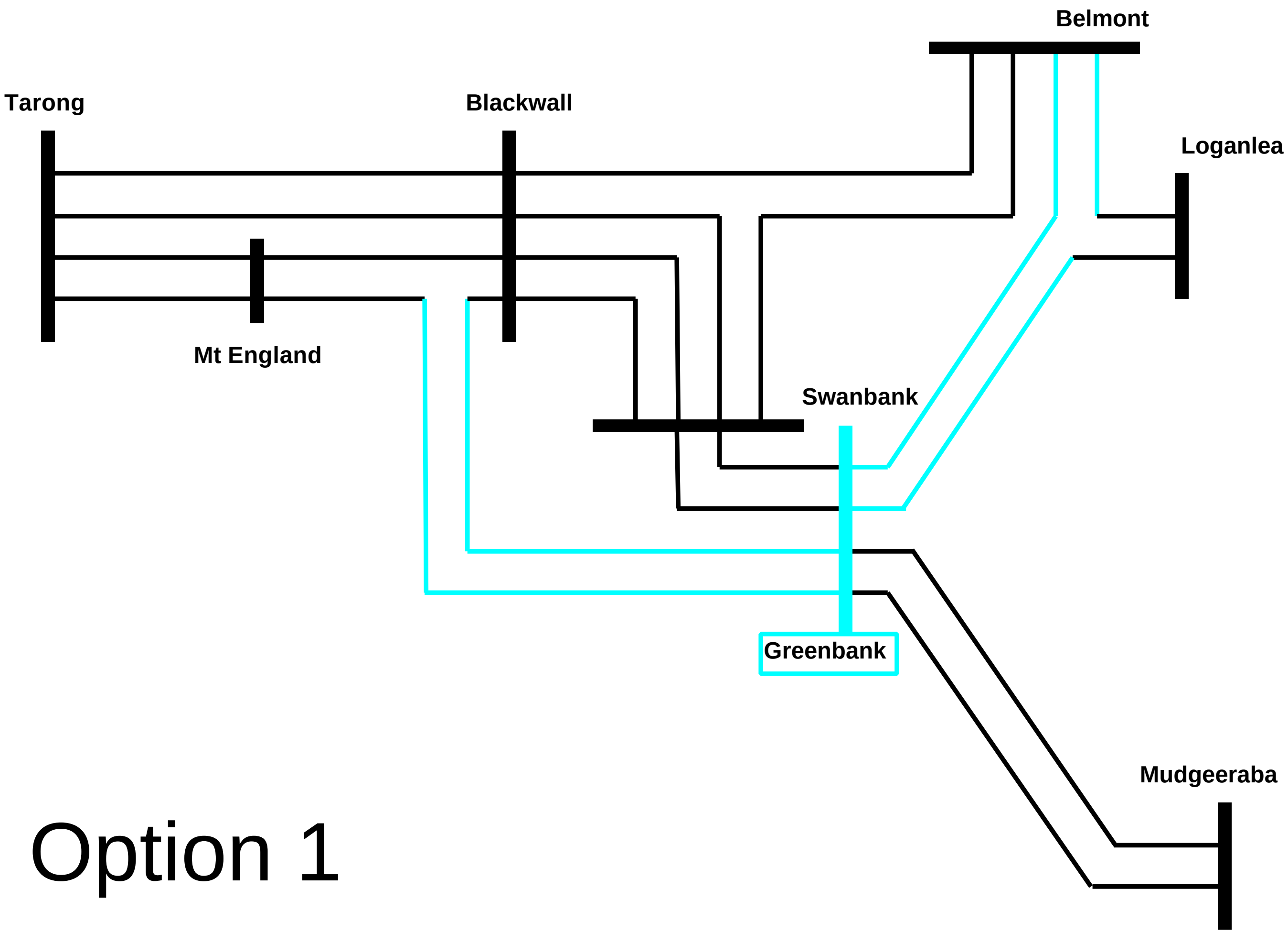
Powerlink invites submissions from Code Participants and interested parties on this draft recommendation. The closing date for submissions is Friday 5th April, 2002.

Please address submissions to:

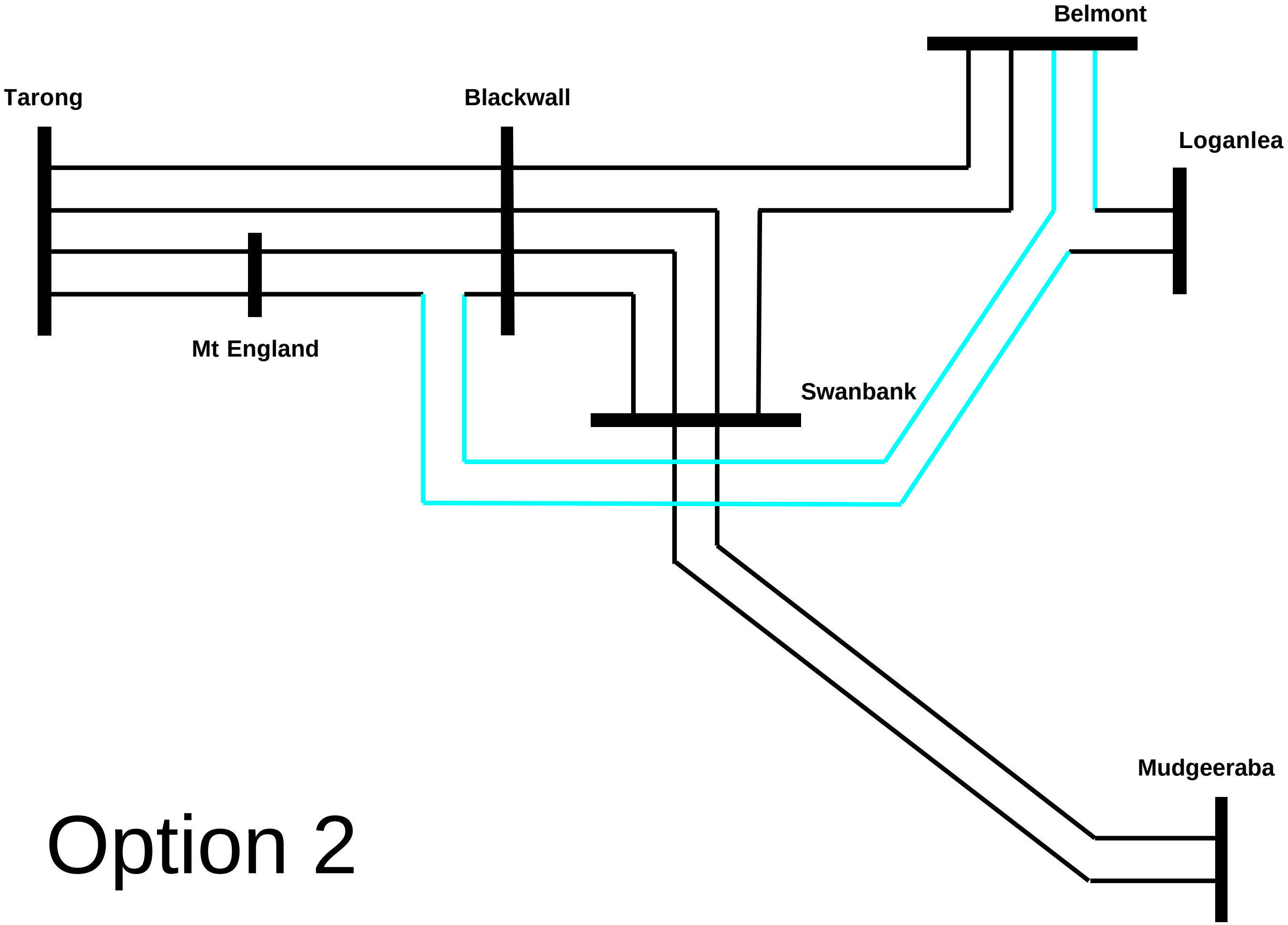
Alison Gray
Manager Network Assessments
PO Box 1193
Virginia QLD 4014
Tel: (07) 3860 2300
Fax: (07) 3860 2388
Agray@powerlink.qld.gov.au

Following consideration of the submissions, Powerlink expects to publish a final recommendation during April 2002.

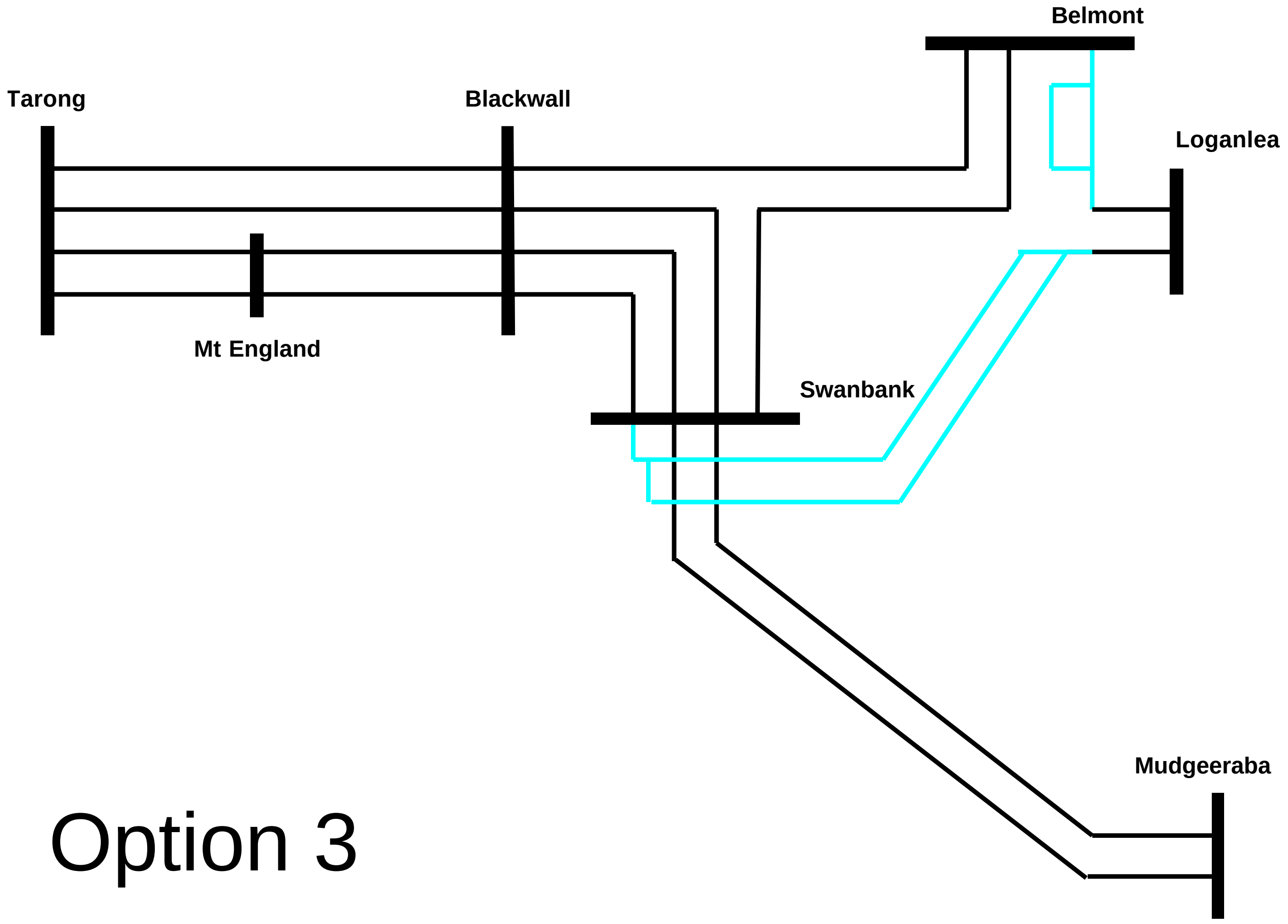
APPENDIX 1 – OPTION DIAGRAMS



APPENDIX 1 – OPTION DIAGRAMS



APPENDIX 1 – OPTION DIAGRAMS



Option 3

APPENDIX 2: FINANCIAL ANALYSIS

Summary

Discount rate 10%	Scenario A *Medium load growth* **NPV ($M)**	 **Rank**	Scenario B *High load growth* **NPV ($M)**	 **Rank**	Scenario C *Low load growth* **NPV ($M)**	 **Rank**	Scenario D *Early Gold Coast* **NPV ($M)**	 **Rank**
Option 1 Augmentation from Blackwall with Greenbank	$53.15	3	$53.30	3	$52.96	3	$53.45	3
Option 2 Augmentation from Blackwall without Greenbank	$47.02	1	$48.71	1	$44.27	2	$50.38	1
Option 3 Augmentation from Swanbank without Greenbank	$47.04	2	$49.31	2	$43.06	1	$51.79	2

Scenario A		***Medium load growth***														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
		02/03	**03/04**	**04/05**	**05/06**	**06/07**	**07/08**	**08/09**	**09/10**	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**
Option 1		**Augmentation from Blackwall with Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	9.773	9.643	9.512	9.382	9.252	9.122	8.991	8.861	8.731	8.600	8.470	8.340	8.209
==> NPV of TUOS	$53.78															
Relative Losses																
* Losses $		0	-0.134	-0.216	-0.231	-0.247	-0.088	0	0	0	0	0	0	0	0	0
=> NPV of Losses	-$0.63															
Total for Option 1	**$53.15**															
Option 2		**Augmentation from Blackwall without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	7.035	6.941	6.847	6.754	6.660	6.566	6.472	6.378	6.285	6.191	6.097	6.003	5.909
==> NPV of TUOS	$38.71															
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	2.844	2.806	2.768	2.730	2.692	2.654	2.616	2.578	2.541
==> NPV of TUOS	$8.83															
Relative Losses																
* Losses $		0	-0.111	-0.178	-0.191	-0.204	-0.073	0	0	0	0	0	0	0	0	0
=> NPV of Losses	-$0.52															
Total for Option 2	**$47.02**															
Option 3		**Augmentation from Swanbank without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	5.529	5.455	5.381	5.307	5.234	5.160	5.086	5.013	4.939	4.865	4.791	4.718	4.644
==> NPV of TUOS	$30.42															
Transmission for Belmont: into Swanbank																
=> TUOS		0.000	0.000	1.281	1.214	1.147	1.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$3.11															
Swanbank - Blackwall																
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	4.350	4.292	4.234	4.176	4.118	4.060	4.002	3.944	3.886
==> NPV of TUOS	$13.51															
Relative Losses																
* Losses $		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	$0.00															
Total for Option 3	**$47.04**															

Scenario B		High load growth														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Option 1		**Augmentation from Blackwall with Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	9.773	9.643	9.512	9.382	9.252	9.122	8.991	8.861	8.731	8.600	8.470	8.340	8.209
==> NPV of TUOS	$53.78															
Relative Losses																
* Losses $		0	-0.134	-0.216	-0.231	-0.082	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	-$0.48															
Total for Option 1	**$53.30**															
Option 2		**Augmentation from Blackwall without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	7.0351	6.9413	6.8475	6.7537	6.6598	6.566	6.4722	6.3784	6.2846	6.1908	6.097	6.0032	5.90944
==> NPV of TUOS	$38.71															
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	0.000	2.844	2.806	2.768	2.7301	2.6922	2.6543	2.6164	2.5785	2.5405	2.50263
==> NPV of TUOS	$10.31															
Relative Losses																
* Losses $		0	-0.111	-0.059	-0.191	-0.068	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	-$0.31															
Total for Option 2	**$48.71**															
Option 3		**Augmentation from Swanbank without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	5.529	5.455	5.381	5.307	5.234	5.160	5.086	5.013	4.939	4.865	4.791	4.718	4.644
==> NPV of TUOS	$30.42															
Transmission for Belmont: into Swanbank																
=> TUOS		0.000	0.000	1.600	1.511	1.421	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$3.12															
Swanbank - Blackwall																
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	0.000	4.350	4.292	4.234	4.176	4.118	4.060	4.002	3.944	3.886	3.828
==> NPV of TUOS	$15.77															
Relative Losses																
* Losses $		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	$0.00															
Total for Option 3	**$49.31**															

Scenario C		Low load growth														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
		02/03	**03/04**	**04/05**	**05/06**	**06/07**	**07/08**	**08/09**	**09/10**	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**
Option 1		**Augmentation from Blackwall with Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	9.773	9.643	9.512	9.382	9.252	9.122	8.991	8.861	8.731	8.600	8.470	8.340	8.209
==> NPV of TUOS	$53.78															
Relative Losses																
* Losses $		0	-0.134	-0.216	-0.077	-0.247	-0.264	-0.283	-0.101	0	0	0	0	0	0	0
=> NPV of Losses	-$0.82															
Total for Option 1	**$52.96**															
Option 2		**Augmentation from Blackwall without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	7.0351	6.9413	6.8475	6.7537	6.6598	6.566	6.4722	6.3784	6.2846	6.1908	6.097	6.003245	5.90944
==> NPV of TUOS	$38.71															
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.8439	2.806	2.7681	2.7301	2.6922	2.654306	2.61639
==> NPV of TUOS	$6.23															
Relative Losses																
* Losses $		0	-0.111	-0.178	-0.064	-0.204	-0.218	-0.233	-0.083	0	0	0	0	0	0	0
=> NPV of Losses	-$0.68															
Total for Option 2	**$44.27**															
Option 3		**Augmentation from Swanbank without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	5.529	5.455	5.381	5.307	5.234	5.160	5.086	5.013	4.939	4.865	4.791	4.718	4.644
==> NPV of TUOS	$30.42															
Transmission for Belmont: into Swanbank																
=> TUOS		0.000	0.000	0.962	0.918	0.873	0.829	0.784	0.739	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$3.11															
Swanbank - Blackwall																
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.350	4.292	4.234	4.176	4.118	4.060	4.002
==> NPV of TUOS	$9.53															
Relative Losses																
* Losses $		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	$0.00															
Total for Option 3	**$43.06**															

Scenario D		*Early Gold Coast*														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
		02/03	**03/04**	**04/05**	**05/06**	**06/07**	**07/08**	**08/09**	**09/10**	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**
Option 1		**Augmentation from Blackwall with Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	9.773	9.643	9.512	9.382	9.252	9.122	8.991	8.861	8.731	8.600	8.470	8.340	8.209
==> NPV of TUOS	$53.78															
Relative Losses																
* Losses $		0	-0.134	-0.216	-0.077	0	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	-$0.33															
Total for Option 1	**$53.45**															
Option 2		**Augmentation from Blackwall without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	7.0351	6.9413	6.8475	6.7537	6.6598	6.566	6.4722	6.3784	6.2846	6.1908	6.097	6.0032	5.90944
==> NPV of TUOS	$38.71															
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	2.844	2.806	2.768	2.730	2.6922	2.6543	2.6164	2.5785	2.5405	2.5026	2.46471
==> NPV of TUOS	$11.93															
Relative Losses																
* Losses $		0	-0.111	-0.178	-0.064	0	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	-$0.27															
Total for Option 2	**$50.38**															
Option 3		**Augmentation from Swanbank without Greenbank**														
Transmission for Belmont																
=> TUOS		0.000	0.000	5.529	5.455	5.381	5.307	5.234	5.160	5.086	5.013	4.939	4.865	4.791	4.718	4.644
==> NPV of TUOS	$30.42															
Transmission for Belmont: into Swanbank																
=> TUOS		0.000	0.000	2.237	2.103	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
==> NPV of TUOS	$3.12															
Swanbank - Blackwall																
Greenbank establishment																
=> TUOS		0.000	0.000	0.000	0.000	4.350	4.292	4.234	4.176	4.118	4.060	4.002	3.944	3.886	3.828	3.770
==> NPV of TUOS	$18.25															
Relative Losses																
* Losses $		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
=> NPV of Losses	$0.00															
Total for Option 3	**$51.79**															