ElectraNet SA
electricity transmission network

FINAL REPORT

Proposed New Large Network Assets
Lower Flinders Region of South Australia

ElectraNet SA
8 January 2004

1.0 EXECUTIVE SUMMARY

ElectraNet SA has identified projected limitations in the electricity transmission network supplying the Lower Flinders region of South Australia: specifically, the area around Port Pirie. However, because of the interconnected nature of the transmission system it is important to note that limitations in the Lower Flinders transmission system have the potential to directly impact on areas as far-reaching as the Eyre Peninsula and far west coast regions of the State under certain prior outage or contingency operating conditions.

Port Pirie is located about 200 kilometres north of Adelaide on the eastern coast of Spencer Gulf, and is South Australia's third largest regional centre. It is essentially an industrial city, with a population of about 18,000. The surrounding area is used mainly for crop, and to a lesser extent, sheep farming. The growing of wine grapes is becoming increasingly popular in the area, but is still in its infancy.

A ridge of hills that has its southern-most point in the vicinity of Lochiel, some 80 kilometres to the south of Port Pirie, and running northwards approximately parallel to the coast and about 20 kilometres inland, combined with flat land between this range and the coast, inherently creates sites with reasonably windy conditions. As a result, this region has been identified as providing ideal conditions for the establishment of large-scale wind generation facilities by a number of wind-farm proponents, and there are initial proposals to establish installations some 50 kilometres to the south of Port Pirie, near Brinkworth. ElectraNet is presently investigating connection options to connect large-scale wind farms in this vicinity.

ElectraNet, as South Australia's Transmission Network Service Provider (TNSP), has undertaken comprehensive studies to fully assess the implications of the projected limitations mentioned above. In performing those studies, ElectraNet has ensured that due consideration was given to the impact of various wind generation proposals, totalling over 500 MW of installed capacity (with an average output of approximately 160MW assuming the wind-farms have an availability level of 30%), that could potentially be connected into the Lower Flinders transmission network.

During the period since the commencement of public consultation for the Lower Flinders reinforcement that started in April 2003, the aged 275/132 kV transformer located at Brinkworth suffered major failure of its tap-changer mechanism. Considering the age of the transformer (40 plus years) and its present performance requirements, the cost to repair the unit was found to be uneconomic when compared with the cost of purchasing and installing a new unit that was sized to meet the regions existing and forecast electricity requirements over the next 10 year period. Consequently, the original 60 MV.A Brinkworth transformer has now been disconnected and replaced with a larger capacity unit that was fortunately available at short notice, and the analysis of the Lower Flinders transmission system has been updated using this new existing configuration.

Careful consideration of the results of those studies, in conjunction with all relevant information received following ElectraNet's initial consultation with interested parties to identify feasible non-transmission alternatives to address the projected network limitations (via the document titled "Request for Information – Emerging Transmission Network Limitations, Lower Flinders Region of South Australia, Ageing Network Assets" that was published on ElectraNet's website in April 2003), has culminated in ElectraNet's preparation and issue of this Final Report.

The following issues are listed to highlight projected limitations concerning the transmission network that supplies the Lower Flinders area and that have the potential to impact on the Eyre Peninsula and far west coast regions of the State under certain contingency conditions:

- **Projected Non Compliance with the South Australian Electricity Transmission Code (SATC) and the National Electricity Code (NEC) Requirements**

  Electricity demand has grown to the point where the existing network would be unable to supply customer load during a single contingency on the Davenport-Playford 275 kV line during a high load period and coinciding with a time when Playford Power Station is not generating, or an outage of any of the Playford-Baroota, Baroota-Bungama or Playford-Bungama 132 kV lines under high summer demand conditions.

- **Aged Assets at end of Technical and Operating Life**

  Bungama 132 kV substation was built in the early 1950's and uses high maintenance bulk oil and air operated equipment that is at the end of its economic service life. The control cabling within the substation is of the Vulcanised Indian Rubber (VIR) type that has deteriorated with age and is in need of replacement. Considerable upgrading of protection and earthing systems is required to return the substation to what is now regarded as "Good Electricity Supply Industry Practice".

- **Operational Flexibility and System Security**

  Studies have recently identified that following a critical contingency involving the Davenport-Playford 275 kV line under high demand operating conditions, the Brinkworth and Cultana 275/132 kV transformers will become overloaded. To avoid system security violations and subsequent wide-spread long term loss of customer load, automatic controls will operate to minimise customer impact and supply-outage duration.

ElectraNet's initial analysis identified three feasible options to address these network limitations:

Option 1: Establish a single-transformer 160 MV.A 275/132 kV substation at Bungama with 275 kV supply provided by turning the Davenport-Para 275 kV "west" circuit in-and-out of the new substation, and replace the function of the existing 60 MV.A Brinkworth transformer with a 160 MV.A unit.

Option 2: Establish a two-transformer (2x160 MV.A) 275/132 kV substation at Bungama with 275 kV supply provided by turning the Davenport-Para 275 kV "west" circuit in-and-out of the new substation.

Option 3: Establish a new 132 kV substation at Bungama and construct a new dual-circuit 132 kV transmission line from Bungama to Playford to replace the existing under-rated Bungama-Playford lines.

ElectraNet SA has carried out consultation with interested parties to identify feasible non-transmission alternatives to address the emerging network limitations. This was done by way of two documents, titled "Request for Information – Projected Transmission Network Limitations, Lower Flinders Region of South Australia, Ageing Network Assets", and "Application Notice – Proposed New Large Network Assets, Lower Flinders Region of South Australia", in accordance with the requirements of Clause 5.6.6 of the National Electricity Code. These two documents were published on ElectraNet SA's website at www.electranet.com.au/news/ in April 2003 and October 2003, with closing dates for submissions of 30th April 2003 and 24th November 2003, respectively.

Having followed due process stipulated by Code requirements to ensure that feasible non-transmission solutions have been properly considered, ElectraNet SA has subjected the network reinforcement options that it has identified to the ACCC's Regulatory Test for *reliability augmentations*, as is the case for the emerging limitations in the Lower Flinders region of South Australia transmission network. (This test requires that the recommended option be the option with the *"lowest net present value cost under the majority of market development scenarios* *considered*".) This Regulatory Test identifies Option 1 as the least-cost solution for all of the scenarios considered, over the fifteen-year analysis timeframe. Furthermore, sensitivity analysis shows this result to be robust under a range of assumptions.

Consequently, a draft recommendation to implement Option 1 to address the identified network limitations in the Lower Flinders region of South Australia was published as an 'Application Notice' in October 2003. The recommended new large network assets were:

- The disconnection of the existing 60 MV.A transformer at Brinkworth substation, and the installation in the spare transformer bay adjacent to it of a 160 MV.A unit to replace the function of the existing transformer (noting that this work is no longer required).
- The establishment of a single-transformer 160 MV.A 275/132 kV substation adjacent to the existing 132 kV switchyard at Bungama, with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation. (The existing 132 kV switchyard would subsequently be dismantled and removed.)

The total cost of these new assets was estimated to be $30.6 M.

As a consequence of the Brinkworth 275/132 kV transformer failure, part of the Option 1 works recommended in the Application Notice has already been implemented. The Brinkworth transformer replacement, which was recommended for completion by late 2004, has already been carried out due to the failure of the existing aged unit and the need to replace this transformer prior to the summer peak load period to maximise supply availability and minimise potential system security issues.

This reduces the cost of the recommended option 1 works to $29.0 M. This reduced cost serves to identify Option 1 more clearly as the recommended augmentation that satisfies the regulatory test.

One submission was received in response to the draft recommendation. The submission was received from the Electricity Supply Industry Planning Council (ESIPC), which was established by the Government of South Australia to provide expert advice in relation to the performance, future capacity, and reliability of South Australia's power system.

The ESIPC stated in their response to the Application Notice that they considered that the proposal as presented appeared to represent a necessary and prudent investment in the Lower Flinders region. The ESIPC had no specific comments on the recommendations of the notice, but provided general comments regarding the assessment of possible generation options and the format of the financial analysis undertaken. These matters are discussed in more detail in section 4.0 of this document.

ElectraNet SA acknowledges the comments made by ESIPC and has accommodated these in Section 4 of this Final Report to the extent possible. Regarding the assessment of potential generation options, ElectraNet notes that, as a TNSP, it does not have generator or market expertise in-house or readily available to it. Rather, ElectraNet, by necessity, has relied on the extensive consultative processes it has undertaken regarding this development, which commenced with a request for information to the market at large in April 2003 to draw out the relevant expertise that does exist elsewhere in the National Electricity Market, and to provide opportunities for these sectors to develop market based solutions to the Lower Flinders supply system. No market-based solutions were received in response to either the widespread request for information or the publication of the Application Notice.

Due consideration has been given to the comments received from the ESIPC. However, these considerations have not materially altered the conclusions that ElectraNet has drawn from its studies, nor the preferred option that it has identified as the means to overcome the projected network limitations in the Lower Flinders region. ElectraNet SA has therefore adopted the draft recommendation to implement Option 1 (with the exception of the Brinkworth transformer work, which has already been implemented) as its final recommendation. Immediate steps will be taken to implement this recommendation.

2.0 INTRODUCTION

This report contains a final recommendation to address emerging transmission network limitations in the Lower Flinders region of South Australia.

The recommendation is based on:

- identification of emerging network limitations in the Lower Flinders region of South Australia during worst case single network contingencies from late 2003 onwards;
- the consultation undertaken by ElectraNet SA to identify potential non-transmission solutions to address these emerging network limitations,
- an analysis of feasible options in accordance with the ACCC's Regulatory Test;
- the discounting of a generation option as a feasible solution based on the requirements of S5.2.5.3 of the NEC;
- the assessment that a major network augmentation is necessary by late 2005 to maintain a reliable supply to customers, and;
- the publication of an 'Application Notice' containing a draft recommendation.

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 REASONS AUGMENTATION IS REQUIRED

3.1 Network Limitations

Primary supply to the Lower Flinders region of South Australia is provided by four ElectraNet SA connection points; Brinkworth, Bungama Rural, Bungama Industrial and Port Pirie (combined), and Baroota.

Because of their design and age the two Playford to Bungama 132 kV lines are a source of power flow limitations on the Lower Flinders transmission network. These two lines were the first long distance high-voltage transmission lines built in South Australia, and as a result construction and quality assurance practices were under development and not at the levels now achievable. As a consequence, many of the spans on these lines were not constructed to meet the original clearance requirements. Recent investigations have shown that this situation has worsened as the lines have deteriorated with age.

The two Playford-Bungama 132 kV lines were constructed to British design criteria that were later found to be inappropriate for Australian climatic conditions. As a result, the actual ratings achieved by these lines are considerably lower than those originally anticipated and will not be adequate to meet forecast loading conditions under all practical operating conditions. In addition, the lines are now over 50 years of age and nearing the end of their physical life.

Work undertaken on the Playford-Bungama and Playford-Baroota-Bungama lines has addressed high priority sections of line and mechanical strength issues only with a view to minimising the risk of mechanical failure and public contact with the lines. A substantive rebuild of these lines is required if these lines are to continue to be serviceable for any substantive period into the future.

The age, physical condition, and electrical standards to which Bungama 132 kV substation was built are also factors that need to be taken into consideration.

Bungama 132 kV substation was built in the early 1950's and uses old bulk oil and air-operated equipment which is at the end of its service life. The control cabling within the substation is of the Vulcanised Indian Rubber type that has deteriorated with age and is in need of replacement. Protection systems within the substation require upgrading to bring them up to what is now regarded as "Good Electricity Supply Industry Practice" and there is also a need to refurbish the substation earthing system.

3.2 Capability During Single Contingencies

There is a range of technical factors that influence network capability, including line and equipment thermal ratings, protection requirements, transient stability, reactive support, generation and load patterns, and voltage stability. In addition, appropriate allowance must also be made to include sufficient capability in the system to allow for unexpected outages or failures of plant and to permit equipment to be maintained in accordance with accepted asset maintenance practices.

In light of these requirements, the following single contingencies on the Lower Flinders 132 kV transmission network are of particular concern:

- For an outage of the Davenport-Playford 275 kV line under high demand operating conditions, ElectraNet has installed automatic controls that are required to operate in order to maintain system security in the NEM, and that will result in significant disconnection of customer load in the region of Bungama and disruption to network operation in order to avoid overloading plant and potential voltage collapse under this contingency. However, studies also demonstrated that the 275/132 kV 60 MVA transformer at Brinkworth substation that was in service at the time would not have been able to support the entire load in the Lower

Flinders region following such a critical contingency, indicating that there is insufficient 275/132 kV capacity in the Lower Flinders region.

- An outage of the Playford-Baroota 132 kV line under typical summer operating conditions will overload the thermal rating of the Playford-Bungama 132 kV line.
- Alternatively, an outage of the Playford-Bungama 132 kV line under typical summer operating conditions will overload the thermal ratings of the Playford-Baroota and Baroota-Bungama 132 kV lines.

With consideration for these single contingencies, and based on the most recent forecast loads supplied by ETSA Utilities, Code compliant 132 kV voltage levels and operation within transmission line rating limits will not be achievable during the summer of 2003/04, indicating that some form of additional reinforcement of the system is urgently required.

Furthermore, from the nature of the projected network limitations described above, ElectraNet SA considers that the new large network assets proposed to address those limitations in the Lower Flinders region are classified as 'reliability augmentations', as defined in the NEC[1].

The late 2004 (Brinkworth) and late 2005 (Bungama) timing conclusions were based on forecast demand growth of approximately 2.3% per annum in the short term. As noted in the April 2003 and October 2003 consultation documents, the load in the Lower Flinders region is predominantly due to a single, relatively constant industrial load. Load growth in such cases is dominated by the expansion plans of the individual customer involved. ETSA Utilities (South Australia's Distribution Network Service Provider, or DNSP) has surveyed that customer and advises that no significant load increase (more than 5MW) is anticipated by that customer for 2002/03 and beyond. Demand forecasts issued by ETSA Utilities for the connection points supplying the Lower Flinders region suggest that load growth will settle to a rate of about 2.1% per annum in the medium term.

A load growth overview and supporting assumptions were provided in Section 3.2 of the public document titled "Request for Information – Emerging Transmission Network Limitations, Lower Flinders Region of South Australia, Ageing Network Assets" that was published on ElectraNet's website in April 2003.

A proposal by SAMAG Limited, a subsidiary of Sydney-based PIMA Mining NL, to establish a large-scale magnesium ore smelter approximately 12 kilometres north of Bungama, would have substantial impact on the electrical load in the area. However, given the ongoing uncertainty surrounding the SAMAG proposal (now spanning some years), and considering that ElectraNet has only limited time in which to implement a solution once a Code violation has been identified on its transmission network, ElectraNet has opted to assume that the SAMAG proposal has been indefinitely postponed in its analysis of the Lower Flinders transmission system. However, it should be noted that due consideration has been given to the SAMAG proposal to ensure that any augmentation that is implemented does not unduly inhibit the development should it eventuate in the future.

With regard for the above discussion, ElectraNet SA has evaluated the sensitivity of the need for augmentation to different demand growth rates using 'market development scenarios' (refer section 7.0 of this document). This analysis also supports the need for the proposed large network augmentation.

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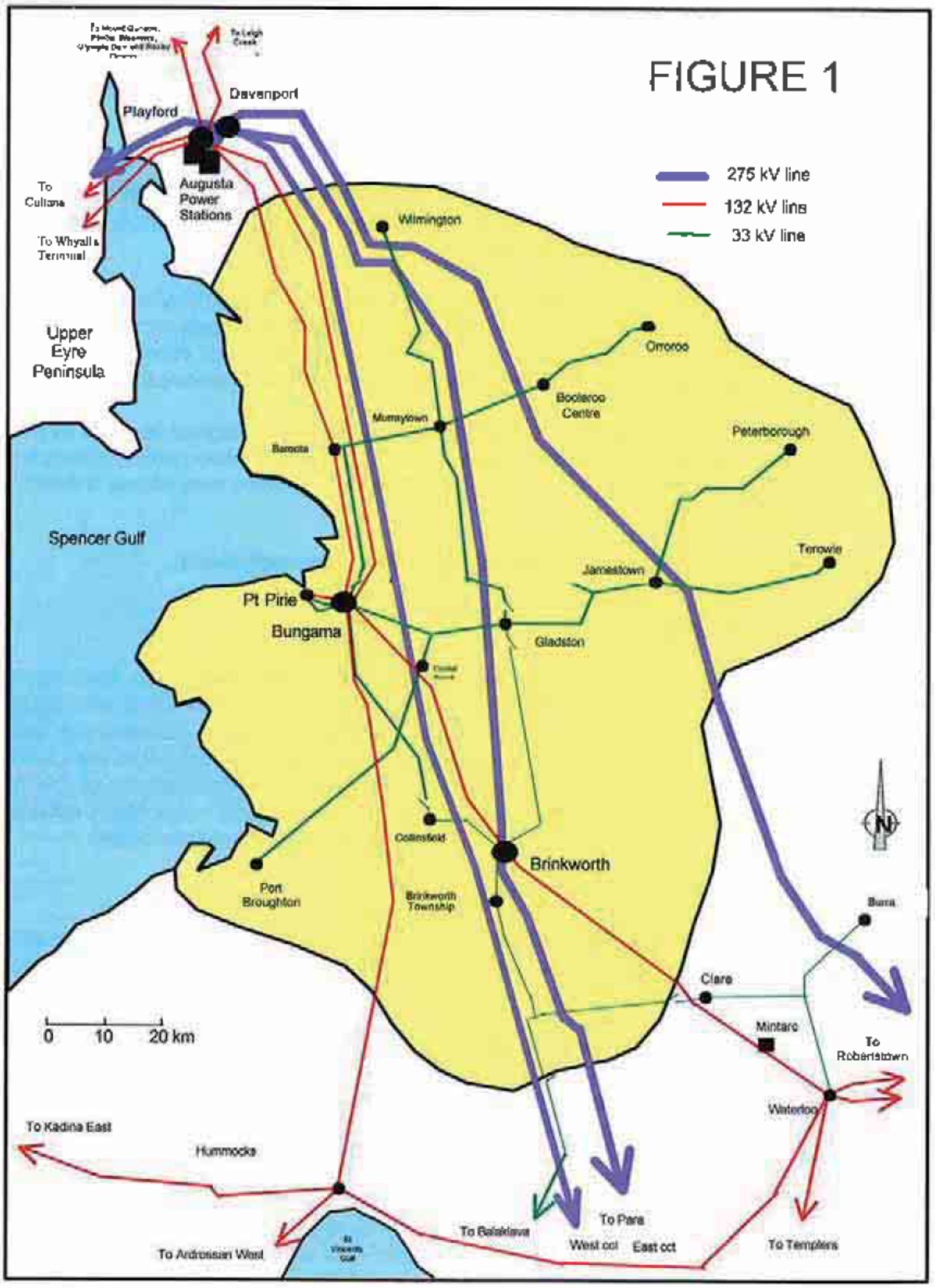
1 A transmission network augmentation that is necessitated solely by inability to meet the minimum network performance requirements set out in schedule 5.1 or in relevant legislation, regulations or any statutory instrument of a participating jurisdiction.



LOWER FLINDERS REGION OF SOUTH AUSTRALIA

ELECTRICITY NETWORK

4.0 RESPONSES TO THE 'APPLICATION NOTICE'

ElectraNet SA issued an 'Application Notice' in accordance with Code requirements in October 2003. This Application Notice contained a draft recommendation to address the emerging network limitations. It was recommended that:

- The disconnection of the existing 60 MV.A transformer at Brinkworth substation, and the installation in the spare transformer bay adjacent to it of a 160 MV.A unit to replace the function of the existing transformer.

- The establishment of a single-transformer 160 MV.A 275/132 kV substation adjacent to the existing 132 kV switchyard at Bungama, with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation. (The existing 132 kV switchyard would subsequently be dismantled and removed.)

  The Brinkworth transformer replacement must be commissioned as soon as possible, but no later than November 2004. The new 275/132 kV connection point at Bungama is to be commissioned by November 2005. The total cost of these new assets is estimated to be $30.6M.

One submission was received in response to the draft recommendation.

4.1 Submission Received

The only submission received in response to the Application Notice was from the Electricity Supply Industry Planning Council (ESIPC). As mentioned in section 1.0 of this document, the ESIPC stated in their response to the Application Notice that they considered that the proposal as presented appeared to represent a necessary and prudent investment in the Lower Flinders region. The ESIPC had no specific comments on the recommendations of the notice, but provided general comments regarding the assessment of possible generation options and the format of the financial analysis undertaken. These matters are discussed below.

4.1.1 Consideration of Generation Options

The Application Notice contained information regarding the ability of existing and known potential generation in the vicinity of the Lower Flinders area to meet the transmission supply requirements and obligations.

The existing sources of generation are the NRG Flinders coal fired power stations at Port Augusta, and Synergen's (International Power) gas turbine powered generating station at Mintaro. Both of these power stations are unable to address supply situation in the Lower Flinders region because of technical limitations. Known potential generation relates to wind farm proposals in the region and a possible gas fired power station that may be developed in association with the proposed SAMAG proposal or as a separate independent power station.

As discussed in the Application Notice, the uncertainty regarding wind farm output discounted the adoption of this source of generation to meet reliability of supply obligations in the Lower Flinders region. The possible "SAMAG" power station, should it eventuate, is also not a feasible solution as it is not technically viable to connect it to the 132 kV network where capacity support is needed. The connection of additional generating capacity to the 275 kV system would not avoid the need to undertake the transmission development outlined in the Application Notice.

No submissions for alternative generation proposals were received as a result of the initial consultation undertaken in April 2003 or in response to the publication of Application Notice in October 2003.

As there were no proponents for alternative generation proposals, ElectraNet considered that alternative generation proposals do not represent a viable solution to meet its reliability of supply obligations under the South Australian Electricity Transmission Code and National Electricity Code.

The ESIPC submission stated that the recent Victorian Supreme Court decision on the South Australia-New South Wales Interconnector (SNI) rejected the proposition that alternative developments need not be considered if a suitable proponent for the development did not exist. The ESIPC also stated that the judgement indicates that the regulatory test requires an objective assessment of all reasonable alternatives based on technical and economic criteria.

ElectraNet notes that the Victorian Supreme Court decision related to assessment of an interconnector between New South Wales and South Australia. As such the regulatory test assessment was for a non-reliability augmentation. ElectraNet is aware that several submissions have been made to the current review of the Regulatory Test by the ACCC stating that it considers that a proponent of a non-network option is essential for such an option to be considered under the reliability arm of the Regulatory Test. A TNSP such as ElectraNet has clear reliability obligations that cannot be fulfilled by reliance on options where no third party proponent exists to provide network support services.

However, in light of the ESIPC's submission, ElectraNet has undertaken further analysis, and provides the following response regarding alternative generation proposals in the Lower Flinders region.

4.1.2 Technical Considerations of Alternative Generation Proposals

Additional generation in the Lower Flinders area would only be capable of deferring/avoiding the need for some of the proposed transmission works recommended in the Application Notice.

The installation of generation on the 132 kV system in the Bungama area would not avoid the need to refurbish and upgrade the Bungama 132 kV substation which is at the end of its technical and economic life. It would also not be possible to avoid installing a 275/132 kV transformer at Brinkworth as this work has now been undertaken independently due to the failure of the existing transformer at that location.

In essence, the installation of additional generation capacity would only avoid the cost of diverting the 275 kV Davenport–Para (West Circuit) into Bungama, establishing a simple 275 kV switchyard and installing a 275/132 kV transformer at Bungama at an estimated cost of approximately $12 M.

Analysis shows that at least 70 MW of generation capacity would be required to defer/avoid the need for this transmission infrastructure as recommended in the Application Notice.

As a TNSP, ElectraNet does not have generator or market expertise in house or readily available to it. Rather, ElectraNet, by necessity, has relied on the extensive consultative processes it has undertaken regarding this development, which commenced with a request for information to the market at large in April 2003, to draw out the relevant expertise that does exist elsewhere in the National Electricity Market and to provide opportunities for these sectors to develop market based solutions to the Lower Flinders supply system. No proposals for market-based solutions were received following the widespread request for information or the publication of the Application Notice.

In the absence of information provided by market participants, ElectraNet has carried out a high level assessment of the situation. It is likely that the cheapest form of generation that could be installed would be simple cycle gas turbine powered generators. The estimated cost of installing this plant and providing a connection to the Bungama 132 kV system would be of the order of

$48 M. This cost assumes two commercially available 42 MW units are installed. More efficient combined cycle generating plant could be installed, however, it is estimated that this would cost in excess of $80 M.

The total cost of installing simple cycle generating plant to meet service obligations in the Lower Flinders area is estimated at $48 M for the plant, and $18 M for refurbishment and upgrade work associated with the existing aged 132 kV system making a total of $66 M. If more efficient combined cycle plant is installed this cost will increase to approximately $98 M. This represents the required capital investment only. Additional costs to the market will occur if the generating plant is despatched out of merit order to provide network support services. This compares to a total capital cost of the recommended development of just over $30 M.

4.1.3 Economic and Other Considerations

The ACCC Regulatory Test has two 'arms' – one which relates to assessment of proposals that deliver market benefits and another for proposals designed to meet required reliability standards.

Market modelling that is carried out when undertaking the market benefits arm of the regulatory test assumes that new generation will be installed when the modelled pool price reaches a level where it becomes economic for a new entrant to invest. This determines the timing and quantity of future generation that is economic to install. In market benefit situations, if a development does not take place at a particular time, the developer of that generation faces no penalties[2].

However, for reliability augmentations, the timing and quantity of additional capacity (transmission, generation, market load, etc) that is needed is determined by the need to meet technical and service standards. In this situation, the timing is defined by clearly measurable standards. Because of the potential for interruptions to customer supply and the requirement to meet statutory reliability obligations, penalties may be incurred if a development is not implemented within the required time frame.

A party considering the implementation of a generation option to address a reliability augmentation requirement[3] must consider the ability of the plant to be operational at the defined timeframe that the augmentation would be needed. The proponent must also consider the forecast pool price at that time and into the future, as well as the additional benefit that could be attributed to the project as a result of being able to defer network augmentation and provide network support services. Consideration of these factors involves additional risk as the development must be available when required to provide network support services, but is still subject to the normal uncertainty associated with market variables.

If at the time of consultation on a reliability augmentation requirement, no proponent appears with a market based solution such as generation or a market network service, then it would suggest that such a solution is not economically viable within the required time frames.

In the Lower Flinders situation, no market-based solutions were nominated by interested parties. A high level analysis of the situation undertaken by ElectraNet in the absence of any generation proponent suggest that the total cost of a generation option to meet the needs of the Lower Flinders Region would be between $66 M and $98 M, with additional costs anticipated due to out of merit order generation. This compares with a capital cost of a transmission augmentation of just over $30 M with associate benefits in terms of savings in network losses and supply reliability.

[2] Other than the theoretical loss of revenue which they might otherwise have received if their proposal was implemented

[3] As a TNSP, ElectraNet cannot develop such generation options since it does not have generator or market expertise in-house or readily available to it.

The high costs of the generation options, the lack of bonafide proponents, and the simple economics tend to suggest that at this point in time the implementation of a generation option in the Lower Flinders situation is not economically viable when compared to the transmission solution.

The additional analysis undertaken by ElectraNet SA therefore shows that a generic generation option based on the installation of commercially available gas turbine generating units would not be viable in a technical or economic sense to meet transmission supply obligations in the Lower Flinders region when compared to the recommended option contained within the Application Notice. In addition, it is difficult to see how a generation option for which there is no proponent, could be deemed to pass the reliability augmentation arm of the regulatory test. Defined service standards cannot be met in situations where there is no party prepared to implement a solution.

4.1.4 Transparency of Financial Analysis

In its submission, the ESIPC highlighted minor discrepancies between the costs of the options contained within the main report and those contained within the appendix. These discrepancies have now been remedied, with no impact on the outcomes of the analysis.

The ESIPC has also requested that additional details of financial parameters and cash flows be provided in future applications rather than simply identifying the TUOS-equivalent cash flows associated with the development.

ElectraNet agrees with the comments raised by the ESIPC in this area, and has included additional details of the cash flows associated with each development (that is, the costs of further reinforcement requirements that will potentially be required during the 15-year period of the financial analysis) in the final report.

The financial parameters used by ElectraNet are contained within the ACCC's revenue determination, which is in the public domain. TUOS pricing has been undertaken in accordance with Chapter 6 of the National Electricity Code and is again based on the ACCC's revenue determination. Additional information regarding ElectraNet SA's transmission pricing methodology is available from ElectraNet's web site at www.electranet.com.au.

4.2 Brinkworth Transformer

The 60 MVA transformer that was in service at Brinkworth at the commencement of the consultation process in April 2003 and when the Application Notice was prepared suffered a major failure while consultation was underway. This transformer was manufactured in the late 1950's and was approaching 45 years of age. The unit was formerly installed at the Port Augusta power station complex and had a relatively onerous service life.

An examination of the failed unit, its physical condition, and the future service, performance, and capacity requirements showed that it was not economic to repair the transformer and return it to service.

As mentioned in the Application Notice, the loading of the Brinkworth 275/132 kV transformer represents a system security issue with widespread ramifications stretching to the Eyre Peninsula and far West Coast. Consequently, the replacement of the failed transformer was regarded as a matter of urgency, particularly with the peak summer load period approaching.

ElectraNet designs and operates the power system so that it remains capable of supplying the peak system load in the event that one of these transformers is out of service for any reason. However, the power system is not designed to cope with the loss of a second unit, which is possible if one of these units is unavailable for a prolonged period, as would be the case in the Brinkworth situation

As discussed in the Application Notice, ElectraNet had recommended the replacement of the Brinkworth transformer in 2004, and identified the potential immediate availability of surplus transformers of suitable size from a magnesium-smelting project in Queensland that did not proceed.

In light of the significance of the failed Brinkworth transformer on system security, and the need to maintain maximum power system operational flexibility over the summer peak load period, ElectraNet has purchased and installed one of the ex-Queensland 275/132 kV transformers at Brinkworth, and this transformer is now in operation.

While the capacity of the Queensland transformers was slightly higher than needed at Brinkworth, the unit was available for immediate delivery and installation, and was purchased at a highly competitive price, which was significantly lower that that of an optimum capacity transformer.

5.0 OPTIONS CONSIDERED

5.1 Consultation Summary

The 2003 Annual Planning Review[4] identified that action would be required in the relatively short term to address impending network limitations related to supply to the Lower Flinders region of South Australia.

In April 2003 ElectraNet issued a "Request for Information" paper on the Lower Flinders power system for public consultation seeking submissions from interested parties and potential solution providers to address the projected network limitations in the region. No submissions were received in response to this request for information. This was followed in October 2003 with the publication of an Application Notice containing a draft recommendation for the reinforcement of the Lower Flinders region of South Australia. Again, as discussed in more detail in section 4.0 of this report, no submissions suggesting alternative conclusions or recommendations to those published by ElectraNet in the Application Notice were received.

5.2 Non-Transmission Options Identified

5.2.1 Existing and New Generation

A single 90 MW gas turbine powered generator is located at Mintaro, about 45 kilometres south east of Brinkworth on the Brinkworth-Waterloo 132 kV line. Two coal-fired power stations, one comprising four 60 MW generators, and the other, two 250 MW generators, are situated at Port Augusta, approximately 80 kilometres to the north of Bungama at the top of Spencer Gulf. The generators are privately owned, and dispatch is market driven.

NEM data indicates that the two 250 MW generators at Port Augusta are being operated as base-load plant, while the remaining generators at Port Augusta and the single generator at Mintaro are dispatched on an opportunity basis, typically when the electricity pool price is at higher levels. The generators at Port Augusta contribute to the supply of the Lower Flinders connection points via the 132 kV network that connects into Bungama and Brinkworth substations. However, these circuits are out of service following the operation of the emergency controls needed to prevent voltage collapse under some single contingency events. Additionally, these generators are unable to reduce the loading in the Playford-Bungama 132 kV circuits for contingencies that result in overloads on these circuits.

Consideration was given to proposals for large-scale gas fired generating plant in the vicinity of Port Pirie. However, the size of the units is such that they could only be technically connected to the 275 kV system and because of this would not impact on the 132 kV supply requirements.

No other generation alternatives that could address the identified network limitations were received in response to the initial 'Request for Information' document or the publication of the Application Notice.

Additional comments regarding the implementation of potential generation solutions are contained within section 4.1 of this Final Notice.

There is the potential for the establishment of large-scale wind generation facilities along the range of hills parallel to the coast to the south of Port Pirie. While, as discussed in the 'Request

4 Published in June 2003.

for Information' and Application Notice documents, any form of generation into the Bungama 132 kV network will have marginal impact on the projected limitations identified, it should be kept in mind by solution providers that, by their nature, wind-farms are granted special dispensation for market access, and are subject to unscheduled dispatch. The impact of these proposals has been taken into account in the scenarios presented in Section 6 of this document.

5.2.2 Demand Side Management

ElectraNet obtains electricity demand forecasts over a ten-year horizon from ETSA Utilities, South Australia's principal electricity distributor and the sole electricity distributor in the Lower Flinders area. ETSA Utilities confirms that these forecasts take into account demand management programmes in-place or proposed that may reduce the forecast demand at transmission connection points. No information was obtained from other Code Participants or Interested Parties regarding other initiatives as a result of the consultation process undertaken so far.

5.2.3 Embedded Generation

As with demand side management programmes, ETSA Utilities electricity demand forecasts take account of embedded[5] generation, either in-place, proposed, or likely to occur, that may similarly reduce the forecast demand at transmission connection points. Again, no information about initiatives was obtained from any other party during the consultation process.

5.3 Transmission Options Identified

In addition to the consultation process to identify possible non-transmission solutions, ElectraNet carried out studies to determine the most appropriate transmission network solution to address the projected limitations. Three feasible options were initially identified, details of which are contained in the next section.

5 An embedded generator connects directly to the low voltage distribution network. Output from such generators therefore reduces the expected energy that the transmission grid is required to deliver. Embedded generators may also reduce the demand the transmission grid is required to deliver, depending on their mode of operation.

6.0 FEASIBLE SOLUTIONS

This section provides an overview of the feasible options initially identified, with a full summary of the financial analysis contained in Appendix 2. In each of the options, analysis has identified that a capacitor bank will be required at Hummocks to provide voltage support in the area. However, the timing of the installation of the capacitor bank for each of the options is dependent on the accompanying transformer and/or line reinforcement, and therefore varies between options. This has been taken into account in the accompanying financial analyses (refer Appendix 2).

Option 1 - 275 kV augmentation at Bungama substation and at Brinkworth substation[6]		
Date reqd.	Proposed Augmentation	Total capital cost
November 2004	Replace the existing 60 MV.A Brinkworth transformer with a 160 MV.A unit.	$30.6M (Note 1)
November 2005	Establish a single-transformer 160 MV.A 275/132 kV substation at Bungama with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation.	
November 2009	Install a 1x18MV.Ar 132kV capacitor bank at Hummocks substation	$1.2M

Note 1: *As mentioned in Section 4.2 of this Final Notice the work at Brinkworth has had to be undertaken due to the failure of the 60 MV.A transformer, and is no longer a part of this proposed augmentation. As a consequence the initial capital cost of Option 1 is now $29.0 M.*

Option 1 proposes that a new 1x160 MV.A 275/132 kV substation be established adjacent the existing site at Bungama, and that the existing 60 MV.A transformer at Brinkworth would be disconnected and a new 160 MV.A transformer installed in the vacant transformer bay at Brinkworth substation.

At Bungama...

The layout of the new 132 kV section would be functionally identical to that of the existing substation at Bungama, except that the 132 kV lines from Playford would be replaced by supply from the proposed single 275/132 kV transformer. The existing 132 kV switchyard would be dismantled and removed. The 275 kV injection would be provided by diverting the existing Davenport-Para "west circuit" 275 kV transmission line in-and-out of the new substation. The route length of this new section of line is approximately 7 kilometres. Additional 132 kV structures would be required to facilitate the connection of existing 132 kV lines to the new substation. The Playford-Bungama and Playford-Baroota 132 kV lines would be removed from service while the existing Bungama-Baroota 132 kV line, which is adequately rated to support the Baroota connection point Agreed Maximum Demand (AMD) for some years into the future, would be retained. Contingency supply would be obtained from Brinkworth substation in the event of a 275/132 kV transformer outage at Bungama.

6 The timing of the augmentation is based on the electricity demand forecast as published in the initial consultation paper issued by ElectraNet in April 2003. The financial analysis evaluates possible variations to the timings for different load growth forecasts using the market development scenarios in section 7.0.

At Brinkworth...

The existing 60 MV.A transformer at Brinkworth was to be replaced with a 160 MV.A transformer, which would be installed in the substation's vacant transformer bay.

This development option provided increased security of supply to the Lower Flinders region by providing diversity of supply from two independent high-capacity sources. This arrangement provides for greater security and operational flexibility during construction and thereafter.

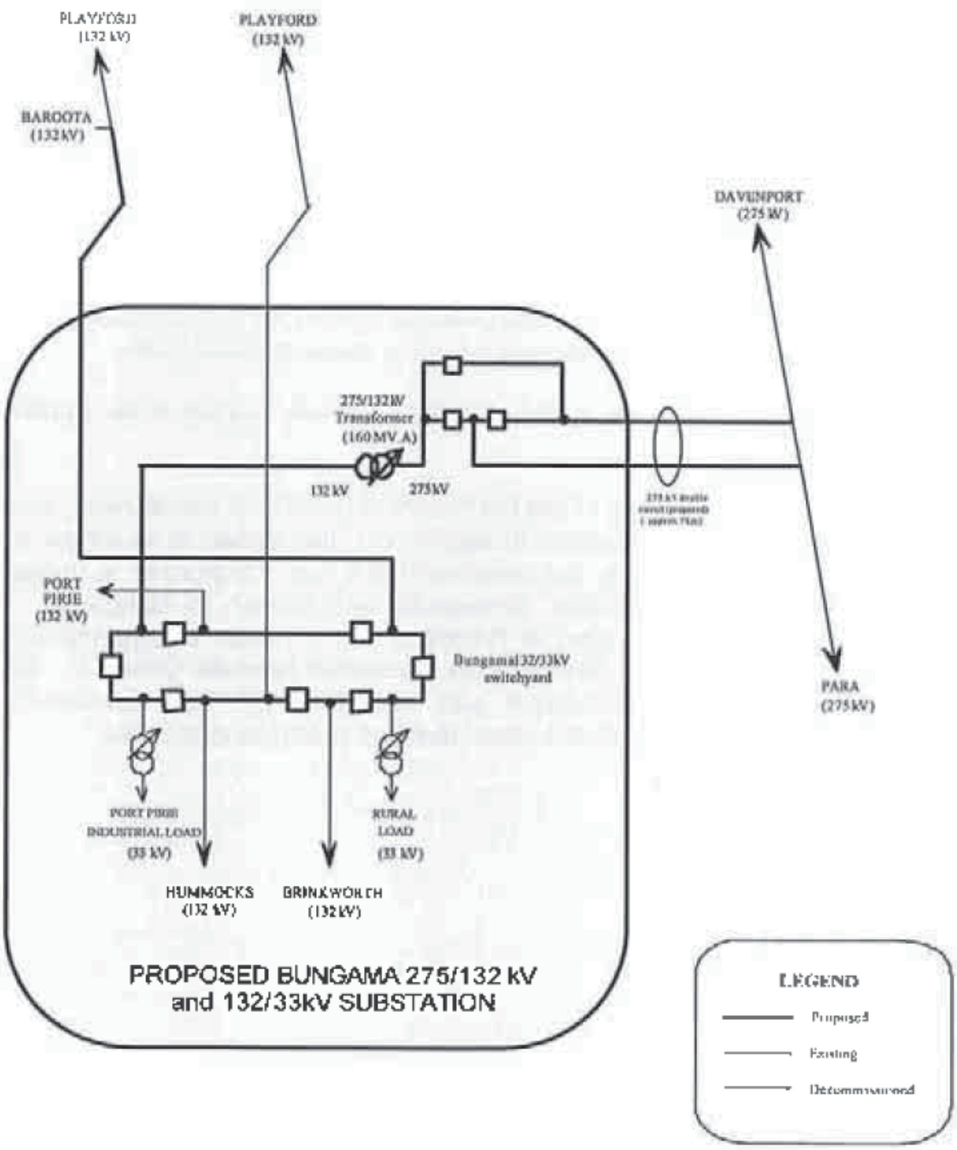
The need for reactive support in the vicinity of Hummocks substation by the summer of 2009/10 has also been identified, and while this cost does not form part of the initial establishment cost of Option 1, it has been included in the financial analysis that has been performed for the purpose of equitably comparing the various schemes over the fifteen year period of the financial studies.

Planning studies show that this option will not materially impact other transmission networks within the NEM.

Option 1

1x160 MVA 275/132kV transformer at Bungama and 1x160 MVA 275/132kV transformer at Brinkworth

(Only the Bungama portion of the proposed work has been represented in the following diagram since the work at Brinkworth simply involves the replacement of the existing transformer.)



Option 2 - 275 kV augmentation at Bungama substation[7]		
Date reqd.	Proposed Augmentation	Capital cost
November 2004	Establish a two-transformer (2x160 MV.A) 275/132 kV substation at Bungama with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation.	$31.2M
November 2011	Install a 1x18MV.Ar 132kV capacitor bank at Hummocks substation	$1.2M

Option 2 involved essentially the same modifications at Bungama as those proposed for Option 1 above, except that two 160 MV.A 275/132 kV transformers would be installed at the new Bungama substation instead of a single 160 MV.A unit. In this option, the 60 MV.A 275/132 kV transformer at Brinkworth, that as mentioned is approaching the end of its technical and economic life, would be disconnected and retired from service (but left in situ).

As with Option 1, the need for reactive support in the vicinity of Hummocks substation was identified, but for this option, the voltage support is required at the later time of summer 2011/12. While this cost does not form part of the initial establishment cost of Option 2, it has been included in the financial analysis that has been performed for the purpose of equitably comparing the various schemes over the fifteen year period of the financial studies.

Planning studies show that this option will not materially impact other transmission networks within the NEM.

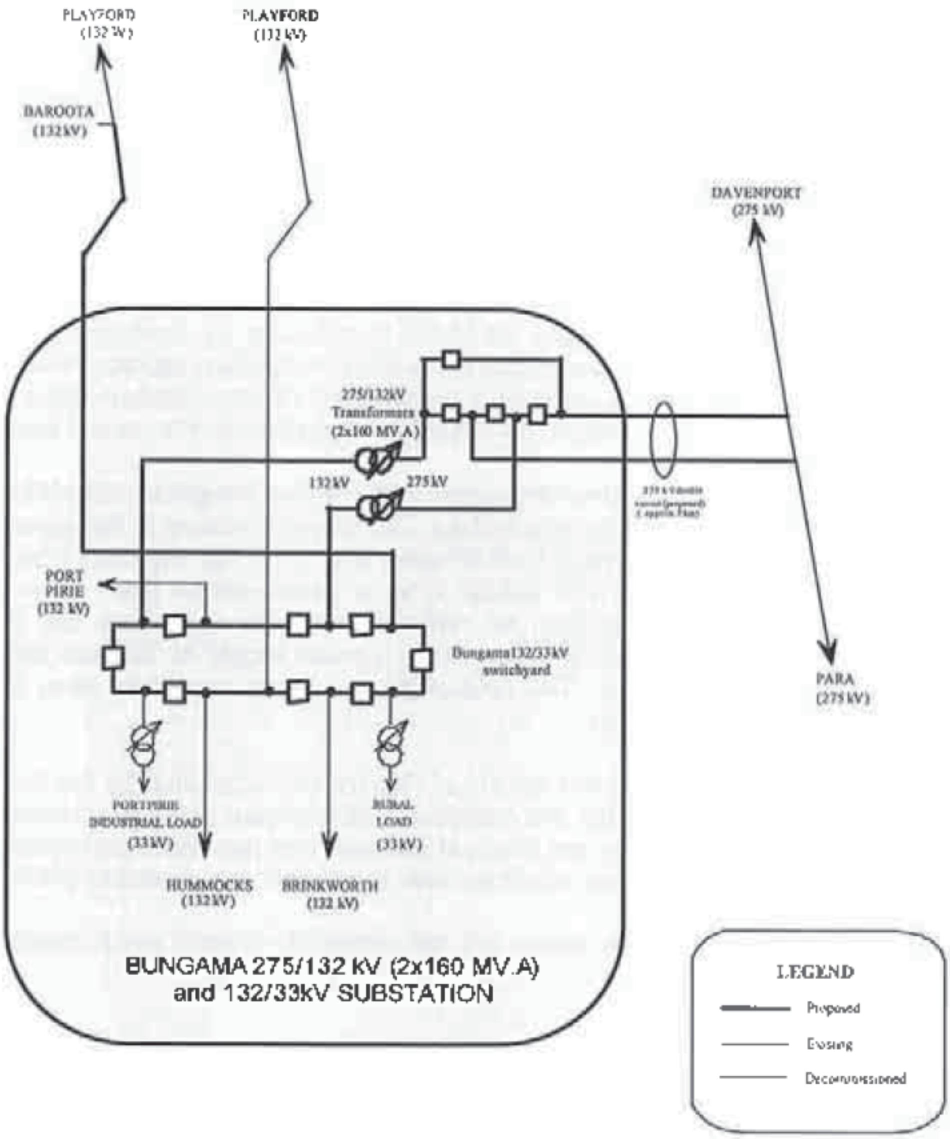
As a consequence of the failure of the Brinkworth 275/132 kV transformer, and the subsequent replacement of this unit as discussed in section 4.2, this option is no longer a practical option, because it would require not only the installation of a new transformer at Bungama, but also the relocation of the recently installed Brinkworth transformer to Bungama. Since the new transformer has had to be installed at Brinkworth as a matter of urgency for system security reasons, this unforeseen event has directed ElectraNet towards Option 1. Combined with the significant additional costs associated with relocating the new Brinkworth transformer to Bungama, ElectraNet has therefore decided that this option be discarded.

7 The timing of the augmentation is based on the electricity demand forecast as published in the initial consultation paper issued by ElectraNet in April 2003. The financial analysis evaluates possible variations to the timings for different load growth forecasts using the market development scenarios in section 7.0.

Option 2

2x160 MVA 275/132kV transformers at Bungama

(Only the Bungama portion of the work proposed for this option has been represented in the following diagram since the work at Brinkworth simply involves disconnecting the existing transformer.)



Option 3 - 132 kV augmentation between Playford substation and Bungama substation[8]		
Date reqd.	Proposed Augmentation	Capital cost
November 2004	Establish a new 132 kV substation at Bungama and construct a new dual-circuit 132 kV transmission line from Bungama to Playford to replace the existing under-rated Bungama-Playford lines.	$40.3M (Note 1)
November 2009	Install a 1x18MV.Ar 132kV capacitor bank at Hummocks substation.	$1.2M

Note 1: *As the Brinkworth transformer has been replaced already the initial capital cost of this project has now been reduced to $38.7 M*

The proposed works for Option 3 involves the establishment of a new 132 kV substation adjacent the existing site at Bungama. The layout of the new 132 kV section would be functionally identical to that of the existing substation at Bungama. The existing 132 kV switchyard would be dismantled and removed. It is proposed that the two existing 132 kV lines between Playford and Bungama be replaced by a double circuit 132 kV transmission line. This dual circuit would be constructed using 373 ACSR conductor and would be designed to operate at a conductor temperature of 80°C. The existing 60 MV.A transformer at Brinkworth would have been disconnected and retired from service (but left in situ), its function replaced with a new 160 MV.A unit to prevent overloads in the event of a contingency on the Playford-Davenport 275 kV line. The new 160 MV.A transformer would be installed in the substation's vacant transformer bay.

Because of the age and condition of the existing Playford-to-Bungama 132 kV transmission lines, these assets cannot effectively be refurbished. A complete rebuild of the assets to modern-day standards is necessary. The most cost-effective way of doing this would be to demolish the Playford-Bungama 132 kV line and rebuild it as a double-circuit line. The Playford-Baroota section of the other line would then be removed from service, while the Bungama-Baroota section of that same line would be retained to provide supply to Baroota that, as mentioned previously, is a Category 1 load. The cost of this additional work has been allowed for in the subsequent analysis of this option.

The need for reactive support in the vicinity of Hummocks substation by the summer of 2009/10 has also been identified, and while this cost does not form part of the initial establishment cost of Option 3, it has been included in the financial analysis that has been performed for the purpose of equitably comparing the various schemes over the fifteen year period of the financial studies.

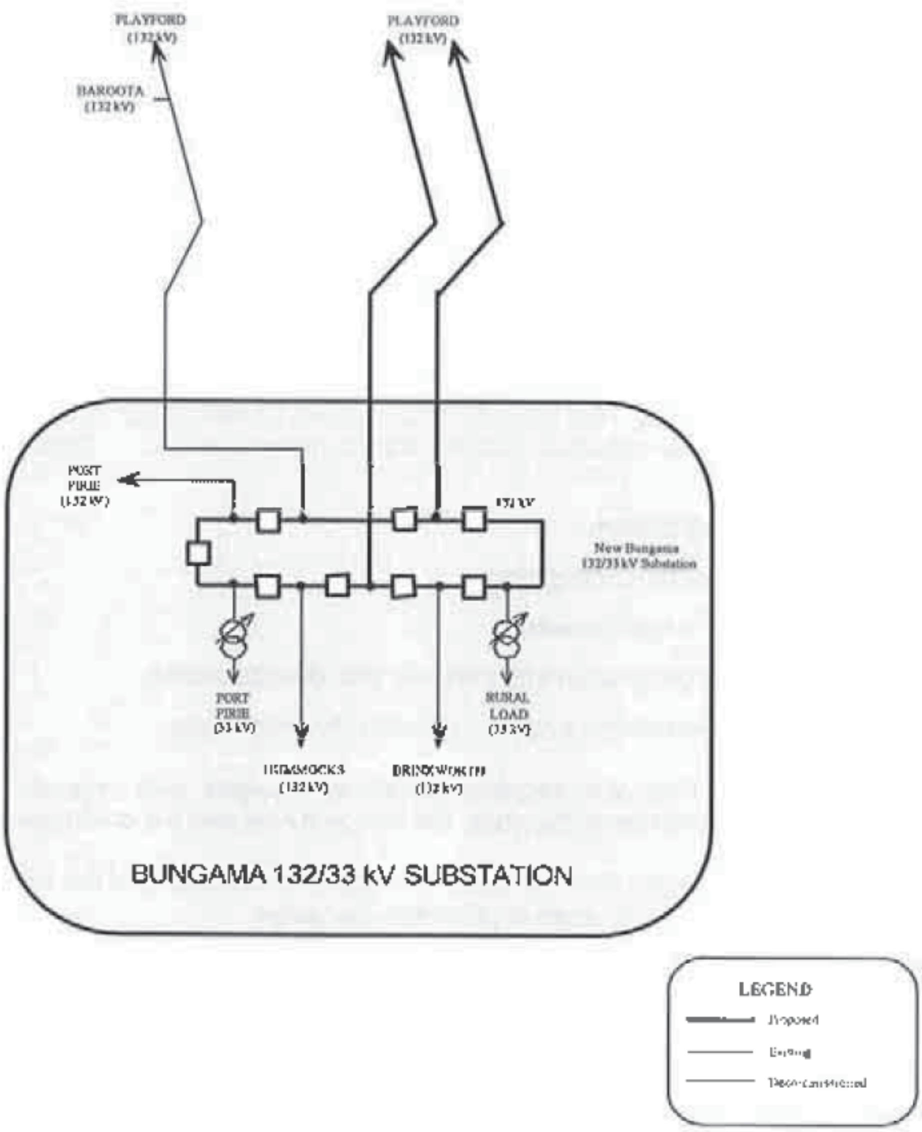
Planning studies show that this option will not materially impact other transmission networks within the NEM.

8 The timing of the augmentation is based on the electricity demand forecast as published in the initial consultation paper issued by ElectraNet in April 2003. The financial analysis evaluates possible variations to the timings for different load growth forecasts using the market development scenarios in section 7.0.

Option 3

New 132 kV substation at Bungama, dual circuit 132 kV line from Bungama to Playford, and 1x160 MV.A 275/132kV transformer at Brinkworth

(Only the Bungama portion of the work proposed for this option has been represented in the following diagram since the work at Brinkworth simply involves the replacement of the existing transformer.)



7.0 MARKET DEVELOPMENT SCENARIOS

7.1 Context for Evaluation of Options

All feasible solutions to the identified network limitations must be viewed in the context of wider developments in the NEM:

- Commonwealth legislation has been in effect since 1 January 2001 to encourage increased generation from renewable resources. ElectraNet has considered both proposed and potential levels of wind generation to connect to the Lower Flinders 132 kV transmission network when formulating relevant market development scenarios.

- NEMMCO's Statement of Opportunities (SOO) issued in July 2003 contained information on existing and committed generation developments in South Australia, an extract from which follows:

  "Victoria and South Australia: The analysis of supply and demand in Victoria and South Australia indicates that while reserves for the winter will be adequate until 2011, summer reserves fall below the minimum requirement in the coming summer. The reserve deficit is forecast to be 69 MW in summer 2003/04, and in summer 2008/09, the demand exceeds the supply side capacity."

  The proposed large network augmentation does not inhibit, but rather, would enhance, the dispatch of existing and proposed new generation.

7.2 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 Regulatory Test also requires sensitivity analysis with respect to key input variables, including capital and operating costs, the discount rate and the commissioning date.

The purpose of utilising this approach is to test the robustness of the NPV analysis of the options being evaluated under a range of plausible scenarios.

The NEC requires ElectraNet as a TNSP to analyse the expected future operation of its transmission network taking into account any Market Network Service Provider (MNSP) options (refer Clause 5.6.2 (a) of the NEC). However, as this is an intra-regional development, there is by definition no feasible MNSP development (refer Clause 2.5.2 (a) of the NEC).

7.2.1 Existing Network and Future Transmission Developments

When formulating the market development scenarios, existing network behaviour and the impact of the three proposed transmission augmentations identified in this document were taken into account. Also considered were the impact of proposed large-scale wind farm developments in the vicinity of Brinkworth substation, and the possibility of private generation at the proposed SAMAG site, just north of Port Pirie. More-detailed discussion concerning the impact of additional generation into the Bungama transmission network can be found in section 4.1 of this document. Other planned transmission augmentations are independent of the identified limitations to supply the Lower Flinders region of South Australia, and were therefore not included within the scenarios.

7.2.2 Variations in Load Growth

ElectraNet's planning studies rely on annual electricity demand forecasts provided by ETSA Utilities. These forecasts span a ten-year horizon and take into account demand management and embedded generation programmes, in-place, proposed, and anticipated, that may reduce the forecast demand at transmission connection points. ETSA Utilities confirms that the forecasts are representative of electricity usage during hot summer conditions.

The analysis of ElectraNet's transmission system in the Lower Flinders region of the State for the 10-year period from 2003 has been based on the *medium* growth forecast provided by ETSA Utilities, as this represents the most likely load growth scenario. The results of this analysis have then enabled ElectraNet to identify and assess what potential limitations may occur in meeting system reliability and security standards in accordance with the NEC and the SATC.

However, ETSA Utilities also provides two other load forecasts - high and low - to provide an *indication* of the effects of possible changes to the level of economic activity within the State. This information and the basis of the forecasts are contained in the 2003 Annual Planning Review.

Market development scenarios have been developed to consider sensitivity to variations in load growth. The scenarios used in the analysis in this report are outlined in 7.2.5.

As mentioned in Section 3.3, given the ongoing uncertainty surrounding a SAMAG proposal to establish a large-scale magnesium ore smelter approximately 12 kilometres north of Bungama, ElectraNet has assumed that this proposal has been indefinitely postponed in its analysis of the Lower Flinders transmission system.

7.2.3 Existing and Committed Generation

As outlined in the 'Request for Information' document, the network limitations are not sensitive to the level of generation at existing and committed power sources. Therefore no scenarios have been developed for differing levels of output by existing power stations.

While the limitations are sensitive to the presence of generation at Playford Power Station, all scenarios used in the Regulatory Test analysis assume 0 MW output at Playford. This represents the 'best-case' scenario, as any generation at Playford exacerbates the network limitations.

7.2.4 Potential Generation Developments

As discussed in Section 1 of this document, a number of wind-farm proponents have shown significant interest in establishing initial installations, and have forwarded conceptual plans to ElectraNet for consideration. Following assessment of the potential wind-farm developments, ElectraNet estimates that up to 160 MW of new wind generation (over 500 MW of installed capacity, equating to an average of about 160 MW of available wind generation capacity if it is assumed that the wind-farms have an availability level of 30%) could potentially be established in the area around Brinkworth, and has incorporated this scenario in its planning for the reinforcement of the Lower Flinders transmission system.

The most likely means of connection into the existing system for the wind-farm proposals tabled to-date will be at the higher voltage levels; either via the 132 kV and/or 275 kV networks. Irrespective of the voltage of connection, the most likely connection point into the existing transmission network, assuming medium to large-scale generation, would be Brinkworth substation. Referring again to the discussion provided in section 6.2.3 above, the identified shortcomings in the existing system are relatively insensitive to the level of generation into the Lower Flinders 132 kV system. However, the overall market benefit of any proposed transmission network development option will be influenced by the level of generation provided by wind-farms connecting into Brinkworth due to the impact on transmission system losses. With this in mind, alternative market development scenarios have been developed to reflect varying levels of generation attributable to the potential wind-farms.

The analysis was conducted using assumed average wind-farm generation levels into Brinkworth of 80 MW and 160 MW, in the absence of more firm information from prospective proponents at these early stages of enquiry. However, ElectraNet considers that conducting studies at these levels of assumed generation will provide sufficient indication of the effects on system losses of the presence of generation at Brinkworth.

For completeness, scenarios involving no wind generation were also included. These scenarios have been included to reflect the existing situation in the absence of wind generation, but also serve to represent sustained periods of low wind should the wind farms eventuate.

7.2.5 Market Development Scenarios

Nine market development scenarios have been developed to simulate the impact of variations in load growth while incorporating the assumptions outlined above:

Scenario A	Low load growth forecast No wind generation into Brinkworth
Scenario B	Medium load growth forecast No wind generation into Brinkworth
Scenario C	High load growth forecast No wind generation into Brinkworth
Scenario D	Low load growth forecast 80 MW wind generation into Brinkworth
Scenario E	Medium load growth forecast 80 MW wind generation into Brinkworth
Scenario F	High load growth forecast 80 MW wind generation into Brinkworth
Scenario G	Low load growth forecast 160 MW wind generation into Brinkworth
Scenario H	Medium load growth forecast 160 MW wind generation into Brinkworth
Scenario I	High load growth forecast 160 MW wind generation into Brinkworth

8.0 FORMAT AND INPUTS TO ANALYSIS

8.1 Regulatory Test Requirements

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

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... An augmentation satisfies the test if ... in the event that the *augmentation* is proposed to meet an objectively measurable service standard linked to the technical requirements of schedule 5.1 of the Code – the *augmentation* minimises the net present value of the cost of meeting those standards ... having regard to a number of alternative projects, timings and market development scenarios." To satisfy the Regulatory Test, a proposed augmentation must achieve a greater market benefit or a lower cost *in most, but not necessarily all*, credible scenarios.

The Regulatory Test contains guidelines for the methodology to be used to calculate the NPV of the market benefit and cost. For example, where an augmentation is required to satisfy minimum network performance requirements (i.e. a reliability augmentation), the methodology published by the ACCC defines "cost" as the total net cost to all those who produce, distribute and consume electricity in the NEM. 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.

8.2 Inputs to Analysis

A solution to address projected network limitations in the Lower Flinders region of South Australia as outlined in this document is required to satisfy reliability requirements linked to Schedule 5.1 of the National Electricity Code, ElectraNet's service obligations under the South Australian Transmission Code, and the requirements of the Electricity Act SA 1996[9].

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 NPV of the various options, are shown in section 8.0.

Cost inputs to the NPV analysis are described below.

8.2.1 Cost of Transmission Augmentations

The cost to implement each of the remaining feasible transmission augmentations outlined in section 5.0 of this document have been estimated by ElectraNet. Sensitivity studies have been carried out using variations in the capital cost estimates of plus and minus 15% (see section 9.3).

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9 Refer section 3.0.

The financial analysis considers all foreseeable 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 $30/MW.h. Sensitivity studies have also been carried out on the assumed cost of losses (see section 9.3).

While the financial analysis assumed that a solution had to be implemented by November 2004 to overcome the identified network limitations, the NPV analysis contains, where necessary, subsequent augmentations required to address long-term supply reliability requirements. The sensitivity of the timing of these subsequent works to load growth and generation development scenarios (and therefore the incidence of the capability expenditure) has been taken into account in the financial analysis.

9.0 FINANCIAL ANALYSIS

9.1 Description of Financial Analysis Approach

The economic analysis undertaken considered the NPV of net market benefits of the three options over the fifteen-year period from 2003/04 to 2018/19. A full summary of the results of this analysis is contained in Appendix 2.

9.2 Net Present Value Analysis

Financial analysis was carried out to calculate and compare the NPV of the costs to market participants of each of the options under the range of assumed market development scenarios.

A fifteen-year analysis period was selected for the financial analysis. ElectraNet has elected to use this period as a balance between the National Electricity Code requirement that TNSPs use a minimum planning horizon of ten years, combined with the view expressed by the Inter-regional Planning Committee (IRPC) that a planning horizon beyond ten years better reflects the long-term nature of transmission infrastructure investments.

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

Capital and operating costs for items that are common to all options were not included in the analysis. These common costs include the capital and operating costs of other future transmission works, where these costs are independent of the identified network limitations. As such, they have no impact on the relative ranking of options resulting from the analysis. 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.

It should also be noted that supporting studies are based on the medium load growth forecast supplied by the DNSP, unless stated otherwise. This level of growth is considered to represent the most likely development scenario, with the high and low load growth options less likely to occur.

Under the Regulatory Test, it is the ranking of the options that is important, rather than the actual net present value results. This is because the Regulatory Test requires the recommended option to have the lowest net present value cost under most (but not necessarily all) plausible scenarios.

The following table summarises the results of the economic analysis provided in Appendix 2. It shows the Net Present Cost of implementing each of the two options and the NPV of the two alternatives for firstly, no wind generation, then followed by what is expected to be the 'typical' level of generation provided by the wind farms (about 80 MW), and finally, for large scale wind generation (160 MW). For each of the scenarios considered, the best-ranked option is highlighted.

Discount rate 10%		Option 1 Establish a 1x160 MV.A 275/132kV substation at Bungama		Option 3 Establish a new 132 kV substation at Bungama and new dual-circuit 132kV line from Playford to Bungama	
		Net Present Cost ($M)	Rank	Net Present Cost ($M)	Rank
No wind generation into Brinkworth	Scenario A (low load growth)	$21.30	1	$28.90	3
	Scenario B (medium load growth)	$21.24	1	$28.83	3
	Scenario C (high load growth)	$21.81	1	$29.32	3
80MW wind generation into Brinkworth	Scenario D (low load growth)	$21.30	1	$28.90	3
	Scenario E (medium load growth)	$21.24	1	$28.83	3
	Scenario F (high load growth)	$21.81	1	$29.32	3
160MW wind generation into Brinkworth	Scenario G (low load growth)	$22.32	1	$28.90	3
	Scenario H (medium load growth)	$21.23	1	$28.82	3
	Scenario I (high load growth)	$20.94	1	$28.57	3

9.3 Sensitivity Analysis

In addition to examining the impact of market development scenarios, the sensitivity of the option-ranking to three other critical parameters was also examined. The following table shows the parameters that were investigated, the range over which each of the parameters was varied, and the resulting NPV and ranking of each of the three options under the stated conditions. The analysis was conducted using medium load growth and an assumed average wind-farm generation level into Brinkworth of 80 MW, as discussed previously.

Parameter incurring variation (all studies at 10%pa discount rate, DNSP forecast loads and $30/MW.h cost of losses, unless stated otherwise)	Net Present Cost ($M)			
	Option 1 Establish a 1x160 MVA 275/132kV substation at	Rank	Option 3 Establish a new 132 kV substation at Bungama and new dual-circuit 132kV line from Playford to Bungama	Rank
Discount Rate (% pa)				
7.5%	**$25.33**	1	$33.76	3
10%	**$21.24**	1	$28.83	3
12.5%	**$18.67**	1	$25.26	3
Cost of losses				
$25/MW.h	**$21.60**	1	$29.14	3
$30/MW.h	**$21.24**	1	$28.83	3
$35/MW.h	**$21.35**	1	$28.93	3
Capital Cost of project				
15% less than estimated cost	**$18.14**	1	$24.59	3
estimated cost	**$21.24**	1	$28.83	3
15% more than estimated cost	**$24.81**	1	$33.48	3

As can be seen in this table, Option 1 is the highest-ranked option under all scenarios. These sensitivity analysis results are consistent with the base case economic analysis, and demonstrate that the outcome is robust in terms of variations in the parameters assessed.

10.0 DISCUSSION OF RESULTS

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

- There is no acceptable 'do-nothing' option. The projected network limitations must be addressed as soon as possible, otherwise it will not be possible to maintain system security and reliability standards during a single contingency on the Playford-Davenport 275 kV transmission line.

- ElectraNet SA carried out the consultation process regarding the system limitations in accordance with NEC requirements, publishing the "Emerging Limitations" document in April 2003, and the "Application Notice" in October 2003, with the 30th April 2003 and 24th November 2003 as the closing dates for submissions, respectively. One submission was received.

- Two feasible network solutions were assessed. Economic analysis identified that Option 1 is the least-cost solution over the fifteen-year period of analysis under all of the scenarios considered. On this basis, augmentation comprising the establishment of a single-transformer 160 MV.A 275/132 kV substation at Bungama with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation, will satisfy the ACCC Regulatory Test.

- Sensitivity analysis showed that this conclusion was robust when considered against variations in capital cost and other factors outside of the influence of ElectraNet. Option 1 is also the highest-ranked option under all of the applicable market development scenarios.

- The "west" circuit does not incorporate an overhead earth-wire and its recorded performance during lightning storms is significantly poorer than equivalent lines with an overhead earth-wire. The recommended development features a second high-capacity supply to Bungama from Brinkworth, and therefore provides superior diversity and reliability of supply to the region.

- Dynamic stability analysis shows that Option 1 enhances network stability more than the other options considered, indicating that it is more conducive than are the other options to the installation of future generation in the area should this occur.

- In addition to minimisation of the NPV cost, the Regulatory Test requires that a TNSP optimise the timing of any proposed network augmentation that is justified under the Regulatory Test. This project must be implemented as soon as possible in order to meet the reliability standards of the SATC. The construction time for the recommended network solution will require works to commence as early as practically possible (first half of 2004) to ensure completion within the required timeframe.

11.0 RECOMMENDATION

Based on the conclusions drawn from the analysis, and with consideration for the submission received to the draft recommendation contained in the Application Notice, it is recommended that the draft recommendation be adopted with the exception of the Brinkworth transformer work, which has already been undertaken. That is, it is recommended that the following 'new large network assets' be constructed to address the projected transmission network limitations in the Lower Flinders region of South Australia:

- The establishment of a single-transformer 160 MV.A 275/132 kV substation adjacent to the existing 132 kV switchyard at Bungama, with 275 kV supply provided by diverting the Davenport-Para 275 kV "west" circuit in-and-out of the new substation. (The existing 132 kV switchyard would subsequently be dismantled and removed.)

The new 275/132 kV connection point at Bungama is required to be commissioned by November 2005.

The total cost of these new assets is estimated to be $30.6M[10].

The proposed construction timetable provides for award of equipment and construction contracts and the commencement of on-site construction in the first half of 2004, following satisfactory resolution of Development Approvals, and final commissioning by November 2005. Immediate steps will be taken to implement this recommendation.

Note : Because of the downsizing of a magnesium smelting plant in Queensland, ElectraNet was able to purchase the 275/132 kV transformer to replace the failed Brinkworth unit at a highly competitive price. While the capacity of this unit is marginally higher than that needed at Brinkworth or Bungama, the purchase price was lower than that of a new 160 MV.A unit. ElectraNet proposes to also pursue this approach for the purchase of the Bungama transformer with a view to minimising the overall capital cost of the project to the NEM.

10 *As mentioned in Section 4.2 of this Final Notice the work at Brinkworth has had to be undertaken due to the failure of the 60 MV.A transformer, and is no longer a part of this proposed augmentation. As a consequence the initial capital cost of Option 1 is now $29.0 M.*

APPENDIX 1

TECHNICAL DETAILS OF PROPOSED NEW LARGE NETWORK ASSETS

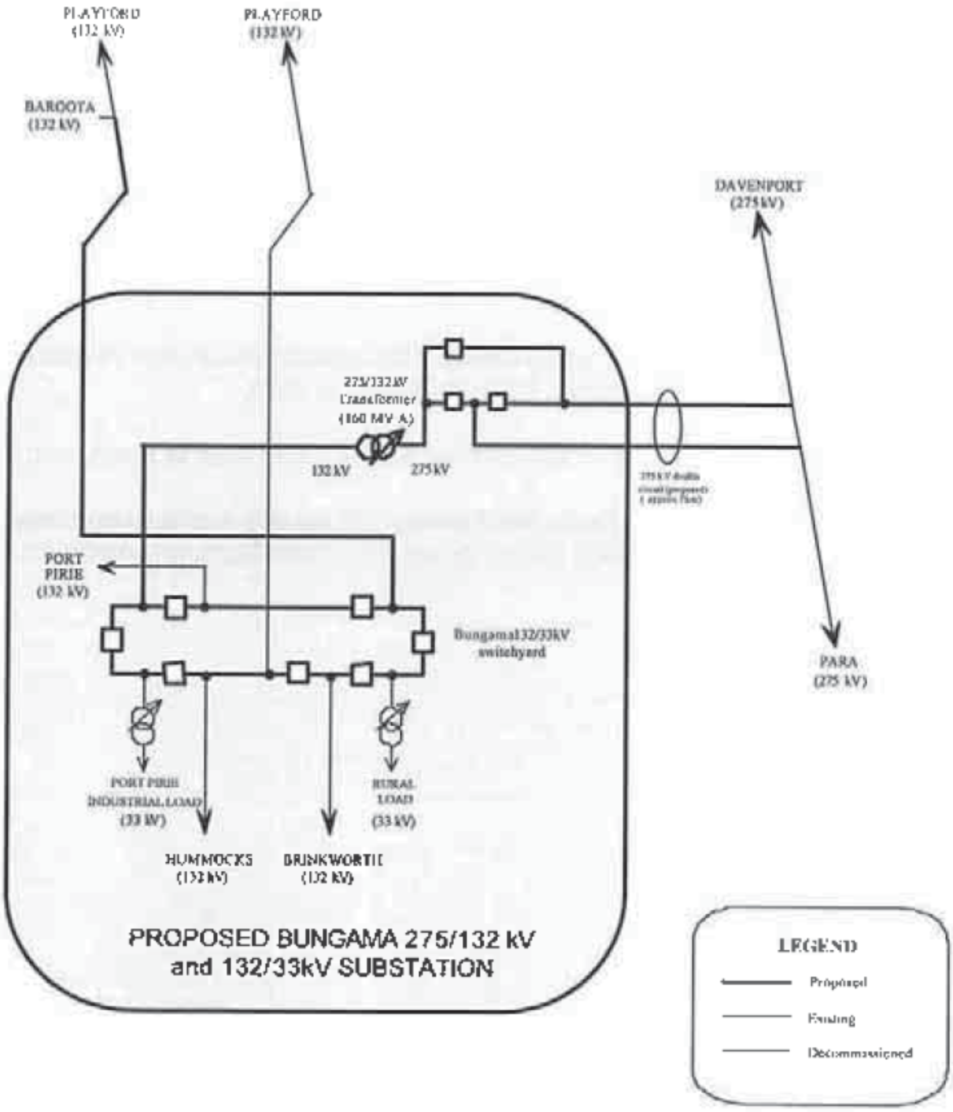
The proposed new large network assets recommended in this Final Report comprise the following works:

- The establishment of a new 275/132 kV substation containing a single 160 MV.A transformer adjacent the existing site Bungama 132/33 kV substation;
- The construction of a new 132 kV section within the new 275/132 kV substation, with the layout of the new 132 kV section functionally identical to that of the existing, aged substation at Bungama, except that supply presently derived from the Playford-Bungama 132 kV network would instead be replaced by supply from the single 275/132 kV transformer;
- The provision of 275 kV supply to the new Bungama 275/132 kV substation by diverting the existing Davenport-Para 275 kV "west" circuit in-and-out of the substation, and the construction of approximately 7 kilometres of dual-circuit 275 kV line to facilitate the re-routing of this existing line to the new substation;
- The erection of additional 132 kV structures to facilitate the connection of existing 132 kV lines to the new substation;
- The removal from service of the existing Playford-Bungama and Playford-Baroota 132 kV lines (with the easements retained for possible future use);
- The dismantling and removal of the existing 132 kV switchyard at Bungama, and;
- The retention of the existing Bungama-Baroota 132 kV line that is adequately rated to support the forecast Baroota connection point Agreed Maximum Demand (AMD) for some years into the future.

Option 1

1x160 MVA 275/132kV transformer at Bungama and 1x160 MVA 275/132kV transformer at Brinkworth

(Only the Bungama portion of the proposed work has been represented in the following diagram since the Brinkworth transformer simply involves the replacement of the existing transformer.)



APPENDIX 2

Financial Analysis Summary – Transmission Use of System (TUOS) Charges

15 Year Analysis Period

Discount rate 10%	Scenario A *Low load Growth, 0MW wind generation*		Scenario B *Medium load Growth, 0MW wind generation*		Scenario C *High load Growth, 0MW wind generation*		Scenario D *Low load Growth, 80MW wind generation*		Scenario E *Medium load Growth, 80MW wind generation*		Scenario F *High load Growth, 80MW wind generation*		Scenario G *Low load Growth, 160MW wind generation*		Scenario H *Medium load Growth, 160MW wind generation*		Scenario I *High load Growth, 160MW wind generation*	
	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank	NPV ($M)	Rank
Option 1: single transformer at Bungama	$21.30	1	$21.24	1	$21.81	1	$21.30	1	$21.24	1	$21.81	1	$21.32	1	$21.23	1	$20.94	1
Option 3: rebuild existing 132kV Playford-Bungama lines, new 132kV substation at Bungama, 160MV.A transformer at Brinkworth	$28.90	3	$28.83	3	$29.32	3	$28.90	3	$28.83	3	$29.32	3	$28.90	3	$28.82	3	$28.57	3

Development Options	Scenario A *Low load Growth, 0MW wind generation*	Scenario B *Medium load Growth, 0MW wind generation*	Scenario C *High load Growth, 0MW wind generation*	Scenario D *Low load Growth, 80MW wind generation*	Scenario E *Medium load Growth, 80MW wind generation*	Scenario F *High load Growth, 80MW wind generation*	Scenario G *Low load Growth, 160MW wind generation*	Scenario H *Medium load Growth, 160MW wind generation*	Scenario I *High load Growth, 160MW wind generation*
Option 1									
TF at Bung,	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05
18Mvar capacitor at Hummocks	11/12	09/10	07/08	11/12	09/10	07/08	11/12	09/10	07/08
Option 3									
Rebuild 132 kV line TF at Brinkworth	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05	04/05
18Mvar capacitor at Hummocks	06/07	05/06	04/05	06/07	09/10	04/05	06/07	05/06	04/05

Scenario A		Low load Growth, 0MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		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	17/18	18/19
Losses $		-0.095	-0.097	-0.100	-0.102	-0.105	-0.107	-0.108	-0.112	-0.115	-0.119	-0.120	-0.124	-0.129	-0.132	-0.135
=> NPV of Losses	-$0.83															
Total for Option 1	**$21.30**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		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	17/18	18/19
Losses $		-0.080	-0.082	-0.085	-0.087	-0.088	-0.091	-0.091	-0.094	-0.097	-0.100	-0.102	-0.105	-0.109	-0.112	-0.113
=> NPV of Losses	-$0.70															
Total for Option 2	**$28.90**															

Scenario B		Medium load Growth, 0MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		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	17/18	18/19
Losses $		-0.116	-0.118	-0.122	-0.124	-0.129	-0.131	-0.132	-0.137	-0.140	-0.145	-0.147	-0.152	-0.157	-0.161	-0.164
=> NPV of Losses	-$1.01															
Total for Option 1	**$21.24**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		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	17/18	18/19
Losses $		-0.100	-0.102	-0.106	-0.108	-0.110	-0.114	-0.114	-0.117	-0.121	-0.126	-0.128	-0.131	-0.136	-0.140	-0.142
=> NPV of Losses	-$0.87															
Total for Option 2	**$28.83**															

Scenario C		High load Growth, 0MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109	0.107	0.106
==> NPV of TUOS	$0.56															
Relative Losses		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	17/18	18/19
* Losses $		-0.067	-0.068	-0.070	-0.072	-0.074	-0.076	-0.076	-0.079	-0.081	-0.084	-0.085	-0.088	-0.091	-0.093	-0.095
=> NPV of Losses	-$0.58															
Total for Option 1	**$21.81**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		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	17/18	18/19
* Losses $		-0.057	-0.058	-0.060	-0.062	-0.063	-0.065	-0.065	-0.067	-0.069	-0.072	-0.073	-0.075	-0.078	-0.080	-0.081
=> NPV of Losses	-$0.50															
Total for Option 2	**$29.32**															

Scenario D

Low load Growth, 80MW wind generation

Option 1		**TF at Bungama and TF at Brinkworth**													
1 TF at Bungama		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	17/1
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.69
==> NPV of TUOS	$21.83														
18 Mvar Capacitor at Hummocks		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	17/1
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.11
==> NPV of TUOS	$0.30														
Relative Losses		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	17/1
* Losses $		-0.095	-0.097	-0.100	-0.102	-0.105	-0.107	-0.108	-0.112	-0.115	-0.119	-0.120	-0.124	-0.129	-0.13
=> NPV of Losses	-$0.83														
Total for Option 1	**$21.30**														
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**													
Rebuild 132 kV line		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	17/1
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.63
==> NPV of TUOS	$29.40														
18 Mvar Capacitor at Hummocks		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	17/1
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.11
==> NPV of TUOS	$0.20														
Relative Losses		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	17/1
* Losses $		-0.080	-0.082	-0.085	-0.087	-0.088	-0.091	-0.091	-0.094	-0.097	-0.100	-0.102	-0.105	-0.109	-0.11
=> NPV of Losses	-$0.70														
Total for Option 2	**$28.90**														

Scenario E		*Medium load Growth, 80MW wind generation*														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		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	17/18	18/19
Losses $		-0.116	-0.118	-0.122	-0.124	-0.129	-0.131	-0.132	-0.137	-0.140	-0.145	-0.147	-0.152	-0.157	-0.161	-0.164
==> NPV of Losses	-$1.01															
Total for Option 1	**$21.24**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		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	17/18	18/19
Losses $		-0.100	-0.102	-0.106	-0.108	-0.110	-0.114	-0.114	-0.117	-0.121	-0.126	-0.128	-0.131	-0.136	-0.140	-0.142
==> NPV of Losses	-$0.87															
Total for Option 2	**$28.83**															

Scenario F		High load Growth, 80MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109	0.107	0.106
==> NPV of TUOS	$0.56															
Relative Losses		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	17/18	18/19
* Losses $		-0.067	-0.068	-0.070	-0.072	-0.074	-0.076	-0.076	-0.079	-0.081	-0.084	-0.085	-0.088	-0.091	-0.093	-0.095
=> NPV of Losses	-$0.58															
Total for Option 1	$21.81															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		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	17/18	18/19
* Losses $		-0.057	-0.058	-0.060	-0.062	-0.063	-0.065	-0.065	-0.067	-0.069	-0.072	-0.073	-0.075	-0.078	-0.080	-0.081
=> NPV of Losses	-$0.50															
Total for Option 2	$29.32															

Scenario G		Low load Growth, 160MW wind generation														
Option 1		TF at Bungama and TF at Brinkworth														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.146	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		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	17/18	18/19
Losses $		-0.093	-0.095	-0.098	-0.099	-0.103	-0.105	-0.106	-0.110	-0.112	-0.116	-0.118	-0.122	-0.126	-0.129	-0.132
=> NPV of Losses	-$0.81															
Total for Option 1	$21.32															
Option 3		Rebuild 132 kV lines + TF at Brinkworth														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116
==> NPV of TUOS	$0.20															
Relative Losses		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	17/18	18/19
Losses $		-0.080	-0.082	-0.085	-0.087	-0.088	-0.091	-0.091	-0.094	-0.097	-0.100	-0.102	-0.105	-0.109	-0.112	-0.113
=> NPV of Losses	-$0.70															
Total for Option 2	$28.90															

Scenario H		Medium load Growth, 160MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		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	17/18	18/19
* Losses $		-0.117	-0.119	-0.123	-0.125	-0.130	-0.132	-0.133	-0.138	-0.141	-0.146	-0.148	-0.153	-0.159	-0.162	-0.166
=> NPV of Losses	-$1.02															
Total for Option 1	**$21.23**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112
==> NPV of TUOS	$0.30															
Relative Losses		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	17/18	18/19
* Losses $		-0.101	-0.103	-0.107	-0.109	-0.112	-0.115	-0.115	-0.119	-0.122	-0.127	-0.129	-0.133	-0.137	-0.141	-0.143
=> NPV of Losses	-$0.88															
Total for Option 2	**$28.82**															

Scenario I		High load Growth, 160MW wind generation														
Option 1		**TF at Bungama and TF at Brinkworth**														
1 TF at Bungama		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	17/18	18/19
=> TUOS		1.893	3.220	3.177	3.133	3.089	3.046	3.002	2.958	2.915	2.871	2.828	2.784	2.740	2.697	2.653
==> NPV of TUOS	$21.83															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109	0.107	0.106
==> NPV of TUOS	$0.56															
Relative Losses		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	17/18	18/19
* Losses $		-0.167	-0.170	-0.175	-0.179	-0.185	-0.188	-0.190	-0.197	-0.202	-0.208	-0.212	-0.218	-0.227	-0.231	-0.236
=> NPV of Losses	-$1.45															
Total for Option 1	**$20.94**															
Option 3		**Rebuild 132 kV lines + TF at Brinkworth**														
Rebuild 132 kV line		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	17/18	18/19
=> TUOS		2.550	4.337	4.279	4.220	4.161	4.102	4.044	3.985	3.926	3.867	3.809	3.750	3.691	3.632	3.574
==> NPV of TUOS	$29.40															
18 Mvar Capacitor at Hummocks		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	17/18	18/19
=> TUOS		0.000	0.000	0.000	0.000	0.000	0.072	0.122	0.121	0.119	0.117	0.116	0.114	0.112	0.111	0.109
==> NPV of TUOS	$0.42															
Relative Losses		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	17/18	18/19
* Losses $		-0.144	-0.147	-0.152	-0.156	-0.159	-0.164	-0.164	-0.169	-0.174	-0.181	-0.184	-0.189	-0.196	-0.201	-0.204
=> NPV of Losses	-$1.25															
Total for Option 2	**$28.57**															